Decision-making in Technology Adoption: The Case for Industrialised Building Systems (IBS) in the Malaysian Construction Industry

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

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DECLARATION

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11 August 2014

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Sharifah Akmam Syed Zakaria Date

Specially dedicated to:

My husband Dr. Ir. Hardiman, M.Sc

for his love, understanding and support

and

my lovely daughter

Wan Rania Azillah

for her patience, love and affection.

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ABSTRACT

Shifting from conventional construction to Industrialised Building Technology (IBS) aims to increase productivity and quality, decrease labour shortages and improve working conditions. Policy approaches have thus concentrated on providing tailored information to encourage IBS technology adoption and to assist IBS decision-making. This research addresses the gap in the understanding of decision-making as a phenomenon in the context of IBS technology adoption, using a qualitative exploratory approach underpinned by an interpretative phenomenological paradigm. It specifically focuses on developing an understanding of how emerging contextual factors (e.g. government policy), structural factors (e.g. project organisation and management factors) and behavioural factors (e.g. human-related matters) influence IBS decision-making.

The role decision makers play in the adoption of IBS technology is increasingly gaining attention, particularly in the context of the pace at which this technology is implemented in the construction industry. In this context, a holistic conceptual framework is constructed and it is analysed through a qualitative multiple- perspective approach encompassing inter-project and intra-project perspectives in the Malaysian construction industry. The inter-project perspective is explored through semi-structured face-to-face interviews with a group of construction-profession stakeholders. The intra-project perspective is explored through three case studies each composing of a group of supply-chain members in IBS building projects with relevant archival data. It was found that structural, contextual and behavioural factors impacted on IBS decision-making in a hierarchical way according to the degree of influence of each factor, with structural factors being the most relevant and dominant.

This research also highlighted the important implications of structural, contextual and behavioural factors for IBS decision-making and discovered that although construction-profession stakeholders and the supply-chain members of IBS projects identified similar factors as influencing IBS decision-making, they perceived the importance of these factors differently. From the findings, this research has generated a major IBS decision-making model with facets or manifestations of the same basic model as it is essential to recognise the complex range of factors associated with IBS decision-making.

This research provides insight into the decision-making of IBS technology in building projects as a means to shift from conventional building methods to a modern building technology which can lead to sustainable construction practice. Hence, by identifying influencing factors on IBS decision-making in construction, supports could be made in terms of better understanding and facilitating, where relevant, the greater use of IBS technology in the construction industry so as to ensure sustainability. Finally, contributions to the literature and research methodology, besides research limitations and areas for further research, were discussed.

Key words: decision-making, industrialised building systems (IBS), building projects, construction industry.

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LIST OF ABBREVIATIONS

A/E/C	Architectural, Engineering or Construction
BIM	Building Information Modelling
C&D	Construction & Demolition
CIDB	The Construction Industry Development Board of Malaysia
CIMP	Construction Industry Master Plan
CREAM	Construction Research Institute of Malaysia
IBS	Industrialised Building System
ICF	Integrated Conceptual Framework
IPA	Interpretative Phenomenological Analysis
IT	Information Technology
MMC	Modern Method of Construction
MS	Malaysian Standard
NEM	National Economic Model
NVivo	NUD*IST (Non-numerical Unstructured Data Indexing Searching and Theorising) Vivo
OSP	Off-Site Production
PWD	Public Works Department
S&P	Standardiszation and Pre-assembly
STUCONBEH	Structural-Contextual-Behavioural
UK	United Kingdom
USA	United States of America
WTO	World Trade Organization

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LIST OF PUBLICATIONS

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1. Zakaria, S. A. S., Brewer, G., & Gajendran, T. (2013). *Decision-making of Industrialised Building System: A Supply Chain Perspective on the Influence of Behavioural Economic Factors,* In *IAENG Transactions on Engineering Technologies* (pp. 767-779). Springer Netherlands.

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I hereby certify that the work embodied in this thesis contains a published paper/s/scholary work of which I am a joint author.

Sharifah Akmam Syed Zakaria	**Dr. Thayaparan Gajendran (Main Supervisor)**	**Associate Professor Dr. Graham Brewer (Co-supervisor)**

CHAPTER 1 - INTRODUCTION

1.1 Chapter Structure

Industrialised Building Systems (IBS) can be defined as the application of modern systemised methods of design, production planning and control with intensive utilisation of various precast elements as well as mechanised and automated manufacturing processes, as an organised entity with defined relationships (Sarja, 2003). IBS is also known as the prefabrication, precast, off-site, modularisation and modern-method construction, manufacturing or process of building methods. This research is about exploring the decision-making of IBS technology adoption and its influencing factors in building projects, with specific focus on the Malaysian construction industry.

Chapter 1 presents an introduction to the research and intends to outline the key concepts that guide the study. This chapter provides a background to the topic (section 1.2), research and knowledge gap (section 1.3) and specifies the research problem and conceptualisation (section 1.4). The research aims and objectives are stated in section 1.5. Section 1.6 outlines the methodological approach of this research. The research process and related tasks are outlined in section 1.7 which also presents a flow chart linking the objectives to the thesis chapters. The justifications and scope of the research are highlighted in sections 1.8 and 1.9 respectively, while section 1.10 provides further detail on the organisation and content of each thesis chapter. Section 1.10 concludes Chapter 1.

1.2 Background

Adoption of IBS technology has allowed the construction industry to achieve remarkable productivity gains. IBS technology is now one of the prevalent and growing building technologies in developed and developing countries (Blismas et al., 2010; Dulaimi et al., 2002; Raji, 2013; Yu et al., 2012). Besides the successful outcomes of the adoption of IBS technology, its slow take-up prevents any real efficiency to be leveraged across the construction industry. In the case of the Malaysian construction industry, building projects tend to be laggards in adopting IBS technology.

Despite a good track record in IBS and the recent introduction of IBS benchmarks i.e. minimum of 70% IBS in all construction projects, the industry as a whole remains quite reluctant to exploit the use of IBS (CIDB, 2009). This reluctance is particularly evident among many small contractors who prefer the use of conventional systems of construction due to their familiarity with such methods (Idrus et al., 2008; Mohamad et al., 2009).

Various other socio-economic and project-related factors have also been identified as significant influencing factors in the Malaysian construction industry and subsequently impacting on the adoption decisions of IBS technology (Abdullah and Egbu, 2010a; Kamar et al., 2012; Taherkhani et al., 2012). Generally, in the construction industry, the IBS technology decision is considered in a building project for the fulfilment of the project's specifications or based on clients' requirements (Blismas, 2007; Boyd et al., 2012; Goulding et al., 2012b; Mohamad et al., 2012; Pan and Gibb, 2009; Pan et al., 2008b).

Factors influencing IBS adoption may not only relate to the technological issues. For example, the ultimate decision outcome is subject to the dynamics and changes in the projects per se and their environments (de Azevedo et al., 2012; Nieto-Morote and Ruz-Vila, 2012), the perceived effectiveness of the implementation process in other past/current projects (Marques et al., 2011; Robichaud and Anantatmula, 2010; Tupenaite, et al., 2010; Williams and Samset, 2010), and the processes and information utilised up to the point at which the decision is made (Azhar, 2011; Sacks et al., 2010a; Scherer and Schapke, 2011).

Adoption of IBS technology is embedded in appropriate and effective IBS decision-making processes which involve complex, consultative, integrative, regulative, long-term and incremental processes in nature (Chiang et al., 2006; Goodier and Gibb, 2007; Rashid, 2009; Yunus and Yang, 2012). Tools dominated by technical viewpoints have long been used, primarily in the project-development phase, for making decisions on IBS technology adoption, which emphasises their focus on the technical aspects of design and build-ability (Blismas et al., 2005; Imbeah and Guikema, 2009; Legrand et al., 2004; Pavitt and Gibb, 2003; Soetanto et al., 2006a; Yang et al., 2003). However, the dynamic and unpredictable nature of economic and political systems impacting on the construction industry (Awuzie and McDermott, 2013; Harris and McCaffer, 2013; Myers, 2013; Rose and Manley, 2010), continues to make optimised IBS technology adoption decisions more challenging.

The complex decision-making process related with IBS technology adoption leads to need to explore IBS decision-making approach to further understand the associated issues. Decision-making in technology adoption can be considered as one of the fundamental processes for implementing a building technology in project development (London et al., 2010; Lutz et al.,1990; Pan et al., 2012a) as technology decisions affect the long-term growth of the construction industry (Eastman and Sacks, 2008; Ortiz et al., 2009; Taylor, 2010). This has long been acknowledged by early scholars in the discipline of management decisions, such as Herbert Simon (1959; 1972; 2000), George Huber (1980; 1981; 1984), Kathleen Eisenhardt (1989; 1999) and Charles Lindbloom (1961; 1965; 1979) who all developed the groundwork of decision-making practice with some insights into the decision-making styles of individual decision makers as well as that of organisations. These decision-making theories emerged to assist with problem solving, specifically in an increasingly dynamic, complex and uncertain environment for managing construction projects (Collyer et al., 2010; Fellows, 2010; Fewings, 2013; Kaplinski and Tamosaitiene, 2010).

In this context, this research investigates the deployment of IBS through studying the decision-making approach embraced by the construction professionals (Thanoon et al., 2003; Rahman and Omar, 2006); exploring their perception towards IBS decision-making and how their decisions to adopt IBS technology are influenced by various factors. Therefore, the research aims to discover the factors that impact on the decision-making of IBS technology adoption in the construction industry. The study is focused on the overall nature of IBS adoption decision-making but does not delve into the decision-making-associated IBS issues in each stage of a construction project.

This study adopts an exploratory method based on the multiple-perspective of decision makers from an inter-project perspective of a group of construction-profession stakeholders and an intra-project perspective with the group of supply chain members in IBS projects, to study the influence of contextual, structural and behavioural factors on IBS decision-making through multiple-case studies using an interpretative phenomenological analysis (IPA). The exploratory approach is useful when trying to explain little-understood phenomena or previously-not- researched areas and to identify or discover important categories of meaning (Maxwell, 2012).

This research reflects on the application of interpretative phenomenological analysis as one particular approach to qualitative research. The IPA in the qualitative research is based on the approach used in psychology research but is increasingly being picked up by those working in cognate disciplines in the human and social sciences (Smith et al., 2009). It presents the theoretical underpinnings of the qualitative approach (Creswell, 2012).

Additionally, IPA is strongly idiographic, starting with the detailed examination of one case until some degree of closure or 'gestalt' has been achieved, then moving to a detailed analysis of the second case, and so on through the amount of cases (Smith, 2004). According to Starks and Trinidad (2007), phenomenological analysts seek to capture the meaning of common features or essences of an event which are subjective and knowable only through embodied perception. As a new and developing approach of phenomenological inquiry, IPA provides a clear set of thorough and accessible guidelines (Cope, 2011).

1.3 Research and Knowledge Gap

There has been much work carried out within the realms of decision-making in the construction industry, examining how people actually do make decisions on building-technology adoptions. Much of the interest, within the construction industry, has centred on promoting the development and use of decision analysis (Abdelgawad and Fayek, 2011; Cambraia et al., 2010; Ng and Bjornsson, 2004; Zavadskas et al., 2012) or normative approach in building-technology decisions (Natee et al., 2013; Zavadskas et al., 2009). These set down how decision makers ideally make IBS decisions in building projects, that are consistent with project objectives (Hedgren and Stehn, 2013;

Smith et al., 2010; Tatum, 2010) and perceive the influencing factors of IBS decision-making (Chen et al., 2010b; Nadim and Goulding, 2010; Pan et al., 2012a).

Therefore, the understanding of human decision-making processes has been a fundamental initiative for the construction industry (De Bruijin et al., 2010; Love et al., 2013b; Ng et al., 2012c; Ng et al., 1999; Ning et al., 2011), as well as the focus of applied research across disciplines such as economics, business, psychology and management (Dainty, 2008; Kent and Becerik-Gerber, 2010; Kim et al., 2009a; Levitt, 2007; Senaratne and Sexton, 2008; Ulubeyli and Kazaz, 2009). Meanwhile, Aritua et al. (2009), Hallowell and Gambatese (2009), Kaklauskas et al. (2007) and Pinto et al. (2010) argue that one of the limitations of decision-making and judgement research is its reliance on quantitative and technical data. As these studies have shown, in the course of decision-making, individuals are likely to rely on a variety of data and numerous different decision-making tools in complex construction environments. In such a situation, it appears reasonable to expect individuals to rely on quantitative and qualitative data because such data options are socially and structurally normalised across all contexts.

Various researches have been committed to IBS decision-making and its processes in the pursuit for an improvement and development of new models that can lead to better-quality decisions and optimised results (Blismas et al., 2006; Chen et al., 2010a; Faludi et al., 2012; Holton et al., 2010; Zavadskas et al., 2010b). This has encouraged other researchers to explore new avenues to better understand the complexity of IBS decision-making in order to discover appropriate solutions to some persistent IBS issues (Abdullah and Egbu, 2010a; Ern and Kasim, 2012; Gibb and Isack, 2001; Ko and Wang, 2010; Lou and Kamar, 2012; Pan et al., 2012b). While some studies provide a useful insight into common barriers to IBS adoption, they generally do not explore the decision-making involved in adopting IBS (or not) and how this is influenced by the contexts (e.g. economic, technological, legal) and structural (e.g. project, procurement) in which it is undertaken.

Therefore from a theory perspective there is limited research into the decision-making of IBS technology adoption from a holistic concept with multi stakeholder perspectives. Moreover, building and construction has been criticised for lacking technological adoption (Aouad et al., 2010a; Arif and Egbu, 2010; Bell and Figueiredo, 2012; Blayse and Manley, 2004; Manley and Kajewski, 2011), warranting further understanding of the issues associated with the decision-making process. From an industry-practice perspective, as governments including the Malaysian Government, begin to impose IBS technology, a better understanding of the decision-making process for effective IBS adoption is needed. Hence, a key to unlocking the potential of IBS technology adoption in building projects depends on exploring the approach and factors influencing IBS decision-making through a holistic framework using qualitative data and encompassing multiple stakeholder perspectives.

1.4 Research Problem and Conceptualisation

IBS building projects' under-performance in the construction industry (Haller and Stehn, 2010; Vernicos et al., 2011), the failure of many IBS technology adoptions to return the expected results (Ceylan et al., 2010; Yee and Siti, 2012) and the slow uptake of IBS technology adoption in building projects (Abdullah and Egbu, 2010b; Kent and Becerik-Gerber, 2010; Ofori et al., 2011) have led to a growing interest in:

a) Understanding the decision-making of IBS technology adoption which emerged in building projects: i.e. the decision-making associated with IBS technology adoption as a dynamic, complex and multifaceted phenomenon. This is established by examining various issues underpinning the two key variables "decision-making" and "IBS technology adoption".

b) How different factors impact on the decision-making of IBS technology adoption; including contextual, structural and behavioural factors as key concepts influencing IBS decision-making. Based on the literature review and from investigations into the perceptions of decision-making, technology adoption and IBS, it is identified that these three major factors, which accounted for the decision-making of IBS technology adoption.

The last decade has seen the growth of the construction industry. This has impacted on the construction management discipline, causing the rise of non-technical studies in project management as an important discipline (Akadiri and Olomolaiye, 2012). The growing need to cope with faster, on time, building-project completion while maintaining the required quality levels, has reinforced the importance of IBS technology adoption in building projects (Arif and Egbu, 2010; Nadim and Goulding, 2010). Against the background of decision-making complexities in the construction industry despite building-technology advancements, the research attempts to examine decision-making that may contribute to the exploration and understanding of IBS adoption behaviour. This thesis focuses specifically on IBS decision-making.

Naturally, decision-making is a human process (Bouyssou et al., 2013) and it is therefore important to identify those who are involved in the decision-making process of IBS technology adoption. IBS decision-making has resulted in a growing awareness of the need to understand its approaches and processes in building projects overtime (Chen et al., 2010a; Demiralp et al., 2012; Engström and Hedgren, 2012; Pan et al., 2012a). For the purpose of this thesis, IBS decision-making can be defined as the process of deciding on the adoption of IBS technology in a building project, based on a set of important factors such as contextual, structural and behavioural factors after considering possible alternatives in order to achieve project objectives that will enhance the project outcomes in a dynamic and competitive construction environment.

Contextual factors can be defined as any characteristics, situations, forces or circumstances that may exist outside a building project that have the probability of influencing IBS decision-making. These factors include economy (Chen et al., 2010a), socio-economy (Blismas, 2007), sustainability (Chen et al., 2010b; Yunus and Yang, 2011), environment (Jaillon et al., 2009), technology productivity (Eastman and Sacks, 2008), technology (Ergen et al., 2007), policy (Park et al., 2011) and innovation (Blismas and Wakefield, 2009b; Pan et al., 2007; Pan et al., 2008a).

The structural factors are the ones that include issues or concerns vital to a building project's operating activities. These factors have implications for building-project management mechanisms and have the potential to influence IBS decision-making. These factors include risk (Kim et al., 2012), management (Ismail et al., 2012), design (Faludi et al., 2012), project (Nadim and Goulding, 2009) and cost (Pan et al., 2007). Meanwhile, behavioural factors that are influencing IBS decision-making involve cognition (Xue, 2010), culture (Smith, 2011) and perception (Blismas and Wakefield, 2009a; Goodier et al., 2010).

The behavioural factors are human-related aspects that define how people behave within the context of a decision-making setup. These could include factors such as attitude, learning, information processing, rationality, experience and awareness which were also identified as influencing IBS decision-making in building projects. In the Malaysian construction industry, although there is a limited number of human-related studies in IBS technology adoption, the impacts of human-related factors are relevant and significant such as research on knowledge management (Abdullah and Egbu, 2010a); skills and knowledge (Nawi et al., 2011), readiness (Ern and Kasim, 2012), experience and mind-set (Thanoon et al., 2003), acceptance (Majid et al., 2011) and awareness (Kassim and Walid, 2013). Meanwhile, behavioural factors or human-related aspects which have been specifically studied under the topics of attitude, awareness, rationality or bounded rationality and experience are also relevant in construction management studies (e.g. Acar and Goc, 2011; Love et al., 2005; Turskis and Zavadskas, 2011; Walker, 2011; Yousefi et al., 2010).

However, it is not clear in the literature what role and influence contextual, structural and behavioural factors play in the decision-making of IBS technology adoption and whether IBS decision-making always follows a particular pattern, i.e. whether it is rational or irrational, systematic or matrix style, centred or dispersed. Moreover, it is also important to determine the most influencing and the least influencing factors on IBS decision-making in a hierarchical way. Literature review showed lack of studies on what the group of construction-profession stakeholders and group of supply-chain members in IBS projects, consider the ways of various factors influence IBS decision-making. In order to investigate the association of contextual, structural and behavioural factors with IBS decision-making, the following question have been formulated to guide this research and to support the investigation:

How do contextual, structural and behavioural influences impact on the decision-making of IBS technology adoption?

The above question will explore how IBS decision-making is influenced by the integration of contextual, structural and behavioural factors as perceived by the group of construction-profession stakeholders and group of supply-chain members in IBS projects, involving professions such as design architect, surveyor, developer, consultant, contractor, project manager, civil engineer, manufacturer and client.

1.5 Research Aims and Objectives

This thesis examines the divergence in perceptions of influencing factors on IBS decision-making by the group of construction-profession stakeholders and the group of supply-chain members in IBS projects, based on a holistic concept and the multi-perspective approach of decision-making applied in the practical sense of building projects in the build environment.

The thesis then aims to:

Explore the impact of contextual, structural and behavioural factors on IBS technology adoption through the premonition of decision-making using a multiple-perspective approach.

The research objectives are:

a) First, to review literature from multiple disciplines, primarily from mainstream management and construction management, on decision-making and the factors influencing the decision-making of IBS technology for the purpose of developing a theoretical framework.

b) Second, to develop a theoretical research framework to explore the decision-making phenomenon focused in the context of IBS adoption in building projects.

c) Third, to develop a research methodology in exploring the decision-making of IBS technology adoption and its influencing factors, using a holistic concept from the multiple-perspective of decision makers based on an interpretative phenomenological analysis.

d) Fourth, to explore the influencing factors that impacted IBS decision-making, using primary data collected from the group of construction- profession stakeholders and the group of supply-chain members in IBS projects.

e) Fifth, to verify how various influences have impacted the decision-making of IBS technology adoption based on an integrated data analysis and results.

f) Sixth, to generate a more integrated framework or models of IBS decision-making in terms of key decision criteria with the integration of IBS technology adoption, focusing on IBS requirements and current practice in project and non-project environments and other problems of consequence in IBS implementation.

g) Lastly, to integrate the overall research and draw its components together in order to present the conclusions, research significance, contributions and recommendations.

1.6 Methodological Approach

Originally grounded in the management science during the 1990s (Dyer et al., 1992; Staw and Ross, 1978), the multiple-perspective approach for problem solving and decision-making was a fundamental outlook of the holistic view for complex decision-making in dynamic industries (Alanne and Saari, 2004). A multiple perspective approach in decision-making provides the outlooks through which one can find ways to evaluate and balance diverse standpoints with differences in views and various people involvement (Maxwell, 2012; Schneider and Shanteau, 2003). It reveals and develops a synthesis of worldview, rather than adopting the limited view of a single perspective (Courtney, 2001).

The holistic concept in decision-making research offers one such avenue. Most research scholars would agree, a holistic concept is a new, distinct concept, worthy of being a research model and relevant in practice (Abdalla and Ebeid, 2011; Fiss, 2011; Hesse- Biber and Leavy, 2010; Hurt, 2008; Ostrom et al., 2010; Smith et al., 2009a; Teddlie, 2009). As evidenced by a number of studies attempting to explore decision-making, researchers generally adopt a holistic and systemic approach (Arquette et al., 2002; Child, 2012; Dane and Pratt, 2007; Savory and Butterfield, 1998; Weber and Borcherding, 1993), as opposed to particularistic and functional outlook (Colignon and Covaleski, 1993), not just on what decision makers do, for example what major considerations they make to decide and serve needs in market spaces, but also on how they do it, for example how they associate product characteristics and their market factors in serving customers' needs and market demands.

Accordingly, by considering both IBS decision processes and their influences based on a holistic concept, it becomes possible to deal with the complexity of project decisions (Arquette et al., 2002; Chapman and Ward, 2007; Kumaraswamy and Dissanayaka, 2001).

Moreover, a holistic concept can lead to better understanding of an entire decision process by examining it from a general but integrative nature (Courtney, 2001; Saaty, 2001; Sinclair and Ashkanasy, 2005) to explore the ambiguities of human decision-making in IBS technology adoption, such as those discovered in the dynamic setting of the construction industry (Al-Bazi and Dawood, 2010; Azimi et al., 2011; Engström and Hedgren, 2012; Tuuli et al., 2010).

Complexity and uncertainty in the decision-making of building technology adoption like IBS have been an important concern of construction management and many contemporary researchers have followed various decision-making approaches using quantitative and qualitative models (Antunes and Costa, 2011; Gibb, 2001; Hashemi, 2006; Pan et al., 2008a) in the attempt to simplify and understand an intrinsically complex and unclear IBS decision-making process (Pan et al., 2012a).

Approaches to involving behavioural or human-related factors in IBS decision-making tend to treat behavioural aspects uniformly in using the holistic concept of involving socio-economic, technical, managerial, institutional and political contexts within which IBS decisions are made. This investigation brings insights into the decision-making of IBS technology adoption that enabled building projects to not only cope with technological innovation, but also to improve their competitive positions in the construction industry.

In recognition of the fact that various project decisions are made by a number of individuals, based on their field of expertise, one group of construction- profession stakeholders, representing an inter-project perspective and another group of supply-chain members in IBS projects, representing an intra-project perspective, were targeted to participate in the interviews. The group of supply-chain members in IBS projects comprises of three selected building projects. Each of the project comprises of design architect, surveyor, developer, consultant, contractor, project manager, civil engineer, manufacturer and clients as they able to contribute their opinions based on multiple-perspective background, expertise, experience, knowledge and skills which fits the multiple-perspective approach of decision-making.

The construction-profession stakeholders' involvement, role and opinion in decision-making are increasingly regarded as a useful contribution (Newcombe, 2003; van de Kerkhof, 2006), and this contribution is increasingly being used by proliferating environmental interest and pressure groups (Ding, 2008; Kiker et al., 2005). According to Gibb and Isack (2003) and Vrijhoef and Koskela (2000), by involving stakeholders in the decision-making process, it is argued that the quality and durability of decisions are likely to be greater.

The data collection from the construction-profession stakeholders' perspective and project case studies on the supply-chain members of IBS projects, enables a multiple-perspective approach to be established. The application of a multiple-perspective approach shows that each perspective yields insights on a matter, based on different perceived realities of people (Linstone, 1989). The approach of a traditional single-criterion perspective has so far not been able to adequately accomplish rapid economic development, besides being no longer supportive and robust enough in technology decision-making (Ho et al., 2010; Leonardi and Barley, 2010; Venkatesh and Bala, 2008).

The inclusion of both construction-profession stakeholders' and supply-chain members' of IBS project' perspectives enables rich multi-perspective data to be collected. In the context of this thesis, the research participants in the 'construction-profession stakeholder' culture are identified by their professional roles that encompass making building-technology-related decisions (Knoeri et al., 2011; Sahin et al., 2013; Thabrew et al., 2009; Zavadskas et al., 2010a). The research participants in the group of the supply-chain members of IBS projects are identified by their involvement in making building-technology-related decisions in a project supply-chain setup (Arbulu et al., 2003; Cheng et al., 2001; Demiralp et al., 2012; Tah and Carr, 2001).

1.7 Research Process

The research process of this study is developed to address the impacts of contextual, structural and behavioural factors on IBS decision-making and the development of IBS decision-making models, using a holistic concept with a multiple-perspective approach based on an interpretative phenomenological analysis, as illustrated by Figure 1.1.

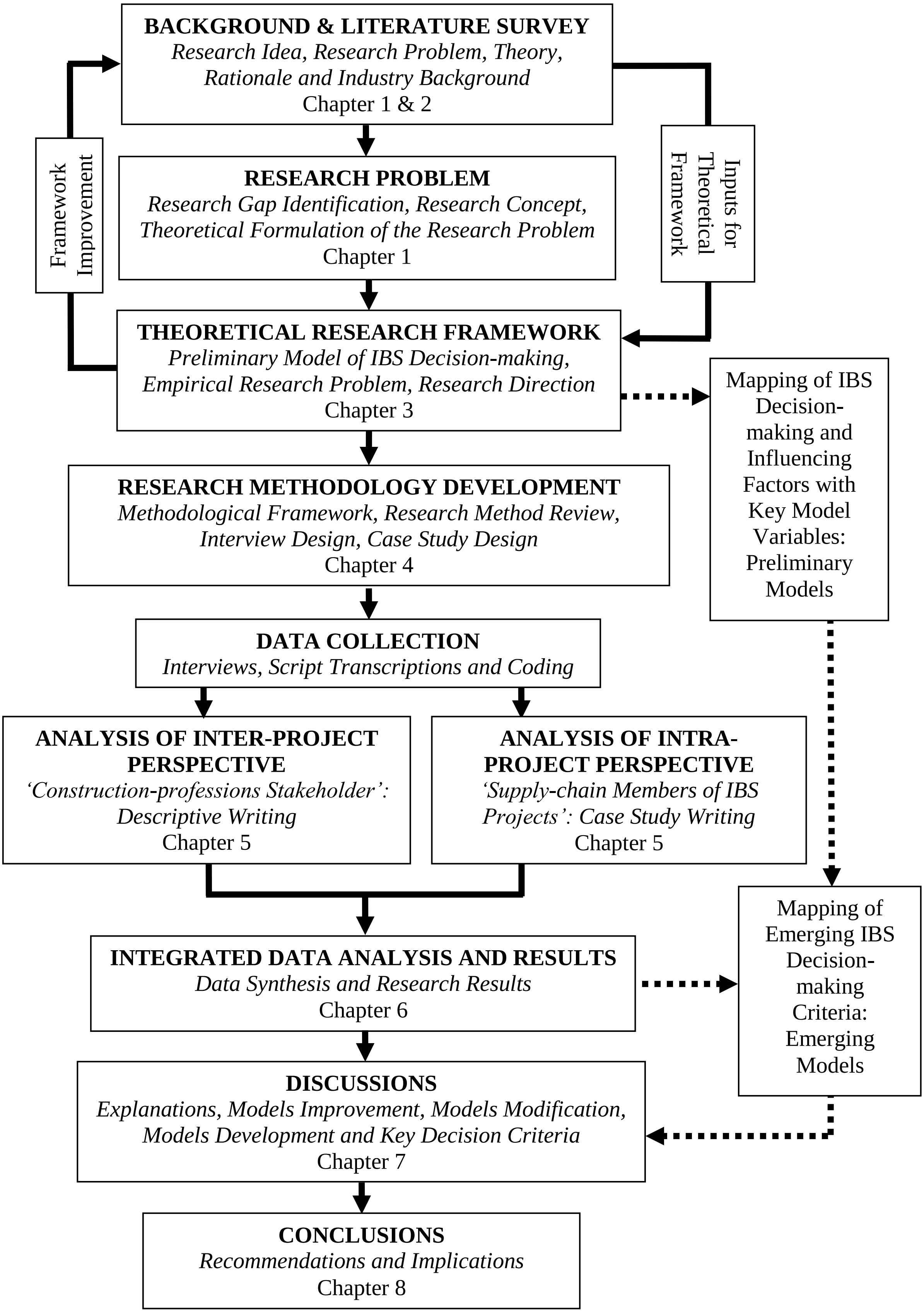

Figure 1.1 Research Process Framework

The research starts with a literature overview in order to provide the theoretical context about IBS decision-making in general, with the focus on its influencing factors. Further, a description of how the construction industry is operating in the field of construction technology adoption is provided. The decision-making of IBS technology adoption is defined, including the explanation of decision-making and its influencing factors are then presented as a theoretical research framework in order to establish the foundation of this thesis.

Subsequently, inputs from conducted, semi-structured face-to-face interviews are gathered, compared and presented as a case study. The overall results from the semi-structured face-to-face interviews are analysed, synthesised and presented to show how both the groups of construction-profession stakeholders and the supply-chain members of IBS projects perceive the influences of contextual, structural and behavioural factors on IBS decision-making. The emphasis on data synthesis and analysis are met with a combination of inter-project and intra-project perspectives for the purpose of models development. The objective is to develop IBS decision-making models to explain the phenomenological context of IBS decision-making, as reflected by the case studies, as well as providing a benchmark for highlighting IBS decision-making deficiencies as potential targets for continuous improvements.

In the discussion part, the results from the semi-structured face-to-face interviews are compared to the theoretical research framework and used as inputs for the development of IBS decision-making model, based on a holistic concept using an interpretative phenomenological analysis. Finally, the final recommendations are drawn up and limitations are identified in the conclusion section.

The research process framework as illustrated by Figure 1.1 has also provided the organisation for the subsequent structure of the thesis according to the research objectives, as illustrated in Table 1.1 below:

Table 1.1 Research Objectives and Relevant Chapters

RESEARCH OBJECTIVES:		CHAPTERS:
Objective 1	To review literature from multiple disciplines, primarily from mainstream management and construction management, on decision-making and the factors influencing decision-making of IBS technology for the purpose of developing a theoretical framework.	Chapter 1 and 2
Objective 2	To develop a theoretical research framework to explore the decision-making phenomenon focused in the context of IBS adoption in building projects.	Chapter 3
Objective 3	To develop a research methodology in exploring the decision-making of IBS technology adoption and its influencing factors using a holistic concept from the multiple-perspective of decision makers based on an interpretative phenomenological analysis.	Chapter 4
Objective 4	To explore the influencing factors that impacted IBS decision-making, using primary data collected from the group of construction-profession stakeholders and the group of supply-chain members in IBS projects.	Chapter 5
Objective 5	To verify how various influences have impacted the decision-making of IBS technology adoption based on an integrated data analysis and results.	Chapter 6
Objective 6	To generate a more integrated framework or models of IBS decision-making in terms of key decision criteria with the integration of IBS technology adoption, focusing on IBS requirements and current practice in project and non-project environments and other problems of consequence in IBS implementation.	Chapter 7
Objective 7	To integrate the overall research and draw its components together in order to present the conclusions, research significance, contributions and recommendations.	Chapter 8

Further refinement on the theoretical research framework is presented in Chapter 3. The research methodologies to address the objectives are developed and described within Chapter 4. In order to address the research aims and objectives, a case study methodology was adopted, based on a multiple-perspective of decision makers using a combination of semi-structured face-to-face interview survey data with secondary document collection and analysis techniques applied. Semi-structured face-to-face interviews were used to collect the data, with the aim of identifying how contextual, structural and behavioural factors were perceived as influencing IBS decision-making.

The group of construction-profession stakeholders is contemplated to use IBS technology across the construction industry, while the group of project supply-chain members in IBS projects is mandated to adopt IBS technology across the building project and their perceptions are explored based on inter-project and intra-project perspective respectively. The research approach was inductive (Amaratunga et al., 2002; Fereday and Muir-Cochrane, 2008; Stenbacka, 2001; Thomas, 2006) enabling the observed IBS decision-making to guide the development of decision-making models. Qualitative data analysis techniques with a holistic concept and multiple perspectives were then used to identify the classification and priority importance of influencing factors on IBS decision-making, based on an interpretative phenomenological analysis.

1.8 Justification of the Research

Technology adoption decision-making is a complex human process and much research has been done on decision-making. Much of the research discovered models through the perspectives of rationality (e.g. Byrnes, 2013; Johnson and Weber, 2009), particularistic (e.g. Calhoun et al., 2002; Langfeldt, 2001; Matsumoto, 2010) and single perspective (e.g. Pennington and Hastie, 1986).

However, there is a growing number of researchers who advocate the non-rational decision-making (e.g. Lee, 2011; Spiegler, 2011; Williams and Samset, 2010), inter-disciplinary perspectives (e.g. Kastenhofer et al., 2011; Piroozfar and Piller, 2013; Urbanaviciene et al., 2009) and the use of behavioural theories (e.g. Aliev et al., 2013; Proctor and Van Zandt, 2011; Sears et al., 2010) to explore technology adoption decision-making (e.g. Arquette et al., 2002; Ferrer et al., 2012; Subramanian et al., 2010). This thesis argues that IBS decision-making is multifaceted, complex, progressing and non-technical in nature, reflecting an emerging method to the decision-making literature.

Existing research on IBS technology development and adoption, which commonly puts forward models and perspectives addressing problems in an isolated, limited and narrow outlook, may be inadequate to explore and understand IBS decision-making. Consequently, a number of current researchers are calling for more integrated and comprehensive models in construction-technology-decision research with different perspectives (Holton et al., 2010; Ioannou and Liu, 1993; Kaklauskas et al., 2007; Koklic and Vida, 2011; Lauf et al., 2012; Love et al., 2004b; Luo, 2008; Sarka et al., 2008; Wu and Low, 2011). This research highlights this trend and proposes generic and integrative models that highlight the nature of IBS decision-making and its influences to discover an identifiable evolutionary configuration throughout the decision process.

Contextual and structural factors in construction decision-making have been commonly researched (Holt, 2010; Jaskowski at al., 2010; Ortiz et al., 2009; Sepasgozar and Bernold, 2013; Tam et al., 2010; Zavadskas et al., 2012), yet there appears to be a lack of attention to the impact of such factors on IBS decision-making. Moreover, the majority of research concentrates on the effects of project and technical factors (Eftekhari et al., 2012; Elizondo et al., 2011; Kamar et al., 2010a; Yunus and Yang, 2012) but largely ignores the effects of behavioural factors (Apaydin, 2011; Elhag et al., 2008; Stanton et al., 2012) on IBS decision-making.

In relation to the constriction industry's position to the Malaysian economy, organisations in this industry operate in an increasingly competitive world, with many challenges in the aspect of labour supply, particularly the availability of foreign labour, project requirements, weather elements and government regulations. This research attempts to synthesise the decision-making and its influencing factors into a theoretical research framework, then proceed to decision-making models to better understand the impacts of contextual, structural and behavioural factors on IBS decision-making in a holistic concept, through the multiple-perspectives of decision makers.

1.9 Research Scope

The decision-making of IBS technology in this study is based on the perception of a group of construction-profession stakeholders and a group of supply-chain members in IBS projects. It is essential to determine their perception towards the influencing factors on IBS decision-making as they might view IBS technology decision-making differently, based on their background, project exposures, skills, knowledge and construction experience.

The group of construction-profession stakeholders consists of professional or construction industry members across the industry who are aware of, but may or may not have been involved in IBS technology adoption. Their perceptions on potential or actual IBS adoption decision-making are important to IBS adoption decision outcomes. Meanwhile, the group of supply-chain members in IBS projects is selected from three case-study projects that have engaged with IBS technology: the three projects represent a successful IBS project, a non-performing IBS project and an unsuccessful building project, respectively. The determination of these projects' performance in terms of IBS adoption are based on the information obtained from the Malaysian Construction Development Board (CIDB) and Public Works Department (PWD) and other publically available information.

The highlight of this research is also demonstrated by empirical work which provides a common model for comparing the influence of contextual, structural and behavioural factors on the decision-making of IBS technology adoption in a hierarchical way. The hierarchy of these influencing factors reflects a clearer outlook of IBS decision-making and how the perceived impact of contextual, structural and behavioural factors affect IBS decision-making in building projects. Decision-making in this research is based on the explorative, normative and prescriptive manner of a decision-making approach which reveals how the construction-profession stakeholders and the supply-chain members of IBS projects actually perform in the decision-making of IBS technology adoption.

1.10 Structure of the Thesis

The following section outlines the content of the following chapters:

Chapter 1 provides a basic introduction to the research project with subject matters and industry background, knowledge gap, research problems, research aims and objectives, research process, research justifications and scopes. These components function as a foundation by laying the ground and outlining major themes that guide the research.

Chapter 2 explores a comprehensive review of past and current research in the areas of decision-making, decision-making process, the Malaysian construction industry, IBS technology adoption, IBS decision-making, decision makers, entities of the construction-profession stakeholders and the supply-chain members of IBS projects, contextual factors, structural factors and behavioural factors based on the setting of IBS decision-making in the construction industry. These components provide conceptual basis for the research.

Chapter 3 constructs theoretical themes and presents a holistic theoretical research framework which defines what major factors influence IBS decision-making. This holistic framework, proposes a number of research propositions to explore the influence of contextual, structural and behavioural factors on IBS decision-making. Conceptual descriptions of IBS decision-making and its influencing factors are also presented in this chapter.

Chapter 4 outlines the methodology that underpins this research. This study adopts an exploratory method based on the multiple-perspective of decision makers, to study the influence of contextual, structural and behavioural factors on IBS decision-making through multiple case studies using an interpretative phenomenological analysis. This chapter documents the research design, methodology design, research strategy which is qualitative, data collection with sampling design, data collection method using semi-structured face-to-face interviews and data analysis design with coding tasks.

Chapter 5 presents the IBS decision-making approach from intra-project and inter-project perspectives, based on the data collected from the group of construction-profession stakeholders and the supply-chain members of IBS projects. Three case studies are presented in this chapter representing the group of IBS supply chain which consist of a successful, a non-performing and an unsuccessful IBS projects. The task is addressed via semi-structured face-to-face interviews. The influences of contextual, structural and behavioural factors are presented based on the hierarchy of the factors for each group.

Chapter 6 brings together the analysis of data gathered in Chapter 5 and discusses the findings in detail in relation to the theoretical research framework developed in Chapter 3. The priority aspects of each influencing factor on IBS decision-making are explained in detail. The overall hierarchal influences of contextual, structural and behavioural factors on IBS decision-making are presented. Cross concept analysis of the impact of influencing factors on IBS decision-making is also presented.

Chapter 7 identifies and highlights significant factors that emerged from the overall analysis. This chapter presents the developments of IBS decision-making models within the context of building projects based on the results of the current research. Emergent issues and corresponding prospects for IBS decision-making are identified in Chapter 7. Whilst, the previous chapter dealt with the hierarchical factors of IBS decision-making as a whole, Chapter 7 then links contextual, structural and behavioural factors and IBS decision-making. It unlocks the factors that predominantly influence the IBS decision-making process.

Chapter 8 summarises the whole findings of the information gathered from the research and provides the answers to the research question posed in Chapter 1. It sets the overall conclusions and suggests future research avenues with theoretical contributions of the research.

1.11 Summary

The potential of IBS technology adoption to deliver a sustainable construction industry with the support of government policies will improve IBS adoption in some countries e.g. Hong Kong, Singapore, Malaysia and China, given the characteristics of the construction industry in each country and the advantages gained in adopting IBS technology. This situation has warranted attention to the adoption of this technology. However, it is ascertained that there is high potential in generating higher usage of IBS technology in the Malaysian construction industry. Individuals and organisations have faced significant barriers, from contextual, structural and behavioural influences, to adopting IBS technology in building projects. It is clear that there is a wide variety of factors related to IBS technology adoption but they are not directly or specifically explored and linked to IBS decision-making. This chapter has laid further foundations for much of the remainder of the research.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

Chapter 1 provided an overview of the thesis, establishing the research question, aim and the research approach was addressed. This chapter reviews existing literatures focusing firstly on the issues and the nature of decision-making, while exploring the nature of building technology adoption, and secondly on IBS technology adoption and its associated decision-making within the construction industry. It also investigates the factors influencing the decision-making process of IBS technology adoption from three constructs, namely contextual, structural and behavioural factors, as a holistic concept. IBS technology is a modern building method, which includes off-site, precast, modularisation and prefabrication construction.

This chapter starts with the background to the literature (section 2.2). This is followed by the major foundation of this research, namely decision-making (section 2.3), decision-making in the construction industry (section 2.4) and the specific nature of IBS technology adoption (section 2.5). Next, section 2.6 presents the nature of decisions surrounding technology adoption. These sections therefore present the literature sequentially, with each section provides a broad information base, whilst the following sections provide the specific focus on certain characteristics or areas, specifically influencing factors on IBS decision-making. This is to provide a broad overview on decision-making and technology adoption, before focussing on their practices in the construction industry and better clarity in terms of IBS decision-making. Section 2.7 specifically views about decision-making in the construction industry with particular focus on building projects and IBS technology adoption. Then, in section 2.8, decision makers in the construction industry are discussed. The influencing factors of IBS decision-making are presented in section 2.9 with the details on contextual, structural and behavioural factors. Section 2.9 focuses on related factors to IBS decision-making, with detailed discussions to identify gaps in the literature and to assist the development of an integrated conceptual framework in Chapter 3. Lastly, section 2.10 summarises and brings together, the concepts of IBS decision-making.

2.2 Background

As the construction industry grows in size and complexity (Bosch-Rekveldt et al., 2011; Puddicombe, 2011; Xia and Chan, 2012), it is important to develop an understanding of context-specific adoption of technology to improve innovation (Sexton & Barrett 2003; Barrett et al., 2008) and productivity in the sector. The increase in research into various aspects of IBS technology adoption by academics and practitioners over the last few years (Blismas et al., 2010; Jaillon et al., 2009; Kamar et al., 2010a; McGrath and Horton, 2011; Meiling et al., 2012; Pan et al., 2012a) is testimony to the importance of the industry (Apaydin, 2011; Blismas et al., 2006; Chen et al., 2010a; Pan et al., 2012b; Polat, 2010).

The highly dynamic nature of the construction industry, influenced by various factors (Doran and Giannakis, 2011; Engström and Hedgren, 2012; Fischer and Adams, 2010) including economy, time and functionality (De Albuquerque et al., 2012), and people skills and attitudes (Holton at al., 2010; Koklic and Vida, 2011), introduces substantial complexity in making IBS technology adoption decisions. Therefore, the importance and influence of socio-economic, project and human- related factors should not be ignored in the decision-making.

The literature on the influencing factors of IBS decision-making aligns to three key themes. These include firstly, contextual factors such as economics (Elhag et al., 2008; Ismail et al., 2012), technology (Blismas et al., 2010; Chen et al., 2010a), government (Panesar and Churchill, 2013; Park et al., 2011; sustainability (Aguado et al., 2011; Holton et al., 2010) and stakeholders (Nadim and Goulding, 2011; Pan et al., 2007). Secondly, structural factors such as project type or size (Winch, 2010), procurement (Patty and Denton, 2010) and management (Holton et al., 2010) and thirdly, human-related features (Lehmann and Fitzgerald, 2013) and the influence of these factors on IBS decision-making. This research seeks to address the deficiency of literatures pertaining IBS decision-making and its influencing factors by undertaking an exploration of the priorities of each influencing factor.

As a consequence, the research by Chen et al. (2010a) reinforces a foundation for the current research on IBS decision-making. While the research of Pan et al. (2012a) concentrates on the decision-making criteria for IBS technology adoption, they also explored the relationship between the key players of IBS projects. However, as with much of the research into IBS technology adoption, the exploration of its decision-making and influencing factors is incidental to the main issue (Fischer and Adams, 2010), which is observed as the decision-making of IBS technology adoption. It is the contention of the research, that these factors play an important role in the facilitation of IBS decision-making. The literature presented here is a foundation to develop the theoretical research framework.

2.3 Decision-making: A Conceptual Position

Decision-making is a broad term that applies to the process of making a choice between options as to a course of action (Hastie and Dawes, 2010; Manktelow, 2012). This concept has attracted a vast amount of attention among researchers and has been studied in a variety of fields including management (Bazerman and Moore, 2008), social science (Del Missier et al., 2010), organisational behaviour (Klein, 2008), strategic management (Anderson, 2012; Schiavone, 2011), information technology (Patel et al., 2013), industrial manufacturing (Kahraman et al., 2010) and construction management (Antuchevičienė et al., 2010).

Decision-making involves the consideration of economic factors, technical practicalities, scientific necessities, human and social considerations beside all other factors, to choose the best alternative that optimises the total value (Saaty and Vargas, 2012). Therefore, every effort to reduce the likelihood of making poor decisions is important in predicting the consequences of decision-making performance (Carmeli and Schaubroeck, 2006). In defining the concept of decision-making, Nutt and Wilson (2010) also use the notion of choice based people's judgements of their capabilities in selecting among alternatives and the act of sense making which allows human to construct a version of reality.

Byrnes (2013) defines decision-making as the process by which a course of action is selected as the solution to a specific problem. Bardach (2011) distinguishes decision-making from choice-making and problem solving. Gilovich et al. (2002) suggest that choice-making refers to the narrow set of activities involved in choosing one option from a set of alternatives. Meanwhile, D'Zurilla and Nezu (2010) explain that problem solving refers to the broad set of activities involved in finding and implementing a course of action to correct an unsatisfactory situation. Vohs et al. (2008) also clarify that decision-making is the process of choosing among alternatives, implementing a decision and using the subsequent outcome data to shape any further decisions associated with the earlier one. It is within this area that decision-making can be based on long and short-term criteria. This will also translate into a long term measure of ensuring sustainable growth as well as minimising socio-economic implications.

2.3.1 The Significance of Decision-making

The area of decision-making has proven valuable in a wide range of contexts. Although most of the empirical research has involved choice determination, decision-making has been the central interest to economists interested in the activities of markets, economies and business management (Jones, 2004). Decision-making from a project perspective involves complex matters that are crucial for the competitive positing and sustainability of its goals (Wong et al., 2011). In this perspective, decision-making involves choices that pertain to the problems and practices of a given project (Kunc and Morecroft, 2010).

Decision-making is influenced by how people conceptualise the decision to be made and the outcome they seek to achieve (Hiller and Hambrick, 2005). An assumption in decision-making research as mentioned by Arrow (2012) is that individuals make decisions with the aim of making the best choice or to optimise decision outcomes. This assumption may be a generalisation, with various decision-makers potentially framing the desired outcomes of their decision-making in alternative ways (Keeney and Keeney, 2009).

In a decision-making progression, different factors are considered to be important, depending on a decision-maker's mental representation of the situation (Hastie and Dawes, 2010; Trope and Liberman, 2010). Meanwhile, Kaner (2007) uses the notion of problem-setting to describe the process in which, interactively, people name the things to which we will attend and frame the context in which they will attend to them. Bierman and Smidt (2012) also support that framing affects the size of what can be seen, and affects the perspective and what is seen to be the problem in decision-making.

2.3.2 The Frame of Decision-making

The setting of desired outcomes in different ways has important implications for decision-making (Gold and Shadlen, 2007). While one individual might see the goal of decision-making as achieving a desired outcome, and is prepared to take a risk to do so, another might see the preferred goal as safety and be much less likely to take a risk (Byrnes, 2013). Meanwhile, Pastötter et al. (2013) place emphasis on the aspect of decision-making which refers to the decision-maker's conception of the acts, outcomes and contingencies associated with a particular choice. In this research, the frame of decision-making consists of decision process, concern, input and output.

a) Decision Process

Ragsdale (2010) investigates decision analysis and discovers the process to be a cycle, repeated until a clear course of action is obvious, before an implementation plan is developed. In addition to concisely summarising the process, Curtis and Lee (2010) and Phillips-Wren et al. (2009) add a feedback loop to the decision process so that learning from both the implementation and the outcome is included. Romero et al. (2009) and Stewart et al. (2012) also emphasise that feedback on a decision cannot change the decision, instead assisting in shaping a future decision process.

D'Zurilla and Nezu (2010) and Saaty and Vargas (2012) also argue that information may require the decision maker to step back to an earlier stage and revise the problem. Therefore, it is also important to look at different portions of a decision process from a top-down perspective, as well as from the bottom up (Rondinelli, 2013). Additionally, Kahneman and Klein (2009); Tavris and Aronson (2008) argue that failures in decision-making process occur because one solution is chosen quickly and the rest of the effort is spent justifying the decision rather than seeking out other alternatives.

b) Decision Concern

As the construction industry is very dependent on the general economic state, for instance, concern about this matter is important (Baumohl, 2012). Therefore, economic condition is another essential consideration in decision-making. The concerns of projects impact or construction-sector dynamic depends on the wellbeing of the volatility of economic growth and structure (Giang and Pheng, 2011).

In the construction industry, where each building project is unique, one of the main decision concerns is monitoring industry's uncertainties over time (Harris and McCaffer, 2013). During the decision-making for planning and designing, most architects and consultants are concerned with new materials and innovation to improve project efficiency (Schumacher, 2012; Tunstall, 2012). Additionally, concerns on clients' needs and wants in technology decision-making is also vital by progressively articulating user requirements (Albert and Nitsch, 2010).

c) Decision Input

Besides various concerns in decision-making, inputs from different sources are also important to deal with project performance, based on various experiences (Edum-Fotwe and McCaffer, 2000). In addition, the focus is on the extent to which individuals use project information and trust the information from inside or outside the project as their decision input (Alwaer and Clements-Croome, 2010; Khalfan, 2007; Phelps and Reddy, 2009).

Hence, inputs from project performance in terms of its success or failure and cost issues for instance, are important in decision-making (Halliday, 2008; Love et al., 2010). In the construction industry, the decision outcome is related to its profit (Liu and Wang, 2008; Senouci and El-Rayes, 2010) and growth (Shenhar and Dvir, 2007). Moreover, the dynamic nature of forecasting means that chance events may subsequently change the decision input from that envisaged during the decision process (Johnson and Weber, 2009; Saaty and Vargas, 2012). Additionally, stakeholders' views are also the source of inputs in project decisions (Olander and Landin, 2005; Turner and Zolin, 2012).

d) Decision Output

Having reviewed the various elements in decision-making, it is now important to shift the focus to a study of the decision output itself. It has been discussed that having a clearly defined decision-making process along with a feedback mechanism will yield better decisions (Demirtas and Üstün, 2008; Ho et al., 2010). However, Hogarth (2010) argues that it would be inappropriate to assert that the success of a decision should rely on the decision output.

In the construction industry, the outcome is important because building project development is a huge industry and must concern itself with the 'bottom line' (Allen and Iano, 2011). Having proposed that a decision-making process is critical to a building project's success (Winch, 2010), it is also important to review the other elements affecting the decision output (Brandon and Lombardi, 2010; Harris and McCaffer, 2013). Meanwhile, Hastie and Dawes (2010) argue that implementing a particular decision-making process will yield a better chance of a better decision output. As uncertainty is always present, making the right decision based on the relevant information available does not guarantee the desired output (Winch, 2010).

2.4 Decision-making in The Construction Industry

Decision-making in the construction industry has become more complex than merely gathering and disseminating information (Podvezko et al., 2010). Research by Sears et al. (2010) reveal that project decision features have levels of difficulty, for example, certain versus uncertain or familiar versus unfamiliar, with further difficulty and complexity arising from the interplay between attributes and other project features.

2.4.1 The Decision-making of Building Projects

Project decisions contain elements of time pressure, specification compliance and highly significant outcomes for the clients (Chachere and Haymaker, 2011). In addition, Rondinelli (2013) links the theory to project decision-making, using a continuum of cognition from intuition to analysis, with modes of cognition occurring in between that use a combination of both approaches. Decision tasks in building projects that induce slower analytical approaches are well structured and present with complete information (Ma and Liang, 2013). On the other hand, when decision tasks are poorly structured in a high level of project uncertainty, there is little chance to conduct decision analysis (Zeng et al., 2007).

Other research undertaken in building project settings involve decision-making features such as lack of familiarity and uncertainty that slow down the decision-making (Kent and Becerik-Gerber, 2010). Additionally, Taroun and Yang (2011) also discover that when making decisions in a building project, decision-makers responded to simple decisions by choosing a usual mode of practice that they found usually worked, and modifying their choice to fit the unique situation by adopting more creative and novel approaches to intervention.

2.4.2 Decision-making Dynamics in Building Projects

According to Kerzner (2013), decision attributes in construction projects include elements such as risk, long-term focus, consensus, instability and uncertainty. In each project situation, decisions are characterised by a unique combination of these attributes (Winch, 2001). Project decision-making by construction professionals is a more complex process, requiring groups of individuals that make defined choices between limited options and resources (Bierman and Smidt, 2012). Construction professionals are required to make decisions with multiple foci (e.g. analysis, involvement, interaction and evaluation), in dynamic project contexts, using a diverse knowledge base (Tam, 2007), including increasing project requirements (Ann et al., 2010) and legislative compliance (Wong et al., 2012).

Emmitt (2010) suggests that decisions in a project will be relatively simple if the context decisions are made within the context of familiarity, certainty, limited variables, stability, congruence, and low risk. Meanwhile, making decisions becomes more difficult if there are uncertainty, conflict, unfamiliarity, changing conditions, multiple relevant variables and high risk (Smith et al., 2009b). Moreover, difficult and complex project decisions have competitive dimensions that the project members found challenging (Baloi and Price, 2003).

2.5 The Specific Nature of IBS Technology Adoption

IBS is often referred to by the literature as off-site construction (Pan et al., 2008a) off-site production (Blismas et al., 2006), pre-assembled building (Gibb and Isack, 2003), industrialised and automated construction (Warszawski, 1999), off-site manufacturing (Meiling et al., 2012), prefabricated building (Tam et al., 2007), precast building, precast construction, non-traditional building and a Modern Method of Construction, MMC (Pan et al., 2007).

In essence, the term ‘industrialisation’ generally has three characteristics, first; it has a generic organisation, second; it is based on quantity and third; it offers an individualised finished product (Richard, 2005). In the construction industry, it is important to decide whether to use a conventional building method or to use some degree of modern industrialised construction method, that is, complete or partial modern technology (Kempton, 2010).

There are various definitions of IBS technology adoption. The definition as given by Hamid et al. (2008) is a construction technique in which components are manufactured in a controlled environment (on- or off-site), transported, positioned and assembled into a structure with minimal additional site work. IBS technology is the mass off-site factory production of building components, assembled and joined on-site to form the final building product (Badir et al., 2002).

2.5.1 IBS Technology Adoption in Building Projects

According to Blismas and Wakefild (2007) IBS technology adoption brings benefits to the construction-project implementation phase, through exploiting the advantages of the manufacturing process (Ko, 2010), including an improved control on the building project (Jaillon and Poon, 2009) and improved quality (Nahmens and Mullens, 2009). IBS technology adoption offers an opportunity to improve a variety of project performance indicators, particularly cost (Pasquire and Gibb, 2002) and time (Pan et al., 2007).

According to Gibb (2001), IBS technology is not new, but its application, pragmatism and perception need to be considered in the light of current technology and management practice. In some developed countries like the United States of America, United Kingdom, Japan, Australia and other European countries, IBS technology adoption is already a common building-construction method that is widely accepted and adopted (Thanoon et al., 2003). Although the situation differs from one country to another in terms of types and degree of adoption in building projects, in most developed countries such as the USA and UK, the adoption of IBS technology has increased since the 1990s (Polat, 2010).

There is a growing demand for infrastructure building and IBS technology adoption driven by the development of socio-economic conditions (Bari et al., 2012). This is also supported by public perceptions of the performance and quality of IBS technology adopted (Goulding et al., 2012b) and also driven by the positive environmental impacts of building construction practices (Lachimpadi et al., 2012). Moreover, this growth in demand is expected to continue in the coming years (Goodier, 2013).

In certain building-project settings such as fast-track projects, unstable weather conditions and congested locations, IBS technology adoption represents the feasible choice of building method (Lu, 2009) as it is relatively more convenient, particularly in the Malaysian context. However, in a normal construction environment, the consideration of IBS technology adoption is not obvious as an alternative to conventional building methods (Azimi et al., 2011).

2.5.2 Research on IBS Technology Adoption in Malaysia

IBS is the focus of many government and private initiatives to increase the productivity of the building and construction industry. Although the benefits of IBS are widely recognised, there are a number of barriers to IBS adoption that impede the realisation of these benefits. Readiness, awareness, costs, knowledge, technological needs, poor planning and negative perception of IBS are just some of the barriers to IBS adoption identified in the literature (Kamar et al., 2010a).

There has also been a change in housing-construction technology from the conventional system to a wider application of an industrialised building system, as the concept of industrialisation has been strongly supported by the federal and state governments (Badir et al, 2002; Majid et al., 2011). Moreover, to promote faster completion of building projects, IBS is applied (Alaghbari et al., 2007).

The current thinking on IBS is that the contractors prefer to choose the conventional system since shifting from conventional to IBS is not motivated by cost factors and there is an abundance of cheap foreign workers in Malaysia (Kadir et al., 2006). However, the risks identified in building projects could assist in making a better and wiser decision in the projects intend to adopt the industrialised building system (Hassim et al., 2009).

Earlier work by Kadir et al. (2006), in fact, investigate the relationship between IBS technology adoption and project performance, but does not do so in dealing with other than project factors. The research by Badir et al. (2002) investigate the IBS components used in building projects and while this research provides insights into IBS technology adoption, it does not examine the impact of project- and economic- related factors on the decision-making process.

2.6 The Nature of Technology Decision

In decision science, a technology-adoption decision involves inter-firm coordination, collaboration between individuals in different stakeholder groups and interventions (Friedrichsen et al., 2013). This is becoming important from a supply-chain perspective, where firms compete in the market as supply chains, not individual firms (Gajendran and Brewer 2012; Doran and Giannakis, 2011). Venkatesh (2006) clarifies that decision-making in technology adoption is based on multidisciplinary work with the consideration of technology outcomes, environmental factors, feelings, reactions and personality characteristics.

Morris and Venkatesh (2000) discover that technology-usage decisions are strongly influenced by attitude toward using the technology, with continuous learning. Manktelow (2012) explores whether organisational philosophy and culture, with respect to training, can overcome some of the barriers to technology adoption. Therefore, technology adoption starts with a state of uncertainty of new technologies (Leonard, 2011). Meanwhile, Chesbrough (2010) and Cunha et al. (2010) suggest that technology adoption is dependent upon the extent to which the adopters find it meaningful and relevant, based on the interaction between cognitive (thoughts) and affective (feelings) attitudes to the meaning of new technology.

Venkatesh and Bala (2008) acknowledge that technology adoption is based on technology usefulness, users' needs and requirements. Bagozzi (2007) discovers that attitudes toward the behaviour of technology implementation, diffusion of innovation and relative advantages derive from the way innovation is perceived. According to Sun and Zhang (2006), technology decisions are shaped by a set of organisational factors based on one's self-confidence in evaluating technological innovations. Hence, the success or failure of technology adoption is based on the need for innovativeness and users' experience as a result of systems control by government, and industry policies with system factors such as regulatory, technology culture and industry trend (Lin, 2003).

2.7 The Decision-making of IBS Technology Adoption

Generally, decision-making research in IBS technology adoption has been dominated by quantitative approaches (Bari et al., 2012; Demiralp et al., 2012; Faludi et al., 2012; Yunus and Yang 2011). The focus on project, economic and technical perspectives may have led decision-making research in IBS technology adoption to underutilise the insights of other economic and human-related factors. Aided by the holistic concept to complement IBS decision-making research, the field has started to realise, however, that people make decisions according to various factors and based on numerous influences. In this review, this research makes a strong case for the utility of this realisation.

Apart from being less efficient due to information-processing processes, IBS technology decisions presented here focus more on the human decision-making process (Gonzalez et al., 2013), since this research uses a case study approach. From the decision-making perspective it is important to understand, why building projects uphold a certain level of conventional building method (Haron et al., 2012; Vicente et al., 2010; Wong et al., 2010), when they can change the building method, what their motives are and how the adoption of IBS technology can be enhanced. This really makes decision-makers perceptions an interesting subject to study, focusing not only on higher-level management involved in IBS decision-making, but also construction professionals at various levels.

2.7.1 The Nature of IBS Decision-making

The construction industry enthusiastically adopts IBS technology in building projects based on the principles unearthed in normative decision-making (Girmscheid and Rinas, 2012; Izetbegović and Bezak, 2010; Sanguinetti et al., 2010; Zhang et al., 2012) because theoretically, these normative approaches, if appropriately applied, should produce improved decisions (Love et al., 2013b; Roos et al., 2010; Zerjav et al., 2013). However, a normative approach alone is not sufficient, as most IBS project portfolios in the construction industry fail to yield their anticipated results (Dawood and Alshawi, 2009; Inyang, et al., 2012; Terouhid et al., 2012). Theoretically, the use of decision analysis and technique should yield optimal decisions (Antuchevičienė et al., 2010; Bildsten, 2013; Gutjahr et al., 2010; Zhong et al., 2011) but this does not always occur in all building projects.

In IBS decision-making, it is vital to have a rank order of all alternatives, thus identifying an optimal IBS strategy as action guidelines for designers who are at the forefront of decision-making (Yunus and Yang, 2012). With adequate training of skilled labour to install IBS components, this factor is expected to improve the perceptions of IBS among the relevant industry players and consequently facilitate the decision to use IBS (Park et al., 2011). There is also a growing trend that IBS decisions should take into account the interplay between people as decision makers of building technology who carry out judgment roles (Goodrum et al., 2009; Lu et al., 2011a), building technology which is the technical sophistication of building construction (Lou and Kamar, 2012; Yin et al., 2013) and the nature of decision-making in a building project.

Berawi et al. (2012) describe that the majority of IBS decisions related to logistics are made by the purchasing department and their decision-making is to forecast the materials demand. Meanwhile, decision-making on IBS technology adoption should enhance environmental awareness through education and training (Abdullah and Egbu, 2010a). Wrong decisions regarding IBS attributes will ultimately alter the performance, outcomes, and quality of the project (Yunus and Yang, 2012).

2.7.2 The Issues of IBS Decision-making

Generally, the initial building cost is also a commonly employed decision criterion for decisions about new innovations in IBS technology (Engström and Hedgren, 2012). In addition, Pan et al. (2012a) discover that in project decisions, multiple players act together based on different roles, with organisational goals and norms to aid the decision process for the application of IBS. Hence the descriptive approach of IBS technology decisions in the construction industry, places it at the forefront in the use of technical decision analysis (Ellingham and Fawcett, 2006; Engström and Hedgren, 2012; Nussbaum et al., 2009).

Research by Goulding et al. (2007) is instructive in that it provides a clearer understanding of the variables of IBS technology adoption, as the authors also suggest that there are other factors, such as people, process and technology, that influence the success of IBS technology adoption. However, the factors discussed in the studies of Chen et al. (2010a) and Goulding et al. (2007) are not evident in the context of IBS decision-making. Similarly, the way these factors impact IBS decision-making needs to be included in the study of IBS technology adoption. This demands the understanding of decision-making that is relevant to changing circumstances, and embraces a diversity of knowledge and values in IBS technology adoption.

The decision-making associated with using IBS for construction projects is based on the economic aspect as an important factor as well as other influencing factors such as plant location, labour-related issues, environmental and organisational considerations, plant characteristics and project risks (Kudsk et al., 2013). Therefore, it is important to examine all factors that can be involved in the decision-making associated with IBS construction (Azhar et al., 2013). Environmental problems, for example, were partly responsible for delays in deciding to use the IBS (Bari et al., 2012). Decision-making in a project environment is uncertain and may change while IBS decisions are being made (Gosling et al., 2012).

2.8 Decision-Makers in the Context of IBS Adoption in Building Projects

In an attempt to integrate the multiple-perspective approach in this research, Cheung (2009) proposes the focus of various participants in decision research and their roles in the subject. Decision-makers operating in the competitive and dynamic construction environment consider alternative strategies and select the one that will give the best outcomes (Ortiz et al., 2009; Tam et al., 2006). Thus, the role of decision-makers in IBS technology adoption is increasingly seen as an important element in the improvement agenda of the Malaysian construction industry (Kamar et al., 2011; Lou and Kamar, 2012). Decision-makers of building projects typically are interested in maximising profit but with the concern of objectives such as corporate goodwill, market share and future growth based on their risk attitude in deciding one choice from several alternatives (Ng et al., 2012a). In a building project, a decision- maker makes informed decisions based on clear and concise information (Zavadskas et al., 2012).

Building projects are governed by people who are directly or indirectly involved in decision-making that results in project implementations. The literature recognises construction professionals as decision-makers in the construction industry particularly on building projects (Langford and Male, 2008). According to Kelly et al. (2002), a decision-taker is a person who has the authority to make and take decisions, whereas a decision-maker can only provisionally endorse solutions, and needs to refer to a higher authority in order for the solutions to be ratified and then implemented, including stakeholders and various users in construction projects. The sections below seek to build an understanding of the construction-industry entities in the decision-making associated with IBS technology adoption.

2.8.1 Construction-Profession Stakeholders

A number of studies have investigated the role of the professional (or profession- based) stakeholders in relation to project decision-making (Pryke and Smyth, 2012). As part of their study, Thabrew et al. (2009) provide a foundation for stakeholders' decision-making and include factors such as sustainability goals, together with the issues of construction scenarios. In terms of their role in IBS decision-making, the stakeholders are particularly important, based on their early involvement and cooperation to improve sustainable IBS construction (Azhar et al., 2013; Yunus and Yang, 2012) and they can also influence decision-making in such a way that a project is implemented (Chen et al., 2010a).

Project decisions are typically complex, uncertain, multi-scale and affect multiple-stakeholders and agencies (Lambert et al., 2011). Therefore, stakeholders' participation is increasingly being sought and embedded into project decision-making processes, in projects of all sizes (ten Heuvelhof, 2010). Widespread participation of stakeholders has been driven by increasing knowledge and interest in technology decisions, ongoing policy and sustainable evolution (Garmendia and Stagl, 2010; Reed, 2008; Spangenberg, 2011).

By involving stakeholders in IBS technology adoption, it is argued that the quality and robustness of decisions are likely to be greater (Goulding et al., 2012b; Hes et al., 2012; Ng et al., 2012b). Moreover, according to Chinyio and Olomolaiye (2010), construction stakeholders are defined as both internal stakeholders, that is, those who are the members of the project coalition or who provide finance and other external stakeholders.

Pryke and Smyth (2012) highlight the problem of a project centralising in a single entity since this would limit the variety of input into decision-making, and hence the scope of the project to grow. The fact that construction stakeholders are involved in multiple aspects of IBS technology adoption (Gambatese and Hallowell, 2011) illustrates the complexity of IBS decision-making. Hamid et al. (2012) suggest that various inputs from the construction stakeholders could improve the generation of innovative alternatives in the decision-making process.

Professional stakeholders' roles in decision-making have progressed from the transfer of technology paradigm (du Plessis and Cole, 2011) into the sustainable development agenda of the construction industry (Abidin, 2010; Elmualim et al., 2010). While various construction stakeholders' consultation over IBS decision-making was expanding the construction industry, a more action-oriented and project- specific approach was emerging in the construction context (Goulding et al., 2012b). However, different types of involvement are likely to be suitable in different building projects, depending on the objective and nature of the project and the capacity for stakeholders to be involved in decision-making (Reed et al., 2009).

2.8.2 Supply-Chain Members of IBS Projects

The supply chain is an emerging concept in the construction industry as individuals and groups work together within a multidisciplinary environment in designing, developing and producing products with common goals aligned with project organisation, even if the most important decisions are made during the design process (Love et al., 2004a). IBS supply-chain members of building projects are important entities, particularly in large building projects (Al-Bazi and Dawood, 2012).

However, there is much debate in the literature regarding the roles of supply-chain members in IBS technology adoption as the supply chain is a complex construction system (Eriksson, 2010). Additionally, Hong-Minh et al. (2001) list several features that describe and discuss the nature of IBS supply-chain members' roles and contributions to the decision-making of IBS technology adoption, such as communication, relationships, trust and commitment.

Supply-chain management appears to be the current project strategy (Harris and McCaffer, 2013; Segerstedt and Olofsson, 2010), including in IBS technology adoption, and is often practised in project development, particularly in a time of growing industrial building projects (Doran and Giannakis, 2011). This approach has been taken-up in large-scale projects whereby such projects have resulted in highly collaborative ventures and harnessing a variety of important skills in responding to the complexity and demand of the construction industry (Gosling and Naim, 2009). Therefore, this requires great skill on the part of the project clients (Gajendran and Brewer, 2012).

Current research on supply-chain members in IBS building projects also covers logistic issues (Berawi et al., 2012; Doran and Giannakis, 2011) and managerial themes (Kahkonen et al., 2010). In decision-making, Aram et al. (2013) discover that the IBS supply chain should be able to integrate the various elements of the chain and information sharing plays a vital role in integration of different members of the chain, requiring highly coordinated efforts of managers and engineers. Managing the supply chain in the context of the IBS delivery process requires some form of transformation from on-site to off-site activities (Gosling and Naim, 2009), so that each process of project execution and implementation must be strategised to reduce risks and bring maximum value (Faizul, 2006).

A construction project supply chain coordinates inter-organisational decision-making and supply-chain members such as suppliers, designers, general contractors, sub-contractors and clients or owners, typically create a decision as a set of possible solutions by considering decision-making variables such as environment, cost, time, quality and safety (Xue et al., 2010). Decisions made by a construction supply chain are influenced by rapid change and immense dynamism based on many factors that are not easily quantified and not well-defined, and thus require the anticipation of judgmental and heuristic rules (Tah and Carr, 2001).

2.8.3 Construction-Profession Stakeholders and The Supply-Chain Members of IBS Projects in the Context of IBS Technology Adoption

The participation of construction professionals may make the research more robust by providing higher quality information inputs (Fan and Fox, 2009). By taking their concerns and perceptions into account in understanding the IBS decision-making process and its influencing factors, it may be possible to comprehend this matter with a variety of ideas and perspectives (Son el al., 2012), and in this way increase the likelihood that the research needs and priorities are successfully met. It appears that all the decision-making entities in the construction industry have all the decision-making process based on their roles, responsibilities, involvement and background.

a) Clients – Winch (2010) mentions that the role of a client, not only as a decision maker but as a resource provider, particularly in terms of specific capabilities of individuals serving on the board, their knowledge and insights, leads to enhanced project performance and competitive advantage. This is consistent with Harris and McCaffer (2013) who reported that clients' involvement relates to investment decisions, standards and regulation complexity as well as achieving project value and hence provides the basis for sound and effective decisions. However, there is a growing concern that clients' decisions are not living up to many of the claims that are being made as these decisions may have interactions with other project members (Anumba and Evbuomwan, 2002). In recognition of the fact that project decisions are made by individuals in the top management of project clients, they are considered as senior decision-makers, that is those of middle-manager level and above as construction professionals. They are engaged in the construction industry as industry players or practitioners based on how project clients made decisions about whether to adopt a technology or other specific choices.

b) Developer – Isaac et al. (2010) investigate whether developers are typically active or passive players in project decision-making, and whether they drive all project specifications. Adams et al. (2012) suggest that both possibilities exist since there is a wide variation in their involvement. Meanwhile, Sara and Reed (2008) clarify that collaborative involvement in the decision-making process showed relationships with decision quality and findings, thus this may lead to a sense of rights over the process and outcomes. This credibility has also been questioned on the basis that many developers may not have sufficient internal expertise to meaningfully engage in what are often highly technical discussions (Bryson and Lombardi, 2009). The roles and responsibilities associated with decision-making in developers' organisations is that decisions are made by their members as construction professionals. Project decisions are likely to be made precisely based on their actual involvement or participation and experience with professional background knowledge. This clarification is to provide a practical sample how the members of developers' organisations as construction professionals undertook IBS decisions based on their roles and further aided the identification of stakeholders' involvement in decision-making process.

c) Design Architect – Is concerned with the design of a building (Rozanski and Woods, 2011) that fulfils client requirements. However, design architects can accommodate a client's requirements to a certain extent in the building project as they can reveal true decision-making power of a project (Pautasso et al., 2008). It is argued that designer roles in IBS decisions should lead to higher quality decisions, as they can be based on more complete information, anticipating and improving unexpected negative project outcomes before they occur during project implementation (Kamar et al., 2010b; Zhang, 2012). Moreover, architectural perspective to IBS adoption decision-making can be focused on achieving sustainable, energy- and material-efficient designs (Faludi et al., 2012).

d) Project Manager – The main task for a project manager is to ensure that the project is properly managed in order to complete it in time, within budget and with required specification (Lindebaum and Jordan, 2012). On the other hand, Paton et al. (2010) argue that decision-making authority should accompany a project manager's position. (Anyanwu, 2012) suggests that project managers can achieve successful building-project delivery, and that the project manager's position in the building-construction industry should be occupied by a professional who has training in the project-management body of knowledge.

e) Quantity surveyor – Hee and Ling (2011) indicate that decision-making can be strongly influenced by quantity surveyors depending on whether the project has adopted a building technology mainly due to investment decisions or cost factors. Eadie et al. (2010) , however, discover that quantity surveyor involvement in decision-making depends on dynamics such as project criteria and resources. There are ways in which quantity surveyors can reinforce certain project priorities but project dynamics may discourage minority perspectives from being expressed (Paton et al., 2010).

f) Consultant(s) – A combination of knowledge and external interface by a consultant is preferred to reach project decisions (Alvesson and Empson, 2008). The extent to which a consultant can decide on, or influence, project decisions is not entirely straightforward. Leonardi and Barley (2010) discover that consultants do influence the decision-making process by shaping the ideas that form the content of project specifications from which those ideas evolve. By establishing common ground and trust between consultants and other project members, and learning to appreciate each other's viewpoints, the decision-making process has the capacity to transform adversarial issues and find new ways for other project members to work together (Andersen and Grude, 2009).

g) Civil Engineer – Ashley (2012) mentions that a civil engineer decides on all the structural design aspects and the integrity of the building to be constructed, all of which differ in the way project constraints and actions are related. More commonly, project supervision is evaluated in the presence of civil engineers, on the basis of project implementation standards or specification (Rodriguez et al., 2011). Shen et al. (2010b) evaluate whether civil engineers' participation in decision-making had improved the quality of project management, and found that the role of civil engineers significantly increased project quality.

h) Contractor – Zavadskas et al. (2009) highlight that the efficiency of a construction process is often associated with the successful choice of a contractor. On the other hand, they purported that there is little evidence that contractors' response to the project clients degrades the decision-making process. Despite the concerns that have been expressed, there have been few attempts to investigate the validity of contractors' roles or contribution in decision-making (Tan et al., 2011a). These few attempts have tended to focus on evaluating the decision process rather than the outcomes that involve contractors (Oo et al., 2012).

i) Manufacturer - In particular, manufacturers are concerned with issues that must be taken into consideration in working hours' decision-making, such as the amount of labour, worker inclination and related regulations that limit the IBS decision-making functions in a building project (Ko and Wang, 2010). Holton et al. (2010) argue that IBS manufacturers also have other functions beyond manufacturing, by embedding sustainable development management in everyday decision-making. Meanwhile, Berawi et al. (2012) discover from IBS manufacturers that their major involvement in building project developments is based on their ability in managing construction logistics.

Although only a few studies have evaluated a handful of the claims that have been made for construction professionals' participation in IBS decision-making, the available evidence appears to support the claims that have been evaluated. So far, the literature on the construction-profession stakeholders and the supply-chain members of IBS projects is not entirely clear on who are the real decision-makers influencing IBS technology adoption. This view is reflected by Shukor et al. (2011) who argue that in IBS decision-making, as with traditional procurement, IBS technology adoption still depends mostly on the client's requirement. Nonetheless, it seems to emerge that although the clients are the major deciders in major projects (Brown, 2009), the expertise of other construction-industry entities associated with IBS technology adoption, is required (Fischer and Adams, 2010). Therefore, it is vital to explore their responses and perceptions towards the influencing factors of IBS decision-making.

2.9 Factors Influencing IBS Decision-making

It was generally stated that various influencing factors are related to decision-making and technology decisions in the construction industry. In order to further demonstrate the influence of these factors on IBS decision-making, to aid the development and foundation of the theoretical research framework, the following sub-sections focus on factors related to decision-making, generally to technology adoption and particularly to IBS technology adoption in building projects. In this section, influencing factors of IBS decision-making are broadly divided into three categories, namely contextual factors, structural factors and behavioural factors. It is recognised that the factors listed here are by no means comprehensive, but discussing them all would go beyond the scope of this thesis. Salient factors relevant to the theme of this study were chosen.

2.9.1 Contextual Factors

The construction industry is characterised by building projects that involve a number of increasingly huge investments (Scott et al., 2011) like IBS technology adoption that are highly uncertain (Bari et al., 2012; Blismas and Wakefield, 2009b; Goodier and Pan, 2010; Pan and Sidwell, 2011) and in some projects involve higher initial investment (CIDB, 2011; Pan and Sidwell, 2011; Rahman, 2013; Sanna et. al., 2012; Smith, 2011). Decision-making in the construction industry is based on interactions between the decision-makers and their environments (Ding, 2008; Goulding et al., 2012b; Håkansson and Waluszewski, 2013; Loizou and French, 2012; Peldschus et al., 2010; Pryke and Smyth, 2012; Sacks et al., 2010b; Singhaputtangkul et al., 2013).

Contexts of the construction industry do not remain constant and may change at a drastic and rapid pace to which companies respond with new strategies in project decision-making (Waly and Thabet, 2003). For the construction industry to survive the current turbulence in the economic environment, it has the option of integrating new initiatives to match the uncertainties (Shehu and Akintoye, 2010). External environmental changes can also lead to evolutionary changes in the decision-making of IBS technology adoption over time, through natural changes in economic forces, government rules and societal values (Lou and Kamar, 2012).

Harris and McCaffer (2013) discover that high environmental dynamism strongly influences decision-making in the construction industry, and thereby performance, positively. This is consistent with findings by Kim et al. (2009b) who conclude that a fit between the external possibilities of building projects and project decisions is related to enhanced project performance. In this research, the main contextual factors influencing project decision-making have been organised into five groups, namely economics, government, stakeholders, sustainability and technology.

a) Economic Condition

Langford and Male (2008) discover that project members decide according to project requirements, which are based on the regular scanning of economic development. Ding

(2008) argues that project decisions should be revised as environmental changes occur too fast and anticipating economic situations is fundamental to project decision-making. Similarly, the construction industry is particularly vulnerable since it relies on a prosperous economic growth and a safe environment for people to work and live in (Harris and McCaffer, 2013).

In many countries the construction industry is, economically, of high importance (Ortiz et al., 2009) and the Malaysian construction industry has been a significant contributor to both the state and federal economies (Ahmad et al., 2011). In IBS technology adoption, factors such as shortage of labour, dependency on foreign labour, cost and time uncertainty, occupational health and safety, better construction quality and productivity, and even unexpected building failures, have seriously impacted on the construction industry (Lou and Kamar, 2012). In addition, the environmental factor can be regarded as a perceptual-cognitive phenomenon, as seen by decision makers, because it affects decision-making that is linked with a degree of uncertainty (Proctor and Van Zandt, 2011). Thus, in IBS decision-making, it is important to understand economic-related factors such as industry competition, business dynamics, market demand, industry uncertainty and industry opportunity.

i) Industry Competition

In the highly competitive construction industry, effective and practical decision-making processes are vital for project development and survival (Flanagan et al., 2007; Sears et al., 2010). Unfortunately, too few researchers are studying areas related to managing engineering, building and construction projects (Porter, 2008). This is important to creating competitive strategies, forecasting the impact of new technologies and enhancing client relationships (Allen and Iano, 2011). Specifically, Yigitcanlar (2009) discovers that competitive and environmental turbulence have profound impacts on decision-making regarding new construction technology.

Although the element of competition is seen as fallacious, it has a place as an important consideration in project decision-making (Sears et al., 2010). This is recognised by several researchers who focus on the need for considering the industry competition in project decision-making (Halpin & Senior, 2010). Further, Jaillon et al. (2009) acknowledge that huge building projects are able to take advantage of large resources by pursuing niche strategies such as new building technology adoption, thus gaining competitive advantages that could not be achieved by small building projects. Davila et al. (2012) discover that certain projects decide to stay small in order to operate at low cost and compete on price. Nevertheless, Goulding et al. (2012b) explain that the effect of conventional building methods on a project's competitive position based on project sizes.

ii) Business Dynamics

Brady and Davies (2004) state that business dynamics such as trade, manufacturing, and buying and selling activities vary in nature in different building projects. In a moderately dynamic construction-industry market, business aspects are stable with predictable outcomes but in highly volatile environments, on the other hand, they become analytical, with unpredictable outcomes (Dangerfield et al., 2010). Specifically, Ibrahim et al. (2010) show a clear link between specific environmental forces such as interest rates and inflation and project decision-making.

Due to the increasing dynamics of the business environment, decision makers need to be more aware of the underlying elements and changes related to business factors, when adopting new building technology (Blankenbaker, 2012). Moreover, understanding the business dynamics related to construction activities in project decisions for the initial stage, creates a better foundation for technology adoptions (Berente et al., 2010) and saves all parties money and time (Sambasivan and Soon, 2007). According to Jaillon et al. (2009), modular construction is more common in the area where land sizes are limited and labour costs have increased.

iii) Market Demand

Understanding and meeting market demand are major driving forces of competitive strategy, and technology decision-making reflects this influence as tastes and preferences constantly change (Lim et al., 2010). End users are a resource whose purchasing behaviour and decision-making can be both rational and irrational, and projects make technology decisions to meet project demands (Moe, 2010). According to Ortiz et al. (2009), consumer preferences have been the target of the marketing segment in order to understand consumer behaviour and to meet consumer demands for sustainable building.

Even in the construction industry, developers are trying to exercise control over consumer behaviour by tapping into consumers' preferences, perception and awareness in order to develop strategies that create passionate attachments to a particular building design (Scott et al., 2013). Certainly, it is important to focus on economic goals (Brandon and Lombardi, 2010) and various marketing techniques are used to tap into innovative building designs using IBS technology (Davidson, 2013). The developments in the demand for building methods with higher quality and safety standards have been related to both higher returns and the increased awareness of the importance of IBS technology adoption (Nawari, 2012).

iv) Industry Uncertainty

Economic change can be problematic as it creates uncertainties (Stern, 2013). This implies an uncertainty element that assumes that the environment is not predictable and beyond the project's full control (Smith et al., 2009b). Moreover, the process of IBS decision-making is essentially a rigorous one, developed over a period of time, and it is also exposed to project- and industry uncertainties (Bari et al., 2012). This is indicated by Gambatese and Hallowell (2011) who assert that building projects which are long-term in nature have difficulties overcoming 'uncertainties inertia' when attempting to match technological innovations to changing and uncertain environments.

Decision-making in the construction industry relies on a strong community practice which attempts to cope with construction-project complexity and uncertainty (Ortiz et al., 2009). Specifically, Dubois and Gadde (2002) discover that project complexities include unpredictable local environments, unfamiliar industry standards and government regulations, lack of complete specifications and lack of uniformity in team works. Therefore, it is suggested that risk assessment methodologies, models and theories are used in decision-making, in order to control the business-process evolution and manage uncertainties (Barthelemy et al., 2006).

v) Industry Opportunity

Chachere and Haymaker (2011) acknowledge that more work has to be done to successfully integrate business challenges as an opportunity in building project decisions. The advantage of technology adoption in the context of exploring project opportunity is realised as an incremental process in project decision-making and has been documented by Pan et al. (2012a) who describe the course of action taken by several projects in breaking into the industrialised housing market in the 1990s.

Other IBS projects arrived in the building market with little pre-convinced ideas as to how to develop construction technology, but took advantage of opportunities that arose and developed their strategy according to changing local conditions (Bryan, 2010). As builders are included in the planning process, there will be more chances to identify IBS technology opportunities as it is important to make the decision to produce modules, at the start of the project design (Lou and Kamar, 2012). Moreover, Dunphy (2011) indicates that technology decisions must be identical for every instance or business opportunity that arises.

b) Government Involvement

Major decisions in building projects are often constrained by governmental or regulatory environment (Harris and McCaffer, 2013). Abdul-Rahman et al. (2011) and Zhang and Skitmore (2012) report that project decision-making was highly constrained due to high dependence on the external environment in relation to necessary project standards needed to operate safely. This was coupled with significant project or building requirements and their related policy implementation in the construction environment (Park et al., 2011; Söderholm, 2013). In addition to normative arguments such as this, from the government's perspective, there are two main reasons for the increasing interest in IBS technology adoption. The first is due to project aims in speeding up the delivery time and quality in building projects (Yahya and Shafie, 2012) and the second is based on the labour supply factors (Kamar et al., 2012a). Consequently, in IBS decision-making, it is vital to comprehend government's involvement through its policy, promotional activities, requirements and rules.

i) Government Policy

Arif and Egbu (2010) discover that the government policy on IBS technology, through its initiative to improve national productivity and reduce environmental impacts, has the power to influence project developments, and hence the related decision-making. IBS policy in the Malaysian construction industry is mainly applied through levy exemptions (Kamar et al., 2012a), which provide a benefit for construction firms who make a commitment to undertake more sustainable building (Abidin et al., 2013; Yunus and Yang, 2011) and less labour- intensive methods (Seman et al., 2013). Additionally, for environmental and public reasons, there is governmental interest to increase IBS technology adoption (Lachimpadi et al., 2012; Pons and Wadel, 2011).

These interests are strongly reinforced by the increasing number of issues in the construction industry like labour supply, costs and working conditions (Jaillon et al., 2009). Moreover, with the concern about public interests and safety, Li et al. (2011) and Boyd et al. (2012) report that there is a stricter safety policy on this issue and the realisation is that IBS technology adoption, by moving components off-site, not only improves safety for contractors' employees and supply- chain partners, but also for the general public. Many governments nowadays have a clear policy on sites with space constraints and IBS technology does not take up space, storing materials (Gibb, 2001) while the reduction in traffic improves the safety of people walking in the area (Shih and Liu, 2010).

ii) Government Promotion

Begum et al. (2010) highlight that the government's efforts to promote IBS technology adoption is based on the principle of reducing construction waste. Moreover, Mullens and Arif (2006) and Park et al. (2011) also discover that the conventional building method which is more labour intensive should be substituted with IBS technology adoption, due to labour issues. According to Nawi et al., (2011) and Yahya and Shafie (2012), the main barriers to adopting IBS technology are lack of government promotion and incentives.

The opportunity to promote IBS technology adoption has been expanded to include residential building projects (Arif and Egbu, 2010; Boyd et al., 2012; Jaillon and Poon, 2009). Moreover, various governments have made several initiatives to attract more private projects with the purpose of improving the level, or degree, of IBS technology adoption (Boyd et al., 2012; Jaillon and Poon, 2009). Likewise, the USA, Australia and the U.K. have been applying various strategies for IBS technology adoption in building projects (Xiao and Proverbs, 2012).

iii) Government Requirement

The demand for building standards for consistency and universal harmonisation of project requirements for IBS technology adoption, both by the government and the industry players, has led to great uniformity (Holton et al., 2010; Sabnis and Carter, 2011; Wang and Zhang, 2013). For example, in Malaysia, the adoption of IBS technology, in terms of building component design, is based on the Malaysian Standard “Guide to Modular Coordination in Building”, MS 1064 (IBS Centre, 2010). According to Nawi et al. (2011), in the Malaysian context, to satisfy the requirements of modular co-ordination, all components need to be standardised.

Certain governments set out strict requirements which must be met before building projects can be executed i.e. the disposal of construction & demolition (C&D) waste from reclamation sites and landfill space (Poon et al., 2004). In particular, government’s regulation restricts the range of construction practices that can be used for large building projects which require each regulating agency to set up an inspection system to certify compliance with these building technologies (Halpin and Senior, 2010; Ismail et al., 2012). In Singapore, the environmental requirement to reduce the carbon footprint of a project is mandatory, so there was more stimulus to utilise off-site manufacturing in order to reduce waste (Masudi et al., 2012; Wang and Zhang, 2013).

iv) Government Rules

The construction industry is a substantial example of a highly regulated environment that impacts technology decision-making (Harris and McCaffer, 2013; Ibrahim et al., 2010). This is due to the fact that building rules and standards provide scope for this in the first place, in relation to project developments (Kent and Becerik-Gerber, 2010; Sweet and Schneier, 2011). The Malaysian construction industry, for example, is regulated by a number of monitoring ministries and agencies such as the Ministry of Housing and Local Government, Construction Industry Development Board (CIDB), Fire Department and local municipality (Sufian, 2008). Moreover, the building regulations introduced by the government (Tricker and Alford, 2013) encourage the adoption of IBS technology, providing for a platform in developing and improving waste management (Begum et al., 2010; Jaillon et al., 2009) and site conditions in project developments. Nevertheless, Abidin et al. (2013) discover that the government's lack of incentive programmes and the slow progress in revising related regulations are major hindrances for institutional enablers in technology adoptions.

Meanwhile, Low (2011) and Zabihi et al. (2013) focus on the key important legislations relating to, not only public health and safety in the usage of precast components, but also to quality and productivity, workplace safety and health, build-ability and environmental sustainability. In addition, the government is also considering tax incentives such as tax deduction for contribution towards environmental funds to further incorporate and apply innovation in construction in the form of Industrialised Building System (IBS) (Kamar and Hamid, 2012). In building innovations, Harris and McCaffer (2013) also discover that procurement standards, contractual legislation and contractor-involvement agreements are also important. In addition, the implementation of modular coordination into Uniform Building by Law, planning standards and building specifications needs to be executed in IBS technology adoption (Mohamad et al., 2009).

c) Stakeholders' Participation

This section aims to examine evidence for the claims that have been made, for and against, stakeholder participation. The first part of the debate on stakeholders' influence is to determine if they have the power to really influence project-, or building-technology decisions, including IBS, through their opinions and views (Liu et al., 2011; Rowlinson and Cheung, 2008) and the second part is to identify whether stakeholders have the technical capability to engage in IBS technology, through partnering (Rowlinson et al., 2009; 2010). Stakeholder involvement is increasingly being sought and embedded into project decision-making processes in both small to large scale projects (Keil and Montealegre, 2012; Petursdottir et al., 2013).

Literature on how stakeholders influence decision-making argues that firms will pay attention to major stakeholders who can affect the project (Ofori et al., 2011). Additionally, Olander (2007) assumes that the control of critical resources or issues in the construction industry is a central principle of how stakeholders acquire power to shape decision-making. Although these studies suggest that the stakeholders' involvement may improve the quality of project decisions, Pryke and Smyth (2012) argue that they do so, with one caution, that is, the quality of a decision is strongly dependent on many other project and situational factors.

i) Stakeholders' Opinion

Stakeholders' participation is related to their opinion and initiative, rather than their attempts to meaningfully engage with IBS technology adoption (Ismail et al., 2012). Moreover, Kamar et al. (2010a) discover that when stakeholders are asked about IBS, much disagreement still exists over what constitutes the best practice in construction methods. In addition, Holton et al. (2008) identify that the distinct views of best practice from those who had taken part in project development processes, differed over how to tackle project issues.

However, not all stakeholders' views are mutually exclusive (Chen et al., 2010b) and a study by Soetanto et al. (2006b) shows that a broad consensus over key features of best construction practice is emerging from official participation by stakeholders in projects. Walker (2000) identifies that if a decision has been made and cannot really be influenced by stakeholders, then their opinion is not appropriate. However, it may be obvious that some stakeholders involve in a decision due to the statutory obligations of building projects (Hughes, 2011).

ii) Partnering

In several projects, advanced integration and collaboration of the different aspects in the construction process have been achieved through partnering, as designers or architects think in terms of prefabrication, early in the process (Love et al., 2013a; Osmani et al., 2008). As Tryggestad et al. (2010) observe, this shift reflects the importance of the relationship between project members, in technology adoptions. Although Gadde and Dubois (2010) discover that project-member relationship is a complex issue encompassing many fields, Rinas and Girmscheid (2010) believe that some technology-related issues can be improved through partnering.

Widespread acceptance and practice of stakeholders' contributions has partly been driven by increasing partnering in technology, and increasing knowledge and interest in decisions that are of environmental and public concern (Ozorhon, 2013). When decisions are highly technical, this may involve developing the knowledge, skills and confidence that is necessary to adopt a technology, through partnering (Chan et al., 2004). Additionally, Bresnen and Marshall (2000) highlight that partnering can be implemented in IBS technology adoption. Although partnering has received much attention in the construction industry, the way partnering influences decision-making depends on the degree to which it takes place and the make-up of the partners (Crespin-Mazet and Portier, 2010; Skibniewski and Zavadskas, 2013).

d) Sustainability Feature

Hukkinen (2013) identifies that sustainability and environmental considerations in decision-making, with the aim of improving community well-being and benefiting future generations, are becoming essential in project developments. Building-technology decisions such as IBS technology adoption, are rapidly becoming the subject of project development, where sustainable aspects and unexpected building-technology failures are universal issues (Ding and Shen, 2010). Consequently, building-technology failure continues to greatly affect the construction industry by making it difficult to effectively plan for future building-technology adoption (Augenti et al., 2013).

Harris and McCaffer (2013) and Holton et al. (2010) conclude that proactive environmental strategy is closely linked to the development of unique project capabilities, to achieve sustainability when deciding on IBS technology. Certain building projects emphasise the use of IBS technology in preference to conventional building methods, for sustainability improvement (Chen et al., 2010b; Shen et al., 2009). In fact, IBS technology is one of several approaches to sustainable construction (Ng et al., 2012a). Moreover, a technology path to sustainability needs to address the perspectives of a wide range of technology benefits and practices related to the technology (Wallbaum et al., 2012). Therefore, in IBS decision-making, it is important to understand sustainability features such as work efficiency, environmental protection, society trends and waste management.

i) Work Efficiency

The term ‘efficiency’ refers to a building-construction process claim, not a building-product claim (Chen et al., 2010b). Meanwhile, Pons and Wadel (2011) realise that building-project efficiency is defined by the technology used in the construction process and not by the inherent features of the project itself. IBS can bring about greater efficiency in project operations, better working environments and these are also concerns in IBS decisions (Yunus and Yang, 2011). Rapid development of building technology has become a top priority in many projects as they could utilise emerging technology and the efficiencies that it creates (Goulding et al., 2012b; Lachimpadi et al, 2012).

As identified by Ozorhon (2013), a safer working environment in off-site construction has created an efficient work process and this can reduce the risk and provide a path to sustainability. The newly recognised importance of building technology has precipitated suggestions for improving the project-development process through an efficient construction system (Ahn et al., 2010). A common understanding of what is meant by efficiency created by IBS technology is always related to project performance (Tan et al., 2011b). Harris and McCaffer (2013) highlight that not only are fewer people working in and around each other, but debris, stored materials and construction traffic are reduced and safer installation practices are being put into place.

ii) Environment Protection

Environmental concerns have been found to be one of the important determinants of IBS technology decisions (Jaillon and Poon, 2008). A growing number of studies have demonstrated a great interest in the related aspects of human well-being when considering IBS technology (Clements-Croome, 2011). Apart from the building process, end-users often perceive IBS technology adoption as representing an environmentally friendly mode of production as well as having certain intrinsic quality and safety characteristics (Kajikawa et al., 2011).

With regard to environmental issues, the link between attitudes, consumer behaviour and technology adoptions is not straightforward (Barr et al., 2011). Moreover, the way construction players make choices in adopting IBS technology is rather diverse and complex because, even though people may be concerned about environmental issues brought by IBS technology, it cannot be assumed that behaviour has changed accordingly (Goulding et al., 2012a). Lam and Wong (2011) emphasise that this is particularly the case when IBS technology represents a conflict between environmental soundness and various other quality attributes and prices.

iii) Society Trends

The growing number of living trends that appreciate modern building in search for sophisticated styles (Abidin et al., 2012; Ibrahim, 2013) and the development of new housing concepts have increased the need for understanding consumer preferences from sustainable perspectives (Schneiderman and Freihoefer, 2013). Moreover, global sustainability trends within the construction industry have brought new standpoints in an increasing and intense effort to adopt IBS technology (Knaack et al., 2012).

In this context, building projects must maintain their competitive advantage by developing and positioning a distinctive image in terms sustainability created by IBS technology adoption (Allen and Iano, 2011; Bari et al., 2012). Today, many construction projects can boost their products to launch dynamic and aesthetic design to satisfy consumers in the technology markets (Beddoes and Booth, 2011). Therefore, building technology may be useful in bringing new building products to market, faster (Allen and Iano, 2011).

iv) Waste Management

Designers, engineers and managers in the construction industry make decisions about what is manufactured, processed or constructed, and how this is done, and therefore the amount and type of waste generated (Lu et al., 2011b). Jaillon et al. (2009) comprehend IBS technology adoption as an essential tool in achieving sustainability through proper waste management at the construction site. El Haggar (2010) also argues that there is a need for new building technology, one that moves the industry to a new industrial system that values the environment, through waste reduction. Begum et al. (2010) present a relatively strong view about the critical importance of waste management at site and its implications for sustainable development in the construction industry.

While linking waste management to sustainability is consistent with (Ma, 2011), the focus is on policy content, decision and the process of transforming the concept into an operational reality through IBS technology adoption. Glass et al. (2012) also highlight that a proper construction system in IBS technology requires an efficient waste management system. Moreover, IBS technology has been a major influence in moving the construction industry sectors, and specific companies, away from simply transporting and managing waste and closer to resource recovery and associated market development programs (Bolden et al., 2013).

e) Technology Development

Technology and innovation adoption policy is one of the strategic fields in the industrial context of the construction industry (Styhre, 2009). Specifically, Charlett and Maybery-Thomas (2013) discover that building-technology advancements have been developing because the construction industry requires rapid, labour-efficient, cost-effective and quality solutions and that building projects struggle to keep up with such developments. Building technology, like IBS in particular, is perhaps the most important technology in construction developments. This is echoed by Tan et al. (2011a) who relate that building projects can gain sustained competitive advantage by establishing their strategies on building technology and leveraging their unique internal capabilities.

Unfortunately, the adoption of building technology in some building projects was recorded as a failure (Allen and Iano, 2011). Moreover, fundamental technological change aimed at innovating building projects, which influences IBS decision-making, is hard to achieve (Love et al., 2013b; Smith, 2011). Langford and Male (2008) discover that failing to stay abreast with technological developments in the construction industry could actually result in being more competitive. The main barrier to greater adoption of IBS technology is the increased cost compared to conventional building methods (Nawi et al., 2011). Consequently, in IBS decision-making, it is important to understand technology-related factors such as technology creativity, innovation, productivity and quality.

i) Technology Creativity

Innovation in the construction industry is often viewed as synonymous with creativity (Egbu, 2004). In addition, Sears et al. (2010) propose that the element of creativity that relates to construction technology is one that is both intended and realised. Langford and Dimitrijević (2002) however, observe that a creativity factor is unlikely as an absolute or pure deliberation in technology decision-making and suggested that construction projects often combine different technology intentions depending on the nature of the project.

Much of the early research on adopting building technology focused on activities and the impact on project-development success (Berente et al., 2010). Kamar et al. (2010b) also discover that satisfactory completion of various building designs using IBS technology is important to new project success. However, Charlett and Maybery-Thomas (2013) discover, in the area of project design, that building technology is a part of being creative in project development tasks.

ii) Technology Innovation

In Rogers' (2010) study, he discovers that technology innovations are developed with intent to capture a certain industry path and are realised during the decision-making process. Meanwhile, Blismas et al. (2010) acknowledge that in IBS decision-making, innovation goals are notified and become a promising project accomplishment through cooperative innovations in IBS technology adoption. Davila et al. (2012) advocate a model of building innovation as guided decision-making. This is consistent with Tidd and Bessant's (2011) emergent premise in building technology innovation that relates to the decision-making process for project development.

Innovation in construction happens when new ideas are developed, established and adopted within the construction process. In order for innovation to take place, there is a need to examine how IBS technology can be synthesised with project decisions, in order to attain the most efficient way possible of performing construction activities. Therefore, exploring the area of decision-making can assist in identifying the condition where technology innovation like IBS technology in building projects is most relevant.

Moreover, innovation culture can also effect technology adoption as Jones and Saad (2003) suggest. They find that working-practice innovation modifies existing construction methods through the ways in which a project is implemented and the contributions of all those involved. Building innovation for construction is important to create integrated and customised offerings that solve end-to-end customer problems (Sawhney et al., 2011). Furthermore, successful project implementation depends upon acceptance by project members, end-users and clients, of the building technology innovation (Gann, 2000).

Many innovations require a lengthy period of many years from the time when they become available to the time when they are widely adopted. In IBS technology adoption, decision makers must be aware of how the process of building technology innovation occurs and learn how to manage this schema. If a decision on innovation is to be of any benefit to the organisation, or a subsection of the organisation or the project, then it has to be translated into organisational or project actions.

iii) Technology Productivity

Productivity in building projects and its associated decision-making has been a long-standing feature of the construction industry (Tam et al., 2007). Thus, in response to productivity matters from conventional construction methods, the construction industry too is increasingly adopting building solutions as a part of strategic decisions to create intelligent buildings (Ralegaonkar and Gupta, 2010). Venkatesh and Davis (2000) discover that the implementation of new technology should consider the factors that are likely to lead to sustained usage, traditional productivity-oriented factors, social factors and facilitating conditions.

Individuals in lower positions in a project hierarchy can slow the diffusion process of building-technology adoption if they reject its productivity benefits (Goodrum et al., 2011). In addition, Jarkas (2012) and Yun et al. (2012) also argue that while the introduction of IBS technology is never straightforward, productivity measures are even more complex because they face resistance from a broad range of stakeholders. They involve consideration of, not only technological and environmental factors, but also the dynamics of social change in relation to productivity (Rojas, 2008).

iv) Technology Quality

Quality is another key feature of IBS technology adoption as it meets manufacturing standards in construction with the production of IBS components or modular units (Jaillon and Poon, 2009). As IBS technology is adopted in a controlled construction environment, this technology is essential in developing good quality-control management for a building project (Boyd et al., 2012). This is supported by Arif and Egbu (2010) who find that the controlled environment of a manufacturing plant lends itself to more thorough quality testing and traceability of components, which in turn enables the team to correct problems before IBS components arrive at the construction site.

The quality issue in IBS technology adoption is multifaceted, for various reasons including meeting project standards and requirements (Smith, 2011), as well as clients' expectations and satisfaction (Azhar et al., 2013). Therefore, advances in building technologies have substantially impacted on decision-making in terms of speed, time and quality (Cennamo et al., 2012). Doran and Giannakis (2011) also look at project decision-making involving technology quality issues which translates to cost savings and effectiveness. This is supported by Baldwin et al. (2009), as the reduction in defects resulting from IBS manufacturing avoids costly changes for the constructor, in the finishing phases of a project.

2.9.2 Structural Factors

One project-related issue that has received considerable attention is determining the structural- or project-organisation factors that influence IBS technology adoption (Ismail et al., 2012). IBS decision criteria have been developed which suggest there is a set of situational project variables which interact and influence the IBS decision-making process (Pan et al., 2012a). Thus, decision-makers need to alert themselves not only to evaluate choice and make judgments, but also to be aware of project situational factors that may influence their decisions (Chen et al., 2010a). This section highlights the importance and influence of project-related factors, from a micro-economic outlook, in the decision-making associated with IBS technology adoption and other building project matters.

IBS decision-makers in building projects have to consider a variety of project aspects such as communication, management, procurement and decision style itself, in the context of the project environment (Wu et al., 2013). Further, Doloi et al. (2012) discover that the fundamental factors related to structural perspective in construction projects are coordination, planning and communication. The importance of these structural factors is confirmed by Kim et al. (2009a) who associate project-related factors with project decisions, for better project performance.

Project organisation is relevant to decision-making (Love et al., 2002; Walker and Shen, 2002) and decisions can insightful impact on IBS decision-making through project and management aspects, via the flow of communications and the decision process (Zavadskas, 2010). Specifically, Ismail et al. (2012) discover that the management factors contributing to successful implementation of IBS projects are working collaboration, effective communication channels and team-member involvement. Research on building technology within construction projects has focused principally on the initiation and adoption stages, based on the understanding of which structural or project-organisation characteristics influence the decision-making (Sears et al., 2010). Accordingly, in IBS decision-making, it is important to understand structural factors such as communication process, decision-making style, management approach and procurement setup.

a) Communication Process

In order to be successful in the present project environment, decision-makers must develop some key communication skills (Dainty and Loosemore, 2012). Dainty et al. (2006) discover that effective communication practice has an adverse effect on project decisions and implementation. Emmitt and Gorse (2003) emphasise the need for effective communication in decision-making by following a set of procedures to achieve the project objectives. Additionally, Uher and Loosemore (2004) look at project decision-making and discover that many project members developed strategies incrementally, by going through a number of communication processes, including consultation with their key people, before announcing a final strategy. Therefore, in IBS decision-making, it is important to understand the communication process which includes formal and informal communications.

i) Formal communication

Kerzner (2013) highlights the importance of formal communication by project members, in project direction-setting. Kines et al. (2010) also reveal that formal communication is more likely to occur in stable project conditions than in unstable conditions. Ning et al. (2011) investigate the importance of formal communication in the decision-making process of project management and it is shown that formal communication occurs in various project groups, in decisions that favour project change and improvement. Fellows and Liu (2009) reveal that it is challenging to clarify whether formal communication actually influences project decisions. Conversely, AbouRizk et al. (2011) disclose that effective communication, rather than formal, enhances decision quality as project members would be required to examine project implementation closely due to project requirements and specifications.

ii) Informal communication

Bolles (2002) and Lindner and Wald (2011) are unable to show whether the practice of informal communication in project management influences the decision-making process but indicate that informal communication, if properly managed and used, can increase decision-making capacity and quality. However, according to Pan et al. (2012a), decision-making approaches can be based on individual experience and informal group discussion.

b) Decision-making Style

Hastie and Dawes (2010) indicate that decision quality is largely determined by the decision-making process and its analysis to achieve the optimisation of decision-making. However, these views are not without complications as decision quality in building projects can be difficult to define (Ding, 2008) Decision-making in construction projects can, however, change in a number of ways. A project management team can have a strong influence on project decisions based on a decision style with a full understanding of all the technical problems involved in construction projects (Fischer and Adams, 2010). Consequently, in IBS decision-making, it is important to determine the decision-making style of a building project such as group decision-making, individual decision-making and decision outcomes.

i) Group Decision-making

It has emerged that in decision-making research, the project-team aspect has occupied an important part since consultation with major project leaders is an integral part of decision-making (Love at al., 2012b; Snowden and Boone, 2007). According to Love et al. (2010), in project decisions, clients mostly judge project performance by the sign of success as recommended by other project members. In recognition of this situation, De Azevedo et al. (2012) and Lahdenperä (2012) call for project members to be actively involved in decision-making processes to ensure project specifications compliance.

It should be noted that group consultation and project compliance are often associated with each other and used interchangeably in project decisions (Volker, 2010). Moreover, Buyle et al. (2013) support team consensus as essential to decision-making and successful project implementation. In the construction industry, the most common way of working is within project teams, which are only temporary organisations and thus decisions are also made on a team basis (Lindner and Wald, 2011).

ii) Individual Decision-making

At board and executive level in particular, although project decisions are made based on organisational structure, certain individuals can also influence decision-making (Walker, 2011). According to Naoum (2001), a clear distinction between the board of directors and the chief executive officer is seen as important in protecting the interest of shareholders, by monitoring the actions of the executives and ensuring the best possible performance in project decisions. In such governance structures of construction projects, the top management's decisions have to be endorsed by the board of directors before further actions can be taken (Toor and Ofori, 2008). In certain circumstances, the project director thus becomes an individual decision-maker, influencing project and organisational strategy (Powell and Buede, 2009).

iii) Decision Nature

In technology adoptions, decision-makers could defuse any crisis or deal with uncertainties by following a decision-making style that would logically lead to the selection of the most effective and advantageous options (Ortiz et al., 2009). According to Engström and Hedgren (2012), decision-making in project management related to IBS technology adoption involves routine and non-routine decisions. Ritala (2013) discovers that in the real project management, it is most likely that a combination of these are made interchangeably. Therefore, it has become clear that ultimate project decisions can be made in a number of ways based on various decision-making styles (Keeney and Keeney, 2009). In this context, the way a problem is viewed, appears to be highly relevant in relation to appropriate decisions and actions (Bierman and Smidt, 2012).

c) Management Approach

De Groot et al. (2010) investigate the project-management approach in relation to environmental responsiveness when deciding on building technology and other project matters. In addition, Polasky et al. (2011) examine the role of the management approach in more detail pertaining project decisions. The value of management aspects in project decisions has been recognised by large projects that requires specific knowledge and skills (Porter et al., 2011). This part presents the interaction between managerial factors and project characteristics in deciding on building technology adoption and other building or construction decisions. Thus, in IBS decision-making, it is essential to determine the management approach as applied in building projects, which consists of project goals, leadership qualities, planning mechanisms, management process and project strategy.

i) Project Goals

According to Solway and Botvinick (2012), a goal is a requisite element in decision-making. In making a decision, the most creative task is to select the important factors for that decision by considering project goals, attributes, issues and stakeholders (Saaty and Vargas, 2012). This is important towards obtaining the overall view of complex relationships that occur in the project situation (Martinsuo and Ahola, 2010). Moreover, the aim of a decision is to achieve the objectives set for the project (Meredith and Mantel, 2011).

The notion of goals as part of a decision-making process affirming that it is more realistic to acknowledge that project goals have to be based on circumstances and changes, thus decision-making will reflect these changes, resulting in more anticipated implementation strategies (Saaty and Vargas, 2012). Specifically, goals can be stated in a number of ways such as project goals and technology adoption goals (Rose and Manley, 2011). Meanwhile, Moodley et al. (2008) reveal that stakeholders can influence or be influenced by project goals in decision-making process and business development activity.

ii) Leadership Qualities

Successful adoption of technology requires significant attention from the corporate or senior management levels of construction firms to plan and make definite decisions

(Langford and Male, 2008). Meanwhile, Rounds and Segner (2010) suggest that among other factors, leadership is central to the decision-making process in a building project. Azhar (2011) and Ma (2013) also examine the relationship between technology adoption and leadership, in project decision-making.

Top management is seen as critical to successful decision-making and project performance (Brandon and Lombardi, 2010). Furthermore, Lloyd-Walker and Walker (2011) express the need for good managerial leadership in project decisions. As working in a project is based on a project team, dependencies between members are based on a hierarchical structure with an effective leadership (Clarke, 2011). In such an organisational form, a formal project leadership is executed by a project manager (Muller et al., 2012) who has the overall responsibility for the project and who organises its structure and operations (Morse and Babcock, 2013).

iii) Planning Mechanisms

Flanagan and Jewell (2008) and Shen et al. (2010b) discover that building projects which are technologically driven, are based on a particular project planning. Winch (2010) suggests that long- and medium-range planning is fundamental to effective project management and in project decision-making. Williams and Samset (2010) emphasise that a well-defined decision-making process is one of the elements of a successful construction project, based on project planning.

ten Heuvelhof (2010) affirms that project decision-making should be associated with strategic planning that must be measurable, whilst Kanapeckiene et al. (2010) propose an information technology-based planning to assist project decision-making. However, these concepts of planning and forecasting that are strongly associated with project decision-making do not adequately consider a constantly changing environment outside of the project control (Therivel, 2012). Thus, other researchers recommended caution regarding the consideration of long-range planning in project decision-making, as Tompkins (2010) and Van Riel et al. (2011) who suggest that long-term planning in building projects is more exposed to changes in the construction industry.

iv) Management Process

The term management process refers to all activities in project stages from forecasting, scheduling, organising, supervising, evaluating, monitoring and controlling (Sears et al., 2010). Further, Scherer and Schapke (2011) explain that management process in a construction project should have a role in project decision-making as human and capital resources are critical considerations in this process. McCarthy (2010) has devoted a lot of attention to management processes in project decision-making, such as organising, monitoring and controlling in building project development.

Winch (2010) claims that the capabilities of management processes are shaped by external conditions. Meanwhile, Dikmen et al. (2007) articulate that many building projects have failed because of poor planning process, improper selection of the development and a lack of follow-up on key milestones addressed in the management process. Although IBS technology adoption may not be appropriate for all parts of a building project, the concept of a collaborative arrangement at the beginning of the process is important (Doran and Giannakis, 2011; Rashid, 2009).

v) Project Strategy

Strategy and project success are the ultimate aims of decision-making and they play an important part in making effective decisions (Langford and Male, 2008). In addition, capacity-management methods that can deal with uncertainties have a decisive impact on successful project strategy (Hans et al., 2007). Such views are related to the large-scale projects, which highlights that strategy formation or strategy implementation is an idealistic construct in a project's decision-making (Williams and Samset, 2010).

Project strategy has progressively moved away from a fully formulated planning process (Hyari et al., 2009) to a more emerging, flexible and developmental approach that better suits project decision-making (Cooke and Williams, 2013). More importantly, the project strategy for the building solution being sought, should be identified and the management decision whether to adopt IBS technology should consider the risks to determine which options can be applied (Bari et al., 2010; Nadim and Goulding, 2010).

d) Procurement setup

Procurement aspects are largely associated with clients, costs, resources and the supply chain, and are often highlighted in the decision-making process of IBS technology adoption (Shukor et al., 2011; Wu and Low, 2011). Moreover, Pan et al. (2007) recommend that in IBS decision-making, the driving forces are based on changing peoples' perceptions, improving procurement, providing better cost data, tackling planning and regulations, encouraging political levers and providing practical guidance despite the traditional drivers of time, cost, quality and productivity.

Therefore, the study of the procurement of IBS construction projects and comparing key performance indicators of IBS projects to those of traditional projects, are vital (Yunus and Yang, 2012). Additionally, costs, schedule, scope, quality and risks for each project procurement must be evaluated (Doran and Giannakis, 2011; Morledge and Smith, 2013). Thus, in IBS decision-making, it is important to explore procurement-related factors such as project clients, costs, project resources and supply-chain roles.

i) Project Clients

Although increased use of IBS technology in a project often shortens construction time, speed is not always the key benefit for clients, as a predictable schedule of project completion is more important (Smith, 2011). According to Nadim (2012), procurement specifically related to IBS construction projects typically focuses on identifying the client's objectives. Thus, to continue to improve the procurement process, clients should anticipate their evolving needs, especially the need for contract management (Eriksson and Westerberg, 2011). This process influences the decision of IBS technology adoption and the client first decides how much weight to give to the technical attributes while the rest of the choice is based on price (Pan and Sidwell, 2011).

For large IBS projects, the client will probably not possess all the knowledge required to make a decision (El Ghazali et al., 2012). Additionally, Smith (2011) investigates the decision-making in a large project and discovers that in the end, the client is always responsible for the procurement process. Moreover, the client's effort to obtain cost certainty on the construction activities for projects, has generally been the accepted approach (Patty and Denton, 2010). So whilst it is recognised that a cost certainty in

IBS technology adoption can have benefits for the client in an appropriate situation, the other cost-related factors governing the decision whether to adopt this technology, need careful consideration (Zhai et al., 2013).

ii) Costs

For the IBS market to develop further, two main problems need to be addressed; first, the lack of transparent information for the decision-makers in the construction process, particularly that relating to comparative costs, and second, the lack of available multi-skilled labour to work in the offsite factories (Goodier and Gibb, 2007). In terms of costs, decisions on new building technology are dominated by short-term costs to the projects (Pan and Sidwell, 2011). While for Kadir et al. (2006), costs should be a major impediment to IBS adoption due to the abundance of cheap foreign workers in Malaysia.

The benefits of IBS technology adoption are not limited to projects in remote areas, as many domestic projects located near major populations are being constructed, with significant cost- and time savings, by using IBS technology (Li et al., 2011). Although there are a number of benefits to IBS technology adoption at this time, direct cost savings may not be significant on many projects (Chen and Okudan, 2010b; Haron et al., 2012). In addition Bari et al. (2012) discover that in IBS technology adoption, variations also cause disputes among various parties, thus resulting in cost uncertainty. However, as IBS technology adoption becomes more common, costs will be easier to control (Sadafi et al., 2011).

iii) Project Resources

Klein (2000) mentions that project resources may be in the form of monetary funds, machinery, equipment and human resources. Such resources are seen as strategically important in project procurement and leading to a competitive advantage in the market place (Kelly et al., 2002). Moreover, Aritua et al. (2009) argue that in project development decisions, the project must interact with its external environment and it is dependent on resources aspects to procure the project. In certain building projects' procurement, IBS technology adoption may be beneficial because of the shortage of skilled labour within the local workforce (Kamar and Hamid, 2011).

Further, Boyd et al. (2012) and Wang et al. (2011) highlight that the benefit of IBS technology adoption is a more efficient use of employees especially in countries that have seen a decrease in the labour force. Recently, Nieto-Morote and Ruz-Vila (2012) and Zavadskas et al. (2010b) discover that decision-making process for contractors' selection by clients are based on contractors' technical qualifications, methodology and schedule. In this case, Lou and Kamar, (2012) and Polat, (2010) clarify that in a procurement process, before adopting IBS technology, the project should ensure the manufacturer meets quality factors or standards to reduce the major interruption concerns associated with project implementation.

iv) Supply-chain Roles

Research undertaken by Bankvall et al. (2010) has identified a number of common project failures resulting from problems associated with lack of integration, misallocation of project risk and poor decisions relating to supply-chain coordination and integration. Moreover, lack of client understanding and contact with the supply chain is another potential source of project failure, in terms of clarity of expected outcomes, roles, risks and rewards (Eriksson, 2010). As such, in IBS technology adoption, procurement teams also need to ensure that projects are packaged to generate sufficient market interest to secure the right supplies at a competitive cost (Eriksson and Westerberg, 2011).

Fluctuating process in a supply-chain management and costs of production continue to influence the procurement for building projects (Hartmann and Caerteling, 2010) and thus IBS decision-making. Among the few studies of supply-chain integration in IBS projects, Doran and Giannakis, (2011) and Kamar and Hamid, (2011) discover that supply-chain management and knowledge for clients are vital to add value and minimise inaccuracy in procurement, from planning and design, through to delivery, installation and operational maintenance.

e) Project Condition

Perhaps one of the most crucial factors in IBS decision-making is the project condition aspect and this notion has been conceptualised in project's characteristics, particularly on site conditions (Chen et al., 2010b). In addition, Demiralp et al. (2012) and Tam et al. (2010) discover that the situation of building projects is also important to determine the technology investment over time when implementing IBS technology. Warszawski (2004) concludes that in IBS technology adoption, various forms of project factors occur dependent on the type of project such as housing, office and infrastructures.

The project features are constantly changing due to the project duration, the number of team members involved and the events along the way (Baiden et al., 2006), which also influence the decision-making process (Thompson and Bank, 2010). Specifically, IBS decision-making is influenced by the project features (Park et al., 2011). Moreover, it is not easy to decide on a technology adoption as there are project issues particularly on project's cost advantages (Blankenbaker, 2012). Thus, implementing IBS technology in building projects involves critical control processes that need to be in place in order to support and protect the project's best interest (Berawi et al., 2012). Thus, in IBS decision-making, it is important to understand the condition of building-project factors such as project development, project information, project operation and project risk.

i) Project Development

Project development is one of the most important factors to affect the decision to adopt IBS technology (Ding and Shen, 2010; Son et al., 2011). Specifically, in building project development, the combination of severe climate conditions, that permit limited construction periods, and high labour costs may dictate the adoption of IBS technology to the maximum extent possible (Chan et al., 2011; Chou, 2011; Shen et al., 2010a). Moreover, Thompson and Bank (2010) discover that pre-development activities in projects, such as initial screening, feasibility study, project analysis, technological analysis and other market-related activities are important for building technology decisions as they are more profoundly executed for successful projects.

Additionally, in IBS technology adoption, prior to the development process, the requirements of the building project should have already been identified clearly (Faludi et al, 2012). Project development does not occur in a vacuum as it requires a strong commitment powered by the full range of project sources, particularly from green building and sustainable projects (Hwang and Tan, 2012). This constellation will be different in each building project, since all projects are unique (Barak et al., 2009).

ii) Project Information

Specifically, the acquisition of specific types of project information like information on IBS project nature, is useful in IBS decision-making as it increases the likelihood of project success (Yunus and Malik, 2012). In addition, the growing body of information about the success of IBS technology adoption in building projects will help contractors educate customers (Berawi et al., 2012). As construction companies incorporate more IBS knowledge and development into building construction projects, their knowledge and information base grows (Cavieres et al., 2011).

Chen et al. (2010b) and Smith (2011) evaluate IBS project performances to describe best practices and provide builders with information that will help them make informed decisions about modular coordination. Moreover, professionals in the construction industry have always expressed concern about the information on IBS technology adoption (Linner and Bock, 2012). However, due to the lack of exposure and information on the subject of IBS decision-making, some professionals have avoided IBS technology adoption (Sweet, 2013). According to Ilozor and Kelly (2012) and Nahmens and Mullens (2011), the major issue has always been that of determining the information on IBS success factors, or characteristics that make IBS technology the best choice.

iii) Project Operation

The ability to bring different trades together in one location to manufacture IBS components, and then install them in one location not only provides an efficient production-line approach to construction, but it can simplify the overall construction operations (Badir et al., 2002; Demiralp et al., 2012). Building components that can be assembled at the worksite do have a positive effect on the project operation, particularly on the construction schedule, which translates into savings for clients (Engström and Hedgren, 2012).

In addition, Arif and Egbu (2010) also discover that project operations are more predictable because building components are produced in a controlled environment that is not affected by weather, daylight or local restrictions on construction activities. For certain building projects, the major reason of acquiring IBS technology is to effectively and efficiently support the project operations (Nadim and Goulding, 2011). Moreover, within the project operation, the tasks are divided among the members, depending on their expertise (Smith, 2011).

iv) Project Risk

In IBS technology adoption, risks are determined, evaluated and managed in the project and responsibilities are shared within the project (Hassim et al., 2009). Moreover, this technology-acquisition process requires an extensive evaluation considering the project requirements, feasibility analysis and risk management assessment (Rose, 2012). In IBS technology adoption, Ko (2013) discovers that under uncertain situations the decision-maker is more risk seeking, to avoid more losses, whereas under conditions of certainty, the decision-maker becomes risk adverse.

Extensive research has been conducted on project risk but almost exclusively on the possibilities or threats of financial and management risk in decision-making (Burtonshaw-Gunn, 2009). Therefore, before IBS technology is adopted, it is essential to ensure that the risks are identified, analysed and managed (Hassim et al., 2009). Some projects have a specific risk- management division which is highly specialised within the field of project risks (Smith et al., 2009b). In this respect, risks associated with IBS technology adoption encompass issues related to the design and planning phases such as late design changes and unpredictable planning decisions (Goulding et al., 2012b).

2.9.3 Behavioural Factors

Since decision-making is essentially a human activity, it has a social and psychological aspect to it, which is well recognised in the behavioural decision concept (Hastie and Dawes, 2010). In this research, in order to investigate the processes of decision-making, a range of psychology (Furnham, 2012) and behavioural economics (Camerer et al., 2011; Wilkinson and Klaes, 2008) literatures are drawn upon, together with influential research in management science and construction management, to incorporate concepts on organisational behaviour (Walker, 2011) and rationality (Koleczko, 2012).

These concepts are grounded through a focus on technology management, organisational behaviour and construction management that provides insights into how behavioural aspects might combine in the contexts of the construction industry (Leiser and Azar, 2008). This lack of progress with IBS adoption has brought about a much needed focus on the decision-making process of IBS adoption. Moreover, the human dimension of decision-making (Proctor and Van Zandt, 2011), along with other intervening factors provides new perspective to exploring the IBS decision-making.

Lyon et al. (2000) discover that project behaviour can be observed, managed and measured. That is, know-how and skills allow decision-makers to adapt to innovative building technology. For many building projects, it was a revelation that the barriers of IBS implementation were readiness, awareness, knowledge, poor planning and negative perception, besides cost issues (Kamar et al., 2010a). In the study of human decisions, the illumination of decision-making principles and behaviour analysis can have greater impact on behavioural economics (Fantino, 2004). According to Faiers et al. (2007), behavioural research inculcates psychological factors to explain human behaviour in decision-making that can be applied carefully in other developing fields. Therefore, in IBS decision-making, it is essential to determine behavioural factors such as experience, attitude, people awareness and bounded rationality.

a) Experience

When facing the complexity of project development, project members draw on their personal experience from previous projects to interpret any project information, in order to make a decision (Bazerman and Moore, 2008). Additionally, Shepherd et al. (2011) indicate that highly skilled and experienced executives can make superior decisions in the setting of project decision-making. Decision-making capabilities that are shaped by various project experiences represent new learning opportunities for the project (Shaltry, 2009). Whilst Powell and Buede (2009) discover that the industry experience of project leaders has a significant effect on project performance, due to superior decision-making capabilities.

Humans' behaviour is also determined by the patterns of their environment which match with their new experience (Griffin and Moorehead, 2011). According to Huffman (2004), psychology is the scientific study of human behaviour and encompasses anything to do with mental processes linked to our private and internal experiences. As a complex cognitive mental process, decision-making requires mental and information resources that reflect our individual biases, therefore, experiences might be summarised by decision makers to facilitate effective decisions and to cope with their cognitive limitations (Ariely and Zakay, 2001).

In decision-making, decisions are translated into action based on persuasive communication, previous experience and information processing when dealing with crucial problems (Gollwitzer and Sheeran, 2009). According to Khatri and Ng (2000), to deal with incomplete information, intuition is needed to retrieve and interpret stored experience, knowledge and information derived from specific understanding of an unstable situation or dynamic environment. Moreover, decision-making is based on prior experiences to categorise situations and to quickly match the situation to the learned pattern, whereas the synthesis of experience is used to make judgement based on knowledge representation (Klein, 2008). Additionally, decision-making is based on personal experience and competence without quantitative data but considering cognitive, behavioural and environmental factors in real-world situations (Lizárraga et al., 2007).

b) Attitude

Manktelow (2012) identify the element of attitude, among others, as an important human character that can be triggered in decision-making. While Chin (2004) reveal that project decision-making is often guided by individuals' beliefs and attitudes, Yu and Tao (2009) also claim that, in the context of new technology adoption, the positive or negative attitude of the industry is important in decision-making and strategy formation, to achieve high project performance. Moreover, Rogers (2010) proposes a caution about negative attitude to new technology as it can lead to delayed awareness and acceptance, which can significantly influence decision-making.

Technology adoption decisions include explanatory variables like attitude to encourage changes in beliefs and evaluations, to achieve successful technology adoptions (Parkes, 2012). Mantel et al. (2006) suggest that the personal characteristics of decision-makers which influence the decision-making include task-related characteristics and attitude towards risk. The element of attitude with other realistic behavioural elements such as personal characteristics are also significant in determining the use of building material (Bysheim and Nyrud, 2008). Moreover, the decision-making process comprises a set of roles with different attitudes based on participant's roles and motivations (Van Kerckhove et al., 2011).

c) People Awareness

Pan et al. (2012a) reveal that barriers to the acceptance of IBS technology adoption are centred around, human awareness grounded in the historical failure of IBS practices to deliver improved performance, technical difficulties (e.g. site specifics, delivery issues, interfacing problems, cost), lack of opportunities for benefiting from economies of scale, and the fragmented structure of the construction supply chain. Therefore, a person's situational awareness is critical to the success of a decision process in any dynamic real world (Byrnes, 2013). Northouse (2012) discovers that the awareness of the same event particularly project problems can be quite different if framed differently in people's mind and this is in turn, can effect individual judgment and thereby decision-making. This is consistent with O'Faircheallaigh (2010) and Salas et al. (2010) who discover that the awareness element influenced decision-makers' information control, and further, their decision-making processes.

Meanwhile, Senaratne and Sexton (2011)) suggest that awareness of a technology failure in the construction industry tends to lead to defensive behaviour. Thus the awareness of threats and opportunities, besides cultural backgrounds can lead to different insights about the adoption of technology and its decision processes (Rogers, 2010). However, Porter et al. (2011) highlight that the link between people's awareness and technology decisions does not fully account for project performance and thus may be more complex. Meanwhile, Sears et al. (2010) discover that under similar uncertain conditions, decision-makers in two projects decided to utilise resources in different ways, as they assigned different values, based on different awareness, to project resources.

Generally, decision-makers have to respond to the changes of environment and they prefer to use self-consciousness or awareness rather than analytical processes (Betsch and Glöckner, 2010). As advances in psychology can be applied to economics in terms of human economic behaviour, decision-making conceptualises the human mind based on differences in awareness, subjective experience and future judgments (Pronin et al., 2008). However, it cannot be claimed that human knowledge is exclusively rule-based, as awareness and imagery are important in decision-making (Schank and Abelson, 2013). Therefore, Keller et al. (2010) declare that the decision-makers' information about their environment is based on the values and facts of their awareness, believes and knowledge that characterise their personality. Thus, in IBS decision-making, it is essential to understand factors related to people's awareness, such as personality, culture, support and values.

i) Personality

Behavioural-decision-making research is concerned with how people make choices and behavioural decision-making is predicted by individual differences in personality traits (Franken and Muris, 2005). Shiloh et al. (2001) suggest that in behavioural-decision-making research, decision complexity is interfered with by interpersonal differences and the drive to obtain the best choice alternative, through various decision rules. In behavioural economics, the application of psychological insights in making economic decisions involves decision-makers' characters and it can have remarkable effects on economic choices, transactions and aggregate economic consequences (Lerner et al., 2004).

ii) Culture

Generally, culture influences human behaviours and mental processes in decision-making (Matsumoto and Juang, 2013). In making economic choices, decision-makers are influenced by market and social factors to rationalise and predict a new phenomenon in the market environment (Walls and Hoffman, 2013). In addition to the evolution of psychology in decision-making, decision-making also involves some variances in economic behaviour such as socialisation, cultural adaptations and individual differences (Tosi and Pilati, 2011). Moreover, the implementation of project strategy requires a set of careful decision criteria such as economical, psychological and cultural aspects at group or individual levels (Milani at al., 2005).

In IBS decision-making, the culture factor would be different from one individual or one project to another. Thus, it is important to focus on whether decision-makers in the construction industry develop decision-making styles to capitalise on amalgamating the decision-making practices with a particular society, project or organisational culture.

This is also to determine the impact of culture factors on IBS decision-making to a great extent. Moreover, the style of management will impact on the way in which individuals participate or are allowed to participate in decision-making. If a manager is autocratic or democratic in approach, it may be a reflection of either an individual style or of the prevailing culture in the organisation or project.

iii) Support

In the interpersonal framework of decision-making, from the perspective of values, support and compassion may affect and influence the decisions (Beach, 2005). This is due to the nature of the relationship between the individual and the issue being negotiated which depended on the importance of individual outcomes and others' outcomes (Deci and Ryan, 2012). It is generally recognised that, despite the positive trend in supporting a technology based on values and attitudes, there are still different factors to the diffusion of the technology (Van Riel et al., 2011). The barriers to technology adoption stressed in project management literature, for example, involve end- users' reluctance to accept and support technology (Porter et al., 2011).

iv) Values

Beach (2005) evaluates the explanatory power of values for analysing people's attitudes and technology preferences in the construction industry. Further, Keeney and Keeney (2009) discover that values are thus considered as important criteria to select and justify actions because values are both self-centred and socially centred, in the sense that they are at the crossroads between the individual and the society. Economics and social psychology are heuristic tools for identifying factors that influence specific behaviours such as values, attitudes, habits, social norms, personal norms and control (Kallbekken et al., 2008). According to Fellows et al. (2002), a decision is the human element in the determination of a course of action, and decisions are not only governed by available information and techniques deployed but also by the outlook of the individual.

d) Bounded Rationality

Simon (1991) discover that bounded rationality is caused by the inability of the implemented decision technique to represent the non-optimal or non-rational conducts in which individuals or a group think and act. Simon's work on bounded rationality focused on his behavioural theory of bounded rationality which outlines decision-makers as partially rational as a result of computational limitations in information gathering and processing (Simon, 1972). Recent research demonstrated that, in the construction industry people can only exercise bounded rationality, when making decisions, as they possess limited cognitive ability (Li and Ma, 2011; Peh and Low, 2013; Ruan et al., 2012).

Nevertheless, bounded rationality is the basis that explain the decision-making process of IBS technology adoption because, in some building projects, individuals and firms exhibit ‘satisficing’ behaviour rather than utility or profit maximising (Bröchner, 2011). For example, according to Simon, and as highlighted by Brewer and Gajendran (2010), Formoso and Isatto (2011) and Levander et al. (2009), decisions made on the basis of bounded rationality are rarely optimal, instead resulting in ‘satisficing’ solutions, and outcomes.

Complex decision-making involves an approach with the best strategy, to make the right choice based on bounded rationality by means of human computational limitations and environmental constraints (Lee, 2011). In complex decision-making, Barney (2012) highlights two important boundary conditions: unconscious thought - for complex decisions, as performance depends on information magnitude, and conscious thought - which performed similarly to unconscious thought. In the bounded rationality of decision-making, Zeelenberg et al. (2008) discover that emotion refers to positive or negative experience, affection and moods that link to human behaviour in the process of determining choice along with providing quick intuitive indications to solve ambiguities or conflicts. Accordingly, in IBS decision-making, it is important to understand bounded rationality aspects such as cognition and learning.

i) Cognition

Decisions are influenced by the psychological context associated with past events, pre-set conditions and future outlooks, particularly the impact of cognitive bias on decision-making (Gigerenzer and Gaissmaier, 2011). In addition, cognitive psychology focuses on higher mental processes such as reasoning, information processing, problem-solving and decision-making (Sternberg, 2009). Cognitive thinking and behavioural-decision theory deal with making decisions in uncertain, complex and ambiguous conditions (Camerer et al., 2011). Meanwhile, Weber and Johnson (2009) indicate that early models in decision research attempted to explain changes in judgments or decisions (the "output") as a result of changes in information considered (the "inputs"). According to Stasser et al. (2012), decisions are eventually made by groups and the members prefer to select their shared, rather than unshared, information, as shared information can influence the preferred choice but unshared information significantly influences the quality of their decisions.

ii) Learning

Decision-making is based on organisation's learning thru a process as a social phenomenon in terms of understanding mechanisms to deviate from embedded culture besides information availability and beliefs (Simon, 1991). Learning is a function of one's ability and motivation, with the strengths of reinforcement derived from personal factors, such as cognitive factors, to learn, organise and understand ideas (Polasky et al., 2011). Garbuio et al. (2011) suggest that investment-related decisions involve the capabilities of integrating information into a judgement that is influenced by a state of mind, feelings or attitudes, biases, risk-taking behaviour, previous learning behaviour and cultural values. Faiers et al. (2007) discover that experience with social learning contributes to one's justification for a decision. According to Dane and Pratt (2007), in the uncertain world, people do seem able to develop some understanding of their environment by engaging important learning processes to understand the relationship between factors in the environment.

2.10 Summary

This chapter has presented the literature review related to the emerging field of decision-making to investigate the research problem: ***How do contextual, structural and behavioural influences impact on the decision-making of IBS technology adoption?.*** The literature covers various aspects of decision-making, technology decisions and decision-makers in the construction industry, building projects and IBS technology adoption. It was ascertained from the literature review that there is much research and development within these areas.

It was also discovered that there are a number of factors that influence IBS decision-making. These were categorised into contextual, structural and behavioural factors.

However, the literature indicates the limitations of previous research and a lack of holistic investigation to explore how various factors, particularly contextual, structural and behavioural factors impact on IBS decision-making. It is the aim of this research, therefore, to explore the decision-making of IBS technology adoption, its influencing factors and the way these factors impact on IBS decision-making, as perceived by the construction professionals in the dynamics of building projects. The next chapter will provide an integrated conceptual framework for this thesis and indicate its application for the current research.

CHAPTER 3 – THEORETICAL RESEARCH FRAMEWORK

3.1 Introduction

In the previous chapter, the literature on decision-making, IBS technology adoption and its influencing factors were reviewed in order to determine the way contextual, structural and behavioural factors impact on IBS decision-making. This situation was not established in the literature and therefore showed a research gap in this respect. This thesis will attempt to address this shortcoming.

Building-project activities, including IBS decision-making are subjected to consideration that regards the industry environment (contextual factors), project matters (structural factors) and human issues (behavioural factors). The selection of the content needed to carry out this study takes into account, not only the research problems and objectives described in Chapter 1, but also the unique characteristics of the construction industry that are the basis for the empirical stage of this research.

This chapter presents a theoretical research framework for the current study, to illustrate the significance of contextual, structural and behavioural influences on the decision-making of IBS technology adoption in building projects. In this study, IBS decision-making is studied based on its nature, and not according to the project stage. An integrated conceptual framework (ICF) is developed to express the importance of contextual, structural and behavioural factors in terms of the way they impact IBS decision-making. It is therefore, to guide this research to address the gap identified in the literature.

Chapter 3 outlines the background of the theoretical research framework (section3.2) and illustrates the Integrated Conceptual Framework of IBS Decision-Making which also presents a diagram explaining the constructs of this research. Section 3.2 also highlights the significance of IBS decision-making constructs as a basis for understanding IBS decision-making and its influencing factors. The components of the Integrated Conceptual Framework are explained in section 3.3 and provide further detail on the influencing factors of IBS decision-making. Section 3.4 outlines the expected outcomes of IBS Decision-Making Framework are the generation of IBS decision criteria and the development of IBS decision-making models. The chapter concludes with how the theoretical framework is applied in the current study, in order to answer the research question and to address the research objectives (section 3.5).

3.2 Constructing a Theoretical Framework For IBS Decision-making

The following discussion explicates how the constructs of IBS decision-making provide a more equitable conduct of the contextual, structural and behavioural influences underlying the decision-making of IBS technology adoption. The proposed framework highlights the concepts and focus of this research, based on the mapping of relevant elements identified in the literature into a comprehensive and integrated structure.

3.2.1 The Theoretical Gaps in IBS Decision-making

This section proposes a research framework and explains how the integration of contextual, structural and behavioural components can serve as the basis for IBS decision-making. In particular, this proposed framework intends to provide a research foundation for studying the influencing factors that help shape the IBS adoption decisions of various entities in the construction industry. The framework is based on the contextual, structural and behavioural perspectives of IBS decision-making with IBS technology adoption is viewed as a dynamic process of sense making in which a decision maker assimilates various dimensions in IBS decision-making. Five main points were identified through the literature review in Chapter 2.

a) Firstly, the literature recognises that IBS technology adoption in the construction industry is becoming increasingly complex, thus requiring a platform to understand the decision-making process leading to it.

b) Secondly, the literature on decision-making in the mainstream management/ behavioural science area and in construction management, does not adequately explore IBS technology adoption.

c) Thirdly, the influencing factors on IBS technology adoption are identified in the literature, but they are not contextualised from an IBS decision-making perspective, thus requiring an integration of decision-making studies in the areas of mainstream management, construction management and IBS technology adoption.

d) Fourthly, therefore, it is evident from literature review that many researchers have taken a narrow view of IBS decision-making, as most of them only consider limited factors impacting on IBS technology adoption, without exploring IBS decision-making as a phenomenon.

e) Lastly, there are various decision-making constructs in the construction industry but there is none on IBS decision-making. Therefore, a number of contemporary writers are calling for more holistic concepts, integrated models and frameworks to confront the new challenges that are faced by society-at-large and the construction-industry entities, in particular, pertaining to IBS decision-making.

Based on these key issues, the current study sought to investigate what drives the decision-making of IBS technology adoption and to understand the impact of various influences on this practice. Contextual, structural and behavioural dimensions offer several theoretical approaches to determine technology adoption and they are also influential in the decision-making process of IBS technology adoption.

3.2.2 An Integrated Conceptual Framework (ICF) of IBS Decision-making

Underlying this framework of IBS decision-making research, it is important to describe the nature and interrelations between the key issues in IBS decision-making and its influencing factors. In order to achieve this, this study used a holistic approach to investigate the decision-making of IBS technology adoption and its influencing factors. A holistic approach which was discussed in Chapter 2, was seen to support an appropriate theoretical framework for the current study because this approach demonstrates a comprehensive view involving how various factors impact on IBS decision-making.

Making holistic associations is not only a characteristic of understanding but also gaining one of perception's advantages over other decision-making approaches (Dane and Pratt, 2007). Moreover, there is a greater understanding of the need for a more holistic approach if the construction industry is to contribute to an efficient and sustainable economy in the future (Myers, 2013). The approach also allows a variety of individual and environmental factors associated with IBS decision-making to be identified, and provides an explanation for how these factors impacted on IBS decision-making. The approach can also be used to understand the decision-making of IBS technology adoption in a universal way. In addition, the approach has been widely used for research into management and to investigate less tangible processes like decision-making (Dane and Pratt, 2007; Garvin, 2012; Salas et al., 2010).

As previously discussed, the broad aims of this research were to investigate what drives IBS decision-making and to better understand its influencing factors. In order to achieve the research objectives, the current study examined a number of issues and sought to:

a) Identify specific factors that decision-makers in the construction industry perceived to influence IBS decision-making;
b) Investigate the impact of these identified factors on the project members' decisions to adopt IBS technology in building projects;
c) Understand the role of these identified factors and the way they influence IBS decision-making.

Although IBS decision-making is perceived as a continuous and complex process (Engström and Hedgren, 2012), for the purpose of further investigation, it is divided into three main groups:

a) The influences of contextual, structural and behavioural factors. All three are present both within and outside of building projects, to a certain extent, those factors have their own impacts on decision-making.
b) The decision-making process of IBS technology adoption. This involves a system that puts into practice the influencing factors to the decision-making processes.
c) Perceptions of decision-makers in building projects: based on inter-project and intra-project perspectives, to understand some of the ways in which contextual, structural and behavioural factors influence IBS decision-making. Inter-project perspective involves the group of construction-profession stakeholders who is contemplated to use IBS technology across the construction industry. Investigating non-specific project context where technology adoption is most likely to happen in construction can assist in identifying the areas where IBS in all probability is most relevant.

> Meanwhile, intra-project perspective includes the group of project supply-chain members in IBS projects who is mandated to adopt IBS technology across the building project. In this case, by focussing on specific project context, the drive to adopt IBS technology is facilitated by the relatively straightforward technological process and decision-making that are already in place within a building project.

Multiple perspectives in research explore the different ‘realities’ of people in the industry (Leu, 2010). Therefore, multiple perspectives could provide better understanding of IBS decision-making as they look at the integration of multiple ‘realities’ in the construction world. Based upon an integrated understanding of the above three perspectives, an integrated conceptual framework of decision-making underlying IBS technology adoption is proposed in this chapter, as illustrated by Figure 3.1.

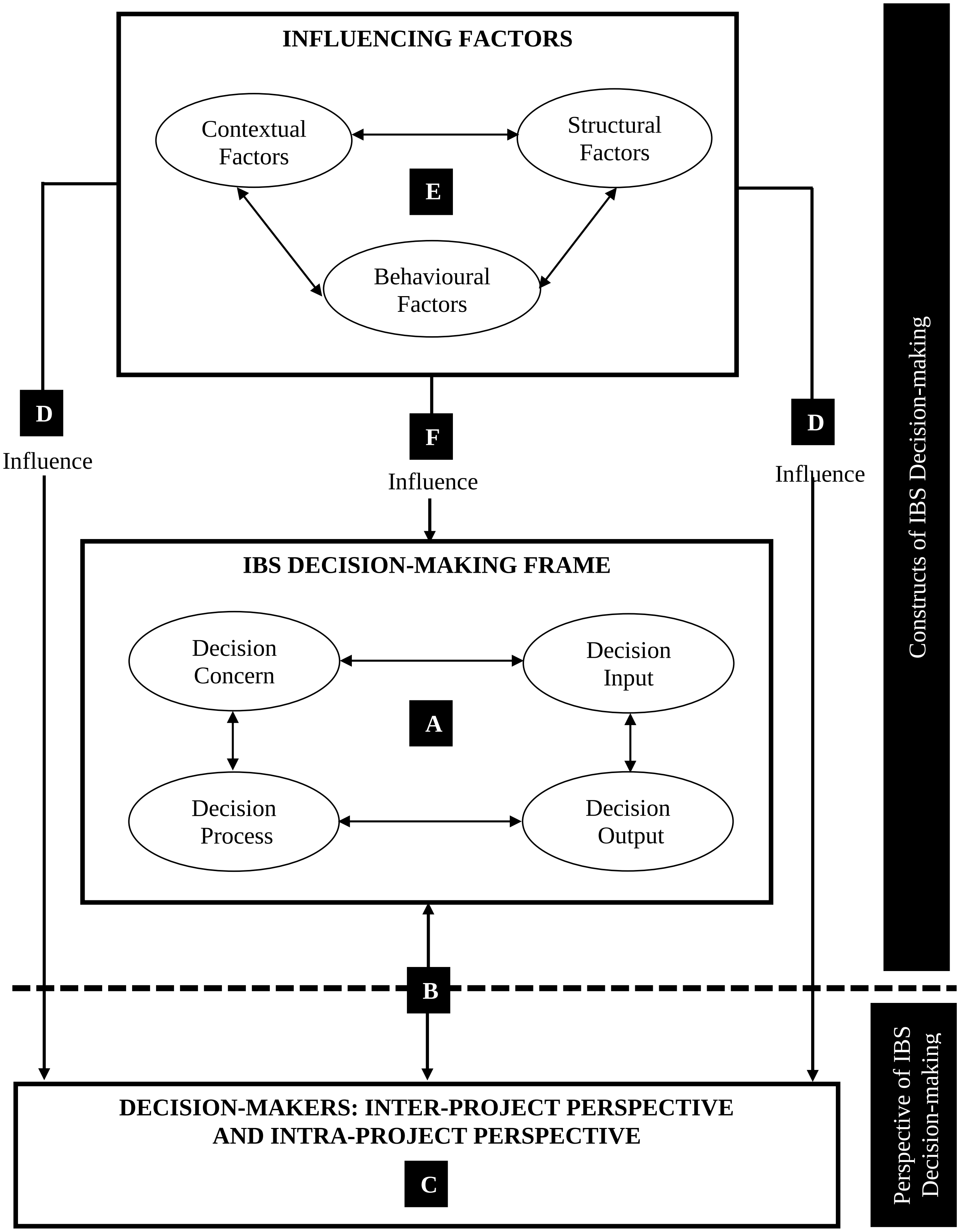

Figure 3.1 Integrated Conceptual Framework (ICF) of IBS Decision-Making

Figure 3.1 expresses the thesis concept and research focus in an ICF, linking the relevant components identified in the literature into a cohesive construct. The diagram reveals that contextual, structural and behavioural factors potentially affect, not only IBS decision-making process, but also the decision-makers from an inter-project and intra-project perspective, due to their inter-connectedness.

3.2.3 Theoretical Model Illustrated

Figure 3.1 depicts the complexity involved in IBS decision-making, by highlighting the interrelations and connections between the components of the ICF. Alphabetical labels from A to F have been assigned to the various arrows to explain how these components interrelate.

A. Component A: In a decision-making frame, IBS decision-making is not stable and linear in nature, but is dynamic through the interactions of various elements namely ‘concerns’, ‘inputs’, ‘processes’ and ‘outputs’. These elements can interact in a number of ways, resulting in different trajectories leading to different outcomes. For example, an IBS decision is made based on the inputs from project members (e.g. Chen et al., 2010a; Pan et al., 2012a) and concerns about risks, uncertainties (Fischer and Arayici,, 2010), management issues (Shih and Liu, 2010), environment (Holton et al., 2010) and business or economics (Arif and Egbu, 2010) in order to achieve certain outputs (Al-Bazi and Dawood, 2012; Ko, 2010).

B. Link B: This arrow represents the way decision-makers perceive IBS decision-making, based on decision-makers’ perspectives including inter-project and intra-project perspectives. It also reflects the influence that IBS decision-making frame can have on decision makers based on each project perspective. For example, a strong reliance on decision outputs indicates a strong emphasis on IBS decision-making from an intra-project perspective in which the project member takes on a more dominant role based on the practical implementation of IBS projects.

This is particularly true under certain project conditions when a building project is mandated to adopt IBS technology due to the project design (e.g. Fellows and Liu, 2009; Lou and Kamar, 2012). Conversely, the arrow may direct the opposite way if, for example, the project is required to adopt IBS technology due to time factor or other project conditions (e.g. Arif et al., 2012; Goodier and Gibb, 2007; Jaillon et al., 2009; Lam and Wong, 2011).

This arrow also represents an actual IBS decision made to pursue a building project goal. The fact that the line is double-arrowed indicates a feedback mechanism whereby an IBS decision may be reviewed, for example during project meetings, particularly in the case of long-term growth of project development (e.g. Blismas et al., 2010; Crews et al., 2011). Some decision-makers, based on inter-project or intra-project perspectives, can influence the decision-making of IBS technology adoption in the future.

However, this situation depends on the nature of building projects themselves. For example, IBS decision-making may require the features of IBS building projects as benchmarks (e.g. Kamar et al., 2012; Ozorhon, 2013; Pan et al., 2012a). Thus decision criteria developed through intra-project perspectives may be appropriate (e.g. Abdullah and Egbu, 2010b; Chen et al., 2010a; Yunus and Yang, 2011). Inter-project perspective across the construction industry on IBS technology adoption, on the other hand, may need a more analytical insight for future IBS decisions (e.g. Park et al., 2011; Segerstedt and Olofsson, 2010; Smith, 2011).

C. Component C: Decision-making in building projects pertaining to IBS technology adoption often depends on what role each project member has played and which decision paradigm the project has adopted. The way these project members identify IBS decision-making and its influencing factors is based on multiple-perspectives. For example, according to the intra-project perspective, IBS technology adoption would be clearly distinguished with the aesthetic aspects of building projects (e.g. Onyeizu and Bakar, 2011; Rahim et al., 2012), but the inter-project perspective across the construction industry may perhaps consider IBS technology from cost- and budget standpoints (e.g. Haron et al, 2012; Laing et al., 2001).

In project decision-making, the project consultants are reporting to the project clients, with the Board of Directors ratifying the decision (e.g. Love et al., 2012b; Taylor, 2010; Tuuli et al., 2010). Varying from project to project, this role of project members in decision-making may be less clear depending on whether it is a public or private project (e.g. Gudienė et al., 2013; Jaillon and Poon, 2009; Lou and Kamar, 2012).

Further, various project members, from an inter-project or intra-project perspective and based on their capabilities within the building project, would further influence IBS decision-making due to their technical knowledge, experience and networks (e.g. Cavieres et al., 2011; de Lurdes Penteado and De Brito, 2010; Nawi et al., 2011).

D. Link D: Decision-makers in building projects could certainly be affected by the contextual, structural and behavioural factors directly. For example, a decision to adopt IBS technology in a building project could be due to a competitive advantage in the marketplace, or a change in the regulatory environment may lead to IBS technology decisions (e.g. Blismas et al., 2010; Eliasson and Gustafsson, 2013; Kamar et al., 2012).

Equally, the level of IBS technology adoption as reflected by the inter-project perspective across the construction industry can also be due to related policies. Therefore, slow adoption of IBS technology in building projects may lead to a revision of policies to increase IBS take-up and competitiveness (e.g. Amar et al., 2012; Holton et al., 2010; Park et al., 2011).

Contextual, structural and behavioural factors would have a strong influence on the decision-makers. IBS influencing factors are particularly highlighted in the long-standing debate (e.g. Badir et al., 2002; Yee and Eng, 2001). Essentially, in an increasingly dynamic construction industry, project members may decide to comply and contribute in this building-technology era and need to alter their internal structure to do so effectively (e.g. Circo, 2008; Sacks et al., 2010a; Tan et al., 2011a). IBS decisions can also result from changes in project requirements, for example, from changing mission statements or employment conditions (e.g. Blismas and Wakefield, 2009c; Nadim, 2012; Ofori et al., 2011) or in cognition and evaluations if project team background leads to varying perceptions (e.g. Love et al., 2013b; Wang et al., 2012).

E. Component E: There are views within the literature that various factors have led to IBS technology adoption in building projects with various resulting performances (e.g. Larsen et al., 2011; Majid et al., 2011; Monahan and Powell, 2011). Regulations, IBS technology and competition are all interrelated in the context of the construction industry. For example, regulations can determine technological requirements such as a certain level of IBS technology adoption, in public building projects (e.g Begum et al., 2010; Seman et al., 2013; Shen et al., 2010a). IBS technology adoption, in turn, can enhance competitive advantage or develop business opportunities in the marketplace (e.g. Abdullah and Malik, 2012; Girmscheid and Rinas, 2012; Sheffer and Levitt, 2010a).

Structural factors which contain project-related features such as management, procurement and communication are highly interactive as was shown in the literature review. Structural factors can have profound impacts on IBS decision-making via the flow of project communication and interaction (e.g. Emmitt and Gorse, 2009; Ismail et al., 2012; Viana and Sampaio, 2013) and through its procurement features (e.g. Jaafar and Radzi, 2013; Johnsson and Meiling, 2009). Project costs, for instance, can be an important consideration in procurement-related matters (Bari et al., 2012; Love et al., 2012a).

The behavioural influences on IBS decision-making are determined particularly via the perception of participants towards a certain issue or phenomenon. The behavioural aspects of decision-makers can affect IBS decision-making particularly via human perceptions (Love et al., 2013a; Majid et al., 2011) but also by attitude, for example, in a culture where new technology is less likely to be easily adopted (Gajendran et al., 2012; Lehmann and Fitzgerald, 2013; Lovell and Smith, 2010; Waziri and Vanduhe, 2013). A negative perception of the technology can lead to a protective behaviour (e.g. Nawi et al, 2011; Yusof et al., 2012), resulting in more precautious decision-making (e.g. Amar et al., 2012; Engström and Hedgren, 2012). Moreover, in IBS decision-making, there is a limit on decision-making capabilities due to bounded rationality, as discovered by Simon (1972), which is applicable in construction projects (Williams and Samset, 2010; Yin et al. 2013). Thus, the remaining concepts of bounded rationality are included.

F. Link F: This arrow expresses the underlying postulation in this thesis that various aspects of contextual, structural and behavioural factors influence IBS decision-making in a certain way or pattern. Impacts on IBS decision-making can be generated by a myriad of contextual causes such as government policy (e.g. Pan et al., 2012b; Park et al., 2011), or socio-economic changes (e.g. Goulding, et al., 2012b; Jaillon et al., 2009) and take on a number of forms such as technology productivity, physical environment and sustainability (e.g. Aye et al., 2012; Wong, 2011). Changes in the external environment such as the regulatory conditions and competitive advantage have various impacts on IBS decision-making (e.g. Ndungu et al., 2012; Ko and Wang, 2010).

Further, structural factors such as project risk and project operation can influence IBS decision-making, despite a requirement from certain regulations or legislation (e.g. Ghaffari, 2013; Hassim et al., 2009). If the project planning is successful, it could lead to a significant influence on IBS decision-making (e.g. Faludi et al., 2012; Zavadskas et al., 2010b).

The way in which a building technology is perceived may influence IBS decision-making (e.g. Pan et al., 2007; Velik and Zucker, 2010). The literature identified that cognition and information-processing capabilities are an important human facet of decision-making (e.g. Appelt et al., 2011; Jones et al., 2011; Parayitam and Dooley, 2009; Zavadskas et al., 2010b). This has however, not been included in the study on IBS technology adoption and its decision-making.

The direct impact of contextual, structural and behavioural factors on IBS decision-making is unclear in the literature and represents the research gap that is being investigated in this thesis.

3.3 Composition of Integrated Conceptual Framework (ICF)

ICF is a decision-making framework from the perspective of behavioural economics (Camerer et al., 2011; Kahneman, 2003; Wilkinson and Klaes, 2008) which is to present IBS decision-making as an integrated practice with a more balanced view of contextual, structural and behavioural consideration; and to demonstrate the need for a more integrated approach with the perspective of dynamics in the competitive construction industry.

According to Davenport (2009), behavioural economics involves the incorporation of research on economic behaviour and thinking, into decision-making, as it illuminates the area of irrationality when findings in the field are still unclear. ICF is an illustration on how both behavioural economics and project management plays their roles in explaining the way they influence IBS decision-making and further, to understand the adoption of IBS technology.

The integrated conceptual framework moves beyond early models in decision research which attempt to explain changes in judgments or decisions (the "output") as a result of changes in information considered (the "inputs"). In the real practice of decision-making, there are more than inputs and outputs, and it is this range of contextual, structural and behavioural factors that are incorporated into the framework of this research.

3.3.1 IBS Decision-making Frame

The exploration moves from general decision-making to the more specific decision-making of IBS technology adoption in the construction industry. Therefore, it is essential to explain the important components of IBS decision-making.

a) Decisions – represent routine and non-routine activities, internally to manage projects through economic effectiveness and to compete successfully by creating knowledge-based advantages, and externally, focusing on a project's positioning in the competitive and uncertain construction industry.

b) Decision-making – represents the task of making choices from a series of potentially viable options or to opt for the best competitive alternative at project level, in the construction industry. In the context of this research, decision-making will be based on the perceptions of multiple-perspective project members.

c) IBS – represents modern construction processes, techniques and technology which include these attributes: off-site production of building components, the use of standardised building components, the use of fabricated and precast concrete components, design using a Modular Coordination concept and repeatability.

d) Technology adoption – represents the actual application or use, or installation of technology in terms of its physical aspects based on users' knowledge, skills and procedures in real the functioning area of construction industry into the firm's operating or functioning systems in implementing building construction projects. The emphasis of this research is on how building projects adapt and modify their building-construction practices with relevant adjustments, in response to technological change in the construction industry.

IBS decision-making represents the combination of various approaches that are standardised and based on decision theories for evaluation (normative model), an actual decision made (descriptive model) and how decisions should be made (prescriptive model), to decide on IBS technology adoption, which is also subjected to the contextual, structural and behavioural factors of the construction industry.

Contextual factors can certainly affect IBS decision-making directly or indirectly and as can structural factors. However, the direct or indirect impact of behavioural factors with the consideration of contextual and structural factors on the decision-making of IBS technology adoption, is uncertain in the literature, thus representing the research disparity that is being explored in this study.

a) Decision Process

The decision-making process encompasses all activities and elements that are involved throughout the decision-making. However, there are differences in decision-making process in terms of decision types; short-term operating control decisions or periodic control decisions or long-term decisions, group or individual decisions, based on various justifications in a building project. The decision-making process involves various elements, stages, approaches and perspectives in people's mind which link to decision outcomes. Static decision tasks involve only a single stage, as one decision is followed by one outcome. Saaty and Vargas (2012) propose three stages, namely pre-decision, decision and post-decision, that are interdependent.

Goodwin and Wright (2007) by comparison, propose a decision analysis with nine stages from the implementation stage to the end of the decision processes. However, Davenport (2010), Narasimhan et al. (2010) and Saaty (2008) argue that it is better to focus on the decision-making process and this will lead to better decisions. It is also important to recognise that identifying effective decision-making necessitates viewing decision-making as a comprehensive process (Barney, 2012; Keeney and Keeney, 2009; Snowden and Boone, 2007).

b) Decision Concern

IBS decision-making is clearly a different subject, when applied to construction activities, than in other industries. In a multi-aspect field such as construction, the issues relating to decision-making are numerous. Generally, decision process and outcome are strongly linked (Ansell and Gash, 2008). It is seen that primary importance should be assigned to the decision process with next importance given to various considerations or concerns (Ortiz et al., 2009; Subramanian et al., 2010). Whilst most authors (Chen et al., 2008; She et al., 2010) discover that the purpose of reviewing decision-making is to facilitate making better decisions in the construction industry, few actually define the major concerns in IBS decision-making. Moreover, IBS decisions are made to reduce project uncertainties created by weather factors (Seman et al., 2013; Smith, 2011).

The IBS design decisions for instance, are based not only on features that went well before, but also lessons learnt from projects that did not meet client needs, which is also an important input for IBS decision-making. IBS decision-making is geared towards developing internal capability in the building-technology adoptions and making the building solutions more credible and robust for the client.

c) Decision Input

Construction is seen as a set of activities characterised by an input and an output, with the objective of producing a certain product (Langford and Male, 2008; Ortiz, et al., 2009; Rondinelli, 2013) and so the same goes for IBS decision-making. IBS decision-making in building projects includes project information about the correct solution, as the IBS technology adoption is not always known (Kamar and Hamid, 2011; Nawari, 2012). A good example of this is seen in attempts to determine the durability of IBS technology (Mirsaeedie, 2012; Onyeizu and Bakar, 2011).

Intuitively, an effective IBS decision is thought to be one for which the result or outcome is excellent project performance. This phase is not the beginning of the decision-making process, rather it is the decision-maker coming up with an initial list of technical and non-technical requirements based on knowledge and experience drawn from previous and ongoing projects. Focusing on the project performance, in this manner, is common practice in construction-industry decision-making, simply because a building project is a result-based environment (Lam and Wong, 2009). Besides this, decision-makers have the opportunity to evaluate the project members and other role-players on the project. Their feedback, reflecting actual experience of the benefits or weaknesses of IBS technology adoption, can be valuable as quantified or measured input, thus providing very specific insights to assist with the management of the technology (Mohamad et al., 2009; Polat, 2010; Yu et al., 2012).

Technically, Demiralp et al. (2012) and Love et al. (2013b) discover that the various input variables used for IBS decision-making are subjected to inaccuracies that result from the fundamental structural-, site-, management practice- and construction- process conditions, as well as from the construction contract. Therefore, differentiation in this respect relates to the variety or diversity of the tasks involved in the construction process, such as number and diversity of inputs or outputs, number of separate and different actions or tasks by IBS technology, time or territory, and number of specialities (Gambatese and Hallowell, 2011; Jelodar et al., 2013; Nadim and Goulding, 2011).

d) Decision Output

In IBS decision-making, IBS technology adoption involves very high initial costs (Baldwin et al., 2009; Bari et al., 2012), for example capital investment in machinery, transportation and materials. In the construction industry, where definite decision outputs are almost always uncertain, the nature of the outcome is extremely important to ensure that decision outputs could also lead to project productivity and profitability (Giang and Sui Pheng, 2011; Mahmoud et al., 2009). Additionally, Lai et al. (2008) and Olawale and Sun (2010) even postulate that performance of building projects is often linked to good output and many decision-makers who have a good output could contribute to a company's persistence.

Kamar et al. (2011) argue convincingly that the output of a decision is linked to not just the decision process, but also to the whole project implementation. This is based on the assumption that decision process and its expected output are very strongly linked and pursuing a good process will lead to achieving a good outcome in the long run (Banzhaf and Boyd, 2012; Puterman, 2009) reinforce the idea that by considering decision output, it becomes possible to confront the challenge of developing explanatory and predictive accounts of human decision-making in complex situations, such as those found in the construction industry.

3.3.2 Influencing Factors of IBS Decision-making

A key focus of this research is to explore the influence of contextual, structural and behavioural factors on IBS decision-making. The literature in Chapter 2 showed that decision-making in building projects could not be separated from the setting and perspective in which it occurred. The project members accounted for circumstances in their decision-making by complying, changing or modifying decisions that they would have otherwise made in response to contextual, structural or behavioural factors, but also by developing approaches to manage and control the situations of their practice.

This is consistent with other findings such as those of Sears et al. (2010) who specify that if decisions are made in different decision conditions or environments, risk and uncertainty are common at higher levels, where problems are more complex and unstructured. The broader context of project decision-making can be seen to consist of different types of factors (Ochieng and Price, 2010; Winch, 2010) that become relevant to IBS decisions; these include social, professional, organisational, and physical and environmental dimensions. The literature contains a number of examples that illustrate how decisions are influenced by these contextual factors.

a) Contextual Factors

The contextual factors in this research which comprise political, economic, legal, technological, cultural and social trends, is the context that establishes the nature of the competitive landscape and these indicate the possible influences on IBS technology decisions. The trends of technology adoption in society indicate the direction that decision-makers in building projects appears to be taking (de Azevedo et al., 2012; Harris and McCaffer, 2013).

The assessment and the mapping of contextual factors are based on perception and understanding of IBS decision-making and its contextual environment among participants from the group of construction-profession stakeholders and supply-chain members of IBS projects. Therefore, these perceptions are encapsulated within the version, interpretation and subjectivity of those who conduct evaluation on these contextual factors and finally make a decision, based on what they believe is the most important or significant of a given context.

As a result of the complexity that characterises the construction industry and the features involved in the adoption of IBS technology, it would be essential to comprehend contextual influences in IBS decision-making. Therefore, the focus and considerations of contextual influences is based on various dimensions. The construction industry comprises of rules, regulations, standards, processes, systems and other aspects that are customary to construction activities (Klinger and Susong, 2006).

The nature of construction activity, its operating systems and its dynamics are changing rapidly (Gong and Caldas, 2011). Besides the stringent regulations, statutory control and environmental concern, there are also concerns about building-product substitution (Monahan and Powell, 2011; Robertson et al., 2012). Other competitive trends such as the entry of new competitors, new forms of competition, and mergers and failures of competitors are also of particular importance in the projects environment, to ensure projects' sustainable competitive advantage (Lim et al., 2010; Holton et al., 2010). In a perspective of this kind, the focus is to outline the scope for comprehensive analysis of the nature of competition in construction projects.

Tan et al. (2011b) discover that the interaction between project context and decision-making was reciprocal, complex and dynamic. The influence of specific contextual factors on decision-making was dependent upon the unique features of the decision being undertaken at the time (Hukkinen, 2013; Langford and Male, 2008). Moreover, Chan et al. (2004) and Smith et al. (2009b) discovered that a project context was not a fixed entity but was found to be dynamic and variable.

A key finding of Turskis et al.'s (2009) research was that contextual factors influencing project decision-making could not be consistently ranked according to their prevalence or importance. Rather, different contextual factors assumed different importance according to the unique circumstances at a given time (Fellows and Liu, 2009). Similarly, according to Gann and Salter (2000), in investigating the elements of judgements and decision-making in building projects, they discovered that decisions and actions were highly relational and contextual, with decisions of one project member being related to the decisions of others in the project.

Accordingly, where the construction industry is concerned, political, economic, legal, technological, cultural and social trends are perforce subject matters because they present features with strong influence upon construction businesses, technology development, technical competencies and project developments (Rondinelli, 2013). Given that the construction industry, whose major stakeholders are the government and project clients, those contextual environmental trends require continuous monitoring, as changes in them have influences and effects on construction-industry decisions (Campo et al., 2010). Similarly, adopting construction technologies requires an in-depth knowledge of relevant rules and regulations, besides the overall economic consequences (Sweet and Schneier, 2011).

b) Structural Factors

Next, the setting of building projects leads to the identification of construction-project dynamics which are known as structural factors. The fundamental operating level of the construction industry is the construction project (Jin et al., 2007; Lam and Wong, 2009) as the construction industry is a project-based industry. The project is the level at which building technology can be applied and the mainstream of such projects are tailor-made to a client's needs, wants and requirements and designed and built through a competitive tendering system (Ann et al., 2010; Hamza and Greenwood, 2009).

When under conditions of uncertainty, project members are susceptible to anchoring on the judgement of others in forming their own judgements (Furnham et al., 2012; Tam et al., 2010), and when all members of a group share similar training or dominant project norms, they can be inhibited from offering or adopting different project standpoints (Lehavi, 2013). In this case, De Groot et al. (2010) mention that the element of communication is important in decision-making.

Beyond direct influences, Abdullah and Egbu (2010a) and Larsen et al. (2011) also recognise that project members refine their project- and IBS knowledge from technically determined aspects of their work environment, including the expertise of co-workers, project management, team functioning and shared experiences. In addition to project influences on IBS decision-making, Ismail et al. (2012) and Ozorhon (2013) discover that project systems such as operations, workloads, interruptions and project policies and procedures also influenced decision-making. Project procurement aspects such as amount and distribution of resources influenced decision-making by affecting the time available to make decisions and provide intervention (Kamar and Hamid, 2011: Shukor et al., 2011).

The project members responded to high workloads in project operations by adapting and incorporating a sense of their workload and their capacity to manage it into their decision-making (El-Mashaleh, 2010; Plebankiewicz, 2010). Where project operations and its workload resulted in limited time availability, compromises with goal prioritisation were made in the decisions that could be made (Jaskowski et al., 2010). Additionally, Meredith and Mantel (2011) and Sears et al. (2010) discover that project members reported prioritising some project management aspects over others, prioritising which problems would be addressed, reducing the project risks and they were also more ready to make decisions.

Organisational factors such as project procurement aspects, cost and clients have also been found to influence decision-making by affecting the capacity of decision-makers (Eriksson, 2010; Ludvig et al., 2010). Other aspects of structural factors that affected the project decision-making were the systems in place to guide decision-making, such as project pathways, policies, protocols, and also system definitions of acceptable practice that were represented in the norms, criteria and standards to which individuals working in a building project should adhere (Ding, 2008; Halpin and Senior, 2010).

Finally, the project environment influenced decision-making by affecting the resources available, particularly in terms of project procurement (Cheng et al., 2010). In terms of IBS decision-making, the project members had to reason and make decisions about the location and supply of material or equipment and which piece of equipment they would use, considering the constraints of the resources they had available (Berawi et al., 2012; Doran and Giannakis, 2011). Structural influences on IBS decision-making have also been described in multi-disciplinary settings (Lau and Rowlinson, 2011), as building-project developments involve various members.

Turskis et al. (2009) report that where multiple players were involved in decision-making, the process and outcomes were influenced by the urgency of the situation and the hierarchy and structure of the project. Construction projects also face potential challenges from trends such as the increasing importance of construction technologies that speed up building project implementation, with quality assurance and cost effectiveness (Bowen et al., 2012; Liu et al., 2013).

Further, Chen (2013), Flanagan (2002) and Li et al. (2013) discover that price competition through a system of competitive tendering in construction projects typically affects the choice of building materials and technology. Indeed, resources are regarded as the major limiting force upon pricing level, based on the cost implications in adopting any types of building technology (Allen and Iano, 2011; Ginevicius et al., 2007). In this matter, the decision of IBS technology adoption can also be influenced by cost factors. Besides that, client-related elements other than price such as timing and quality assurance are becoming increasingly significant (Groak, 2013).

The complexity of building projects is considerable because of their structure and operational nature (Geraldi et al., 2011; Xia and Chan, 2012). Building projects have a challenging clientele environment, a range of project types and sizes, and a character of service provision besides a range of input combinations, systems and techniques (Meredith and Mantel, 2011; Winch, 2010). These influences concerning IBS decision-making are being increasingly considered in building projects, to improve competitiveness, quality and productivity in the construction industry.

c) Behavioural Factors

This research develops a mechanism to determine the specific behavioural factors and their specific influence on IBS decision-making. Thus, it is essential to determine the influence of behavioural factors on IBS decision-making based on those significant factors in order to prioritise and categorise them, with the intention of reducing the effect of negative behavioural factors and increasing the positive factors for the effectiveness of IBS decision-making.

The issue of behavioural factors in the decision-making of IBS technology adoption is also exposed to environmental influences. Moreover, the absence of a particular behavioural knowledge in the technology management and economics of construction makes it necessary for concepts to be borrowed from other fields of study, such as psychology and organisational behaviour.

Behavioural factors consist of all constructs that are related to human behaviour. In this situation, specific behavioural traits that affect decision-making are clustered as applied to IBS technology adoption in building projects. In order to understand the interaction between contextual and structural factors with decision-making, Camerer et al. (2011) offer a behavioural perspective explaining human behaviour in which context, or the environment, acts in a dynamic reciprocal way with the cognition and personal attributes of group decision-makers.

Proctor and Van Zandt (2011) and Tomasello (2009) suggest that human functioning is explained in terms of a model in which behaviour, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other. Decision-makers view a problem and perceive its environment as a selective process which requires their ability to structure the environment and comprehend its stimuli accordingly (Cameron and Green, 2012; Weick, 2012).

The social aspect, in particular, has been shown to have a large influence on project decision-making (Baiden et al., 2006; Fernández-Sánchez and Rodríguez-López, 2010; Kissi et al., 2010). Meanwhile, Taroun and Yang (2011) discover that project members refer various aspects of their decision-making to others in the project, particularly when a decision is difficult to make and to check their decision-making from different perspectives. Fiske (2013) and Hmieleski and Baron (2009) indicate that the effects of the social outlook on decision-making can be both positive and negative.

Positive influences include using other individuals to check for errors, utilising positive synergies arising from the combination of team members' knowledge, and recognising that there is an increased likelihood of generating novel solutions and diverse perspectives when more people are consulted in decision-making (De Bruijn et al., 2010; Hastie and Dawes, 2010). Conversely, Bohner and Dickel (2011) mention that the social context can have negative effects when individuals choose to do what others do, to avoid social rejection or to take advantage of others' decision-making rather than being responsible for their own decision-making.

Saaty and Shih (2009) and Zavadskas et al. (2012) discover hierarchical systems existed that provided decision-making support for less-experienced staff, who passed information and provisional decisions on to more-experienced staff until someone made a decision. Consistent with other literatures, Winch (2010) discovers that social factors directly modified and changed decisions for project members, whereas more experienced practitioners adapted to, controlled and manipulated these factors.

Cognitive maps contain information for decision-making in dynamic environments and, as such, gain utmost importance for project management (Emmitt and Gorse, 2009; Sears et al., 2010). Further, Bierman and Smidt (2012) and van Vliet et al. (2010) add that cognitive maps store the result of sense-making from previous experiences, as they provide for learning across the borders of building projects.

Kamar et al. (2012) and Pan et al. (2012a) discover that the flow of project decision-making was disrupted by human-related matters such as perceptions of the public of IBS technology adoption. Abdullah and Egbu (2010b) and Byrnes (2013) suggest that negative perception adds to the complexity of the decision-making process, increasing the demands on cognitive capacity to recall information and make decisions. Nawi et al. (2011) also propose that strong values on building technology can positively influence IBS decision-making by providing project members with additional support.

Albert and Nitsch (2010), Goodier (2008) and Kanjanabootra et al. (2012) discover that project members needed to develop specific knowledge of IBS management and technology and the allocation of resources. With increased experience of working in the same IBS project context, project members developed a familiarity with equipment that improved their efficiency in IBS decision-making.

Bounded rationality of individual decision-making for example, can be viewed from a behavioural perspective, thus it is important to consider factors which limit rationality in decision-making (Bazerman and Moore, 2008; Simon and Viale, 2008). Based on the classifications of behavioural factors, it is possible to generate a profile of IBS decision-making. Without more systematic study on the impacts of behavioural factors on IBS decision-making, it would be difficult to have appropriate confidence that behavioural elements are present and relevant in construction-management practice.

3.3.3 Decision-Makers: Inter-project and Intra-project Perspectives

The discussion to date deals with, what may be termed, project decision-making. Few decisions in a project are made solely by individuals (Sears et al., 2010). Decisions in the construction industry, like many other industries, are made by individuals working in groups or teams, in a project perspective. In fact, Baiden et al. (2006), Kiker et al. (2005) and Winch (2010) discover that early work on the benefits of group decision-making were recognised in the construction industry.

In order to investigate the impact of contextual, structural and behavioural factors on IBS decision-making in detail, the determination, details and classifications of these factors, besides additional relevant IBS decision issues are identified, which are based on the perceptions of project members towards the decision-making of IBS technology adoption. Therefore, the role of project members as decision-makers is included as a part of the integrated conceptual framework of this research.

In this research, they are classified as the group of construction-profession stakeholders and IBS project supply-chain members. The group of construction-profession stakeholders represents the inter-project perspective and the group of supply-chain members in IBS projects represents the intra-project perspective. The inter-project perspective pertaining to the area of decision-making in the construction industry, is widely researched (Gil et al., 2012; Senaratne and Sexton, 2009).

This research explores the contextual, structural and behavioural factors further, beyond the literature, through primary data collected via inter- and intra-project-based perspectives on IBS decision-making. Moreover, IBS decision-making in the proposed model is a conceptualised dynamic process that takes place by considering the project members' views, involvements, technology, in-depth knowledge and interpretations from a multiple-perspective (Boonstra, 2011; Maaninen-Olsson and Müllern, 2009).

However, the extent to which decision-makers can embrace all ends of management and construction aspects is an issue IBS decision-making. The terms 'construction-profession stakeholders' and 'IBS project supply-chain members' are being used in this research deliberately. They refer to project members involved in any aspect of the building project, ranging from designers to clients. The perceptions of construction-profession stakeholders towards the decision-making of IBS technology adoption at the inter-project level may be of significance across the industry as they are contemplated to adopt IBS technology. Nevertheless, it is important to recognise the variability of IBS decision-making that exists among the group of construction-profession stakeholders. Further, a complete understanding of the perception of supply-chain members in IBS projects regarding the impacts of various factors on IBS decision-making, is essential as it contributes to a better perspective of IBS decision-making across IBS building projects, as they are mandated to use IBS technology.

Moreover, the research intention, underlying the integrated conceptual framework of IBS decision-making, is to depict the nature of IBS decision-making based on the supply-chain members of IBS building projects, in order to undertake the 'lived-experience' of IBS decision-making. Therefore, IBS decision-making is explored in the chosen IBS building projects, and, based on the perceptions of the supply-chain members, the impact of contextual, structural and behavioural factors on IBS decision-making is determined.

Specifically, exploring the IBS decision-making intra-project perspective can give valuable information on the real nature of IBS technology decisions across IBS building projects. Although IBS technology adoption is seen as a complex and continuous process (Larsen et al., 2013; Wu et al., 2013), for the purpose of determining related influencing factors on IBS decision-making, Ismail et al. (2012) believe that these factors can be discovered by investigating upper management involvements and decisions in IBS projects.

Moreover, the implications or issues associated with IBS technology adoption in a building project are too complex for a project or community to rationalise and comprehend (Jaillon and Poon, 2010; Li et al., 2011). Further to this, for instance, there are clients who want their building projects to be completed on a fast-track basis without compromising the safety and quality compliance (Smith, 2011). Additionally, Demiralp et al. (2012) and Olawale and Sun (2010) advocate that IBS projects usually take a longer time due to the precise design information and development which are required prior to the beginning of the building project. This requires extensive collaboration and coordination of clients, consultants, design architects and contractors, which has obvious implications when communicating and consulting in IBS decision-making.

The view in the construction industry, that IBS projects are more expensive than traditional site-built projects, can also influence IBS decision-making (Haron et al., 2012; Hwang and Ong, 2013; Zhang and Skitmore, 2012). In addition to this, Hassim et al. (2009) discover that the IBS technology situations are sometimes different in reasoning between the official and scientific estimates of effects and risks. Differences in awareness towards IBS technology adoption could lead to misunderstandings of the goals and objectives of a given IBS project (Nawi et al., 2011). Therefore, in IBS building projects, it is important to recognise that IBS influencing factors from different perspectives are as tangible as real IBS technology adoption, as far as the decision-making is concerned.

3.4 IBS Decision Criteria and IBS Decision-making Models

This section focuses on the theoretical applications of an integrated conceptual framework on the current research, with an emphasis on two components of the framework, namely the constructs of IBS decision-making and the perspectives of IBS decision-making. The current study initially used the framework to investigate the decision-making of IBS technology adoption in the Malaysian construction industry.

The framework was then used to provide guidelines for understanding the influences of the identified factors on IBS decision-making, with the generation of IBS decision criteria. It is anticipated that the generation of the IBS decision criteria will help to conceptualise and develop the models of IBS decision-making. One valuable aspect of these models is that it will allow a range of factors to be used in investigating how the members of the Malaysian construction industry perceive these factors in IBS decision-making.

Schematic models are useful devices for understanding IBS decision-making, especially in situations where the decision-maker is subjected to various forces. The decision-making dynamics of IBS technology adoption, faced with issues involving contextual, structural and behavioural factors, are complex. However, current models of project decision-making are generally not very helpful in developing a contextual understanding of IBS adoption decision-making.

It is also believed that this conceptual framework of decision-making underlying IBS technology adoption would be of considerable use to those who are seeking to develop and implement programs which would facilitate IBS technology adoption on the part of decision-makers, as well as to those who desire to turn their research from the descriptive study of IBS technology adoption to an investigation of the underlying structure of such behaviour and the process leading to it.

Building projects involve a group with special concerns in the decision-making of IBS technology adoption. It is expected that in a building project, decision-makers' responses regarding IBS technology adoption vary in line with compliance to rules and regulations, based on these paradigms: from customary to prospective, from planned to controlled, from essential to dominant, from resistance to appreciation and from reactive to proactive. With the mapping of these transitions, a typology of IBS decision-making which responds to the dynamics of the construction industry can be developed. Concerning the construction sector's dynamics, the configuration of contextual-, structural- and behavioural-factor impacts could be the cause and effect of IBS decision-making as the decision-making of IBS technology adoption can both effect, and be affected by, contextual, structural and behavioural factors.

3.5 Summary

This chapter has sought to provide an overview of the theoretical framework and how it was used in the current study. In this chapter, an integrated conceptual framework (ICF) of IBS Decision-making was developed and graphically expressed in Figure 3.1. This framework links the relevant components of IBS decision-making into a cohesive construct or system with the influencing factors on IBS decision-making. The diagram reveals that contextual, structural and behavioural factors potentially affect IBS decision-making, directly, and thereby indirectly the changing role of decision-makers under various building-project circumstances. To further steer this research, this framework serves as a foundation that will specifically address the research question and also help the development of IBS decision-making models. This chapter concluded with an explanation of theoretical applications of the study, focusing on the model of IBS decision-making and how the model can be used to provide theoretical guidelines for understanding the IBS decision-making of building projects. The following Chapter 4 outlines the methodology for the research.

CHAPTER 4 – RESEARCH METHODOLOGY

4.1 Introduction

This chapter provides an overview of the methodology adopted in this research for investigating the research problems and the research question developed as a result of the literature review. In Chapter 3, an integrated conceptual framework (ICF) of IBS decision-making was developed to fulfil the aim of this research: to explore how contextual, structural and behavioural influences impact on the decision-making of IBS technology adoption. This chapter will discuss the research design, including the justification of using interview and case study as the research strategy, interview procedure as the method, with coding and analysis as the techniques. Additionally, it will discuss data collection tools, analysis methods and results interpretation. The chapter also highlights the ethics approval procedure followed in the research process.

This research employs an exploratory qualitative study (Creswell and Clark, 2007; Morse et al., 2008) based on an overview of the phenomenological perspective, with exploratory and interpretive views (Finlay, 2009) of IBS decision-making. This research was undertaken from a qualitative outlook (Bryman, 2012) within a behavioural-economics theoretical framework (Wilkinson and Klaes, 2008), a perspective positioned predominantly in the interpretative phenomenology viewpoint. Generally, this qualitative research is based on an interpretative paradigm as highlighted by Creswell (2012), which is aimed at understanding the social structure and patterns of interaction between those working within, and affected by, the construction industry and institutions which structure it (Dainty, 2008).

The chapter is presented in ten sections and starts with the background of this study (section 4.1). Section two and three present the research paradigm and approach respectively. Section four specifies the research design which consists of methodology outline, research strategy and research implementation plan. Section 4.5 describes a specific research method of exploring inter-project perspective, while section 4.6 explores intra–project perspective. Methodologies for both perspectives comprise of research context, participant-recruitment technique, unit of analysis, data collection method and research procedures. Following this, section 4.7 presents the data analysis for the current study. Justifications of the research methodology are acknowledged next (section 4.8) before ethical considerations are addressed (section 4.8). Finally, a conclusion on this chapter is made (section 4.10).

4.2 Research Paradigm

The conceptual foundation of this research is based on the interpretative paradigm (Denzin and Lincoln, 2002; 2003) using the strategies case study and interviews, as methods. The context of this research is gathered from a multiple-perspective (Baxter and Jack, 2008; Hatch, 2012; Hesse-Biber and Leavy, 2010; Stake, 2013). Furthermore, research with multiple-perspective includes a post-positivism view which has the element of being logical, empirical, cause-and-effects-oriented and deterministic (Creswell, 2012).

This qualitative research incorporates the human element into the primary decision-making study of IBS technology adoption. Instead of studying the physical characteristics of a technology adoption, construction management research, for example, seeks to understand the way in which humans perceive, decide on and adopt a technology within their environment (Lou and Goulding, 2010; Wang et al., 2013). Therefore, in order to determine the workings of any technology decision, the people involved must be observed (Hastie and Dawes, 2010). Finding out what factors influence IBS decision-making in the construction industry thus fits directly within the realm of qualitative research, as it requires observing the behaviour of people in specific environments.

It was anticipated that the research result based on this qualitative research could provide insights into the factors of IBS decision-making and to be acceptable within the broader context of the case study in the construction industry. This may further aid IBS technology adoption and project management approaches in building projects that more appropriately reflect decision-makers' perception of IBS decision-making.

Consequently, this research involves the exploration and determination of various factors that impact on IBS decision-making, based on the perception of construction professionals. Qualitative research constitutes the element of science that requires the perceptions of reality related to a selected phenomenon (Stake, 2010). Perception is a concept of judgement and decision-making that links modes of cognition to features of the task (Hastie and Dawes, 2010). The rationale of using perception in this research is to explore IBS decision-making and its influencing factors under the current situation, based on the way construction professionals recognise and identify these factors using their own justification, outlook, views and opinions.

By exploring the perception of the construction-profession stakeholders and IBS project supply-chain members in particular, this technique is a complement to the pre-determined IBS decision-making factors derived from the literature. It also enriches the gaps of ordinary IBS decision-making research as it discovers unknown aspects in IBS decision-making. Moreover, in researching some subjective topics, it requires the exploration of people's perception on such topics. For example, the study on trust in project relationship is strongly influenced by the perceived fairness of decision processes (Kadefors, 2004).

Another study was also conducted by Cheng and Wei (2010), exploring the process of human interaction using people's perceptions in ergonomics. Similarly, the research undertaken by Ding (2008) explores the perceptions of design quality embodied in buildings. Assaf and Al-Hejji (2006) progress some way to investigating the impact of various project components and their relationships, particularly the difference in perceptions as to causes of delays of different groups of participants in building and civil projects. Chan and Chan (2004) argue that even the same person's perception of project success can change from project to project, and key performance indicators provide an indication of how well the key participants perceived the project success.

4.3 The Philosophical Underpinning for the Research Approach

In order to determine what factors are related to, and how they impact on, IBS decision-making in the construction industry, it is necessary to use an approach that fits directly within the qualitative outlook and as such, will deal directly with that outlook.

Therefore, an interpretative phenomenological analysis (IPA) is used as the research approach. IPA is commonly used as a research approach that is able to focus upon people's understandings of particular phenomena (Smith et al., 2009), to answer a research question which aims to understand what a given involvement was like (phenomenology) and how someone made sense of it (interpretation) (Larkin et al., 2006).

In general, IPA aims to offer insights into how a given person in a given context makes sense of a given phenomenon (Smith and Osborn, 2003). Specifically, Smith et al. (2009) highlight that IPA is a qualitative research method for gaining an insight into how an individual perceives a phenomenon, as it focuses on the uniqueness of an individual's thoughts and perception. By using the technique, researchers gather qualitative data from the individual using a number of techniques such as interview and focus-group.

The understanding of IBS decision-making and its influencing factors can be extensively explored in a holistic concept by applying a multiple-perspectives approach rather than a single perspective. The holistic concept is based on the integration of diverse concepts, constructs and systems and in decision research, it provides greater insight into the nature of the problem and does not end with separate technical, organisational and personal perspectives (Belton and Stewart, 2002; Ritchie, 2003). As this concept is essentially an inclusive style, and dynamic, it is highly generic and has thereby found its way into other areas of studies outside natural decision-making (Kiker et al., 2005; Ordoobadi and Wang, 2011). Moreover, the holistic concept was found to be relevant in decision-making in technology adoption (Linstone, 2011).

Using a holistic concept in IBS decision-making research, as a conceptual platform, it supports the argument of this research that the influencing factors of the IBS decision-making process are unpredictable and can be related to different characteristics in the construction industry (Chen et al., 2010a; Goodier and Gibb, 2007; Holton et al., 2010), ranging from technical and technological aspects up to human factors. Moreover, the holistic concept complements the study about the influencing factors associated with IBS decision-making, making it possible to determine and coordinate the influencing factors in such a way that these factors become IBS decision criteria, leading to improved decision-making regarding IBS technology adoption (Blismas et al., 2006; Idrus and Newman, 2002).

Taking into account the IPA approach for the qualitative representation of this research, a methodology framework is devised as the basis of this study. IPA is a broad approach that takes into account a holistic concept and a multiple-perspectives approach. As previously discussed, the IPA approach is the foundation of the current study and is used as a methodology framework of this thesis as illustrated in Figure 4.1.

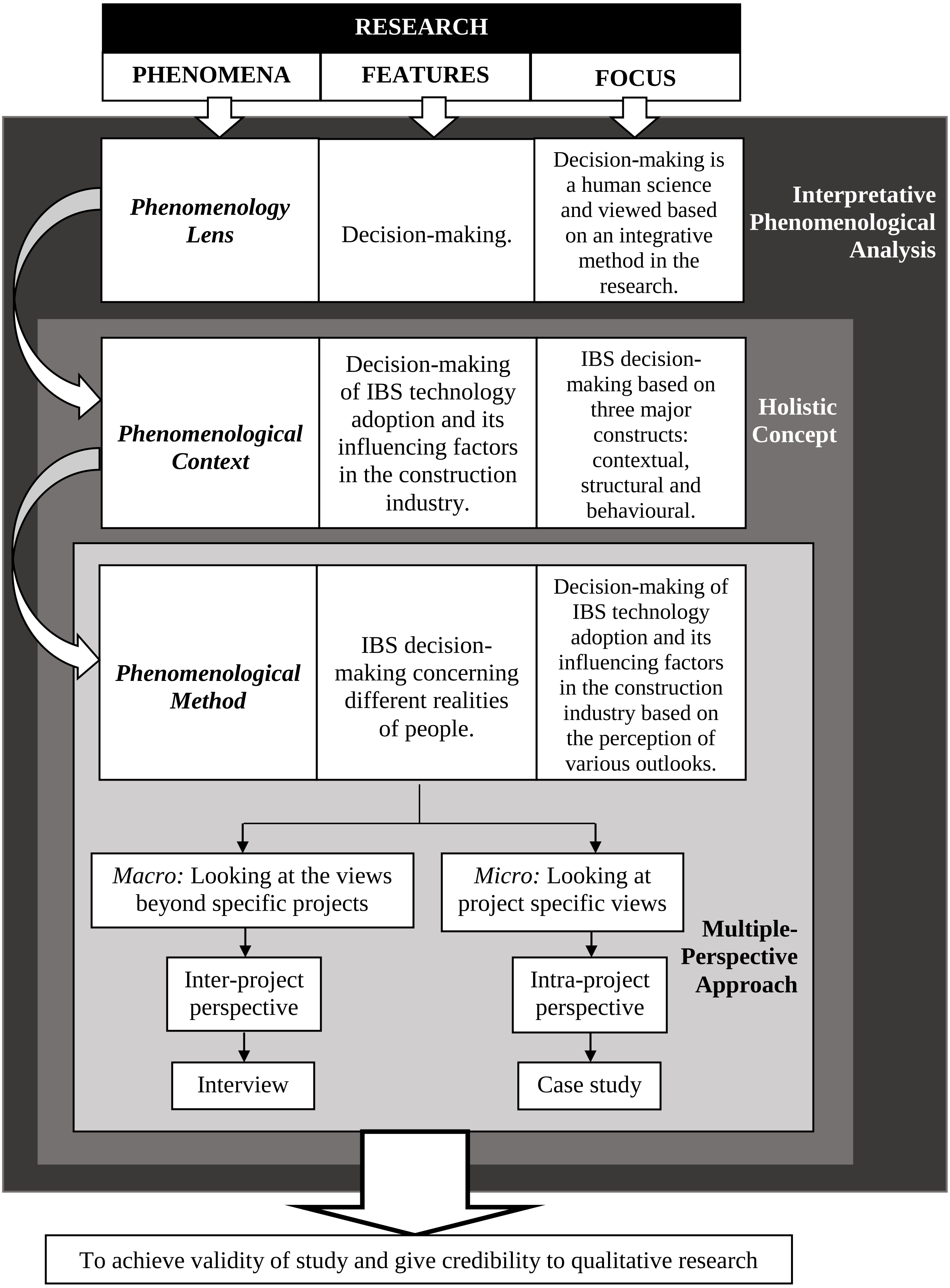

Figure 4.1 Qualitative Methodology Framework for IBS Decision-making

As shown in Figure 4.1, the broadest level is the IPA approach to understand phenomenal issues in this research. IPA has a combination of approaches and comprises of a set of phenomenology lenses, phenomenological context and phenomenological method. Further details on each component of the methodology framework are explained as follows:

a) Interpretative Phenomenological Analysis and Phenomenology Lens

This is the foundation for the methodology framework that establishes the overall nature and scene of decision-making, IBS decision-making and its influencing factors. IPA focuses on personal meaning and sense-making in a particular context and in this research the context is the construction industry. The combination of approaches gives an interesting perspective on IBS decision-making research since the complexity of decision-making can be understood clearly as how different people make sense of IBS decision-making and its influencing factors. IPA also emphasises the multiple realities of the construction world to determine the impact of various factors on IBS decision-making.

The phenomenology lens on decision-making indicates the possible paths that exist in this research. The broadest analysis level, in terms of scope, it focuses on a common structure of decision-making in the mainstream. From this standpoint, this research attempts to identify the decision-making aspects that explained the general path of the area studied, from the initial decision to the current state. Thus, adaptation to the specific context, from this research point of view, is the key element of the next level.

b) Holistic Concept and Phenomenological Context

Consequently, as far as the decision-making of IBS technology adoption is concerned, contextual, structural and behavioural factors are perforce subject to analysis because they represent aspects with strong influence upon IBS decision-making. Therefore, this exploration and analysis requires a holistic concept to acquire a better and comprehensive understanding of IBS decision-making and its influencing factors, for the generation of IBS decision-making criteria and the development of IBS decision-making models. This approach provides an integrated view of IBS decision-making in the building projects studied.

The phenomenological context is the pathway that specifies the direction of important aspects which are emerging, pertaining to IBS decision-making. It focuses on the practice of decision-making in the construction industry. Additionally, the adaptation of state-of-the-art IBS decision-making should be understood in the construction industry context of building projects by focusing on three major influencing factors, namely contextual, structural and behavioural.

Looking at these factors from this angle, it is possible to understand how the dynamics in the construction industry take place. Regarding the building projects dynamics, it is vital to understand that the configuration of various factors is concurrently the cause and effect of IBS decision-making. A full consideration of these factors regarding IBS decision-making is one of the major highlights of this analytical level because it can contribute to a better understanding of IBS decision-making related to building projects.

c) Multiple-perspectives Approach and Phenomenological Method

This approach involves two different perspectives on the same subject to obtain different views on the same phenomena, then, both views are collaborated to obtain a more convincing results and to obtain the richness of data. This research explores the inter-project and intra-project perspectives among various construction professionals such as project managers, design architects, quantity surveyors, civil engineers and project consultants, to integrate the influencing factors of IBS decision-making for the development of IBS decision-making models.

The construction industry has intense influence on building projects. In this research, the focus is on how various factors influence IBS decision-making, in order to develop an explanatory level. From the standpoint of building projects in the construction industry, this research looks for the way contextual, structural and behavioural factors impact on IBS decision-making. The mapping and the evolution of IBS decision-making factors are under phenomenological method and encapsulated within the subjectivity of the point of view of the research participants from inter-project perspective and intra-project perspective who make evaluations based on what they consider is the most important or typical of a given context.

d) Validity of Study and Research Credibility

The framework of qualitative methodology intends to produce results or research outcomes that are able to achieve validity of the study through experiments or observations based on certain events under different sets of circumstances. This framework seeks to understand IBS decision-making as consisting of multiple realities where construction industry players interact and shape each other, which is investigated using phenomenological method. Therefore, the research outcome of qualitative research is judged in terms of its validity as well as its credibility.

4.4 Research Design

The research design has been defined as the framework for conducting research and helps researchers to ensure that the study will be carried out successfully (Robson, 2002). Generally, the research design is used to justify decisions and choices relating to the research procedure (Maxwell, 2012). The current study follows the qualitative methodology framework as discussed in Section 4.3, to develop further aspects of research design. Qualitative research is defined as a research approach that investigates the constructed nature of reality and emphasises the quality of entities, processes and meanings rather than statistical measurement (Denzin & Lincoln, 2005). This research approach was used to gain a more comprehensive understanding of the way in which the aspects of contextual, structural and behavioural factors impacted on IBS decision-making.

Since the major area of exploration in this research is the study of how contextual, structural and behavioural factors impact on IBS decision-making, this research is an exploratory study based on the investigation of two perspectives, namely exploring inter-project and intra-project perspective on the decision-making of IBS technology adoption and its influencing factors. IBS decision-making is a focused kind of study concerning the different ‘realities’ of people based on a multiple-perspective of decision-makers. Rather, the study of IBS decision-making calls for the contextual-, structural- and behavioural points of view that require a capacity for insights and focus into various dimensions in decision-making. This section provides an overview of the research methodology for the current study. It also justifies the research strategy used and implementation of the research methods.

4.4.1 Methodology Outline

This study was targeted at members of the Malaysian construction industry, both as the construction-profession stakeholders in exploring the inter-project perspective, and the supply-chain members of IBS building projects, in exploring the intra-project perspective, all of whom hold or held key roles in decision-making. The methodology outline illustrated in Figure 4.1 consists of two components of this research.

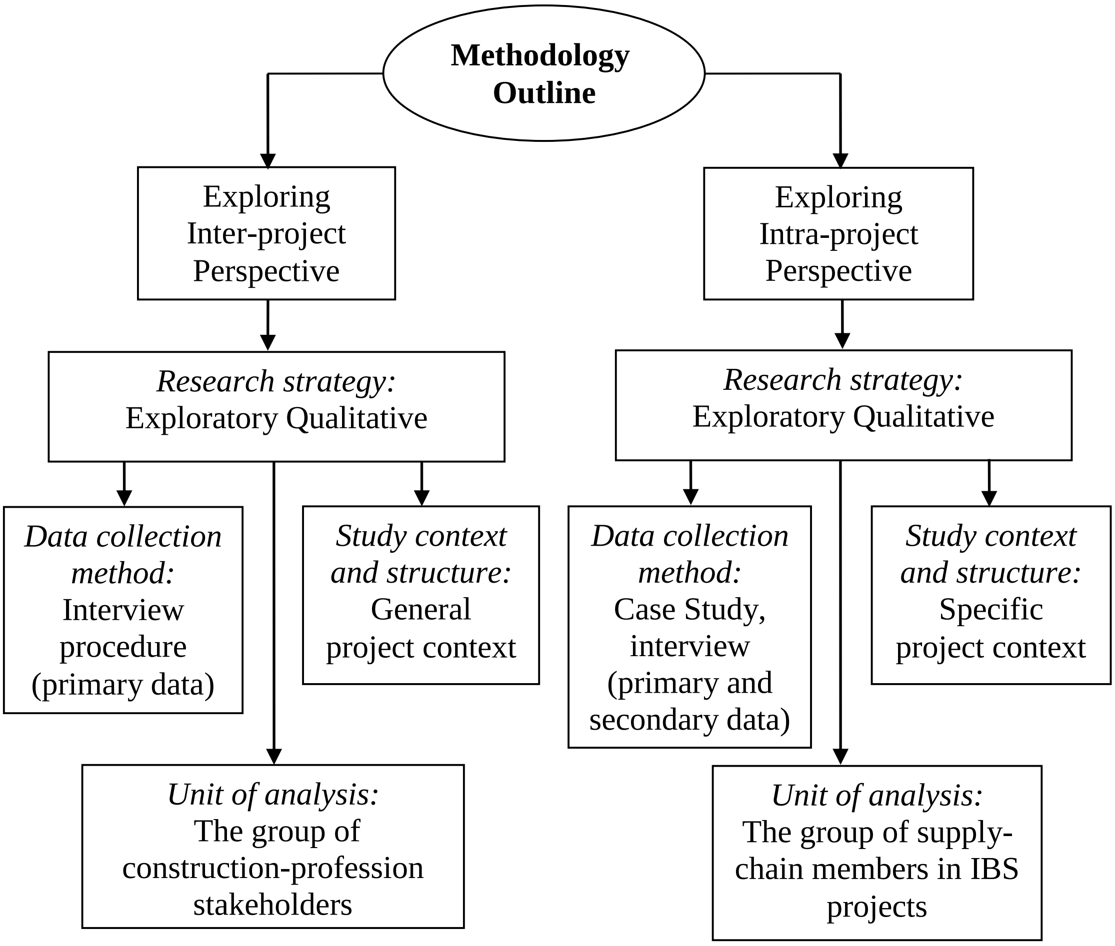

Figure 4.2 Methodology Outline

The first component, inter-project perspective, explores the construction-profession stakeholders' viewpoints on IBS decision-making and its influencing factors. This component seeks to explore perspectives that are not specific to a building project (i.e.

any one case study). The second component, intra-project perspective, explores IBS decision-making in the context of the supply chain in IBS building projects, based on specific case studies.

Construction professionals selected for the unit of analysis in this study for instance, represent building project clients or owners and developer organisations. Moreover, the players or practitioners of construction industry are based on their established largely in professional contexts, such as developer, consultant, contractor and survey organisations. Regularly, the practice of decision-making rests on a set of informal associations and tacit understandings amongst groups of design architect, quantity surveyor, developer, consultant, civil engineer, project manager, manufacturer and client or owner as construction industry players. It recognises the fundamentally supply-chain nature of practice and, as such, is concerned with how construction industry players coordinate themselves to jointly perform particular construction practices. It also shows that getting decisions done does not rest on single individuals deciding in isolation and performing it. Later sections provide further explanations on the research strategy and the research implementation plan.

4.4.2 Research Strategy

This research starts with a grounding in literature on decision-making, IBS technology adoption and their influencing factors, then identifies a research gap and proposes a research question that addresses the gap. As many governments are imposing IBS technology adoptions in building projects, there is a gap in research concerning the decision-making process of IBS technology adoption. Moreover, little is known in research on exploring how people actually do make decisions on building technology adoptions and whether these general assessments apply to the decision-making of IBS technology adoption which can be explored in technical, managerial or other features.

a) Developing Research Methods

The choice of research methods for the current study was influenced by the research question: How do contextual, structural and behavioural influences impact on the decision-making process of IBS technology adoption? Three criteria were considered in designing the research methods to answer these research questions. Firstly, the selected research methods were needed to identify the variety of factors associated with the IBS decision-making. Secondly, the selected research methods were needed to allow in-depth information to be collected and analysed in order to show how decision-makers from different project contexts identified and perceived contextual, structural and behavioural factors as important for IBS decision-making. Finally, the selected research methods had to be able to determine the way each of these identified factors impacts on the decision-making of IBS technology adoption.

b) Choice of Research Method – An Exploratory Qualitative Strategy

Due to the nature of the research, it is clear that IBS decision-making is most effectively investigated via an exploratory qualitative research approach. This research is exploratory in nature as the state of knowledge about the decision-making of IBS technology adoption, from multiple-perspectives in the Malaysian construction industry, is insignificant and subjective. Qualitative research methods were used to identify factors that were perceived to impact on the decision-making of IBS technology adoption. Qualitative research methods were used to gain a better understanding of the way the groups of construction-profession stakeholders and the supply-chain members of IBS projects identified and interpreted factors that influence IBS decision-making.

Thus, the study is interested in exploring the way in which the factors identified by the qualitative study appeared to operate in two different project contexts. For example, it investigated the perceived importance of contextual, structural and behavioural factors from different project settings, namely inter-project and intra-project perspectives, and the way in which these factors influenced IBS decision-making. Using a quantitative research strategy, for instance, would not have allowed more detailed information to be obtained. Therefore, a qualitative method was selected to explore, and gain a more comprehensive understanding of, the way in which the selected project contexts of the Malaysian construction industry perceived the factors that impacted on the decision-making of IBS technology adoption.

Choosing to conduct the study on a qualitative basis is more appropriate since the type of problem statement in this study indicated that interview and multiple case studies are more feasible (Robson, 2011). Moreover, the combination of face-to-face interview and case-study method is for the synthesis of ideas derived from these two dependent studies based on their distinctive characteristics. The dimensions of these two studies are illustrated in Table 4.1. Thus, the study is set to explore the interactions between inter-project and intra-project perspectives on IBS decision-making, in a holistic conception.

Table 4.1 Dimensions of Qualitative Strategy and Exploratory Study on Inter-project and Intra-project Perspectives

Qualitative Strategy : Exploratory Study			
Dimensions:		**Inter-project Perspective**	**Intra-project Perspective**
1.	Context and outlook	Inter-project perspective on IBS decision-making in the context of the construction industry (not any specific building project).	Intra-project perspective on IBS decision-making in the context of a specific building projects.
2.	Goals	To gain IBS decision-making background and better understanding on IBS decision-making.	To determine the current status of a phenomenon on IBS decision-making.
3.	Purposes	To explore the perception of IBS decision-making based on the exposure across building projects development.	To explore and describe the perception of IBS decision-making based on the practical implementation of IBS projects.
4.	Features	Members who contemplated and/or deployed IBS technology in building projects.	Project team members who engaged with IBS technology in building projects.
5.	Focus	Decision-making in stakeholders' environment across the construction industry.	Decision-making in supply-chain environment across IBS building projects.
6.	Research subjects (participants)	The group of construction-profession stakeholders.	The group of IBS project supply-chain members.

Table 4.1 provides a comparison of the six dimensions of scope difference for inter-project and intra-project perspective. Aouad et al. (2010a) suggest that inter-project perspective in construction offers a further insight into perspectives on innovation at

the industry level. The inter-project perspective does not refer to any specific building project and participants give opinions and views based on their involvement, knowledge and understanding across different construction projects – as an industry level perspective. Whereas intra-project perspective is a more specific perspective based on selected IBS building projects. The main advantage of intra-project perspective is in terms of its specific nature of inquiry and the opportunity to engage in in-depth by analysis using several subjects and sources of information. Moreover, Abdul-Rahman et al. (2011) indicate that intra-project perspective involves an acquisition approach with the use of knowledge and involvement within construction projects.

Inter-project and intra-project perspectives, therefore, were considered to be appropriate for the current study because, whilst the construction-industry professionals have an important role both in IBS technology adoption and its decision-making, their perception of IBS decision-making and its influencing factors may differ. Meanwhile, the inter-project perspective has different orientations towards IBS decision-making and its influencing factors. For example, although the stakeholders of construction projects value building technology as beneficial, they are likely to avoid certain activities such as making decisions which would cause a negative impact on their organisations (Abidin, 2010; Shen et al., 2010b). Conversely, from an intra-project perspective with a number of IBS building projects, the supply-chain members value IBS technology in terms of its performance and therefore they are likely to be able to cope with its dynamics (Demiralp et al., 2012; Pan et al., 2012b; Shukor et al., 2011). From these research perspectives, a coordination of research strategy is developed to outline the final outcomes of this research, as presented in Table 4.2 below.

Table 4.2 Research Strategy Coordination

Research Perspective:	**Research Implementation Plan:**	**The Nature of Research Outcome:**	**Outcomes:**	**Final Outcomes:**
Exploring Inter-project Perspective	*Target group (Who):* The group of construction-profession stakeholders. *Location (Where):* Malaysian construction industry. *Inquiry Strategy (How):* Personal face-to face interview.	The first depiction of IBS decision-making and its influencing factors from a professional but non-project-specific context.	Identification of critical aspects of IBS decision-making.	Key Decision Criteria in IBS Technology Adoption and IBS Decision-making Models
Exploring Intra-project Perspective	*Target group (Who):* The group of supply-chain members in selected building projects involving IBS technology. *Location (Where):* Malaysian construction industry. *Inquiry Strategy (How):* Multiple-case studies, personal face-to-face interview and secondary data collection.	The depiction of IBS decision-making its influencing factors from a professional in a project specific context.	Contextualised understanding of IBS decision-making.	

The inter- and intra-project approach to this study, employing face-to-face interviews and multiple case studies, enables exploration of the constructs in the theoretical model on IBS decision-making in Chapter 3 and development of further insights and theoretical propositions. Thus, a research strategy which incorporates and coordinates all research perspectives, purpose, and implementation approaches, is required to generate the research outcomes (Bryman, 2012; Denscombe, 2010). The outcomes of this research, as presented in Table 4.2 include the generation of a set of decision-making criteria for key attributes within the emerging of contextual, structural and behavioural aspects in IBS technology adoption, to provide a decision tool for continuous improvement in project management. This is also vital in order to develop IBS decision-making models based on the establishment of a valid exploratory foundation.

Most studies on the decision-making of IBS technology adoption are typically based on methods that measure quantitative outcomes which are grouped into economic, technical and managerial performance measures. Such studies treat technological descriptions, environmental features and individual characteristics as static and objective rather than dynamic and subjective (Engström and Hedgren, 2012; Petridis et al., 2009). Since such studies are restricted to readily measured static constructs, they overlook certain aspects of contextual, structural and behavioural influences on IBS technology adoption that can affect, not only its decision-making, but also the development of IBS technology adoption as well. Since concepts and attributes of decision-making may change over time, they may be defined differently according to how decision-makers view, experience and perceive the influences of other behavioural factors on decision-making (Heekeren et al., 2008; Saaty and Vargas, 2012).

4.4.3 Research Implementation Plan

As there are several strategies for implementing the qualitative method for a multiple-perspectives study in one research design, it is important to ensure that the selected strategy matches the research problem and purpose (Bloomberg and Volpe, 2012; Morse et al., 2008). Thus, the current study used the qualitative approach to identify factors associated with IBS decision-making and the way these factors impacted on IBS decisions, in the construction industry. The qualitative data was used to explore the importance of the factors, as identified and perceived by the groups of construction-profession stakeholders and the supply-chain members of IBS projects. In other words, the selected qualitative, exploratory strategy for the current study linked the inter-project and intra-project perspectives results in order to interpret and explain IBS decision-making and its influencing factors. As briefly illustrated in Table 4.2, the research implementation plan of this research consists of a data collection plan and the recruitment of participants.

a) Data Collection Plan – Inquiry Strategy

A qualitative strategy focuses on an interpretative approach using inquiry methods such as interview and case study that use data to both pose and resolve research questions (Creswell, 2012; Silverman, 2013). Thus, the use of qualitative research, through the combination of interview and case study methods, develops initial understanding of the perspectives of those being studied (Patton, 2001; Rossman and Rallis, 2003). Two common methods that are used for qualitative data collection are interview and written document (Bernard and Ryan, 2010; Grbich, 2012). Each of these techniques has advantages and disadvantages. This study used face-to-face interviews to collect the qualitative data. Rubin and Rubin (2011) suggest that although conducting face-to-face interviews can be time consuming, it allows a full range and depth of information to be gathered about participants' opinions, perceptions and experiences associated with their decision-making.

In this research, face-to-face interviews explore the interactions between the various contextual, structural and behavioural factors to uncover their influences on IBS decision-making from inter-project and intra-project perspectives, as illustrated by Figure 4.3.

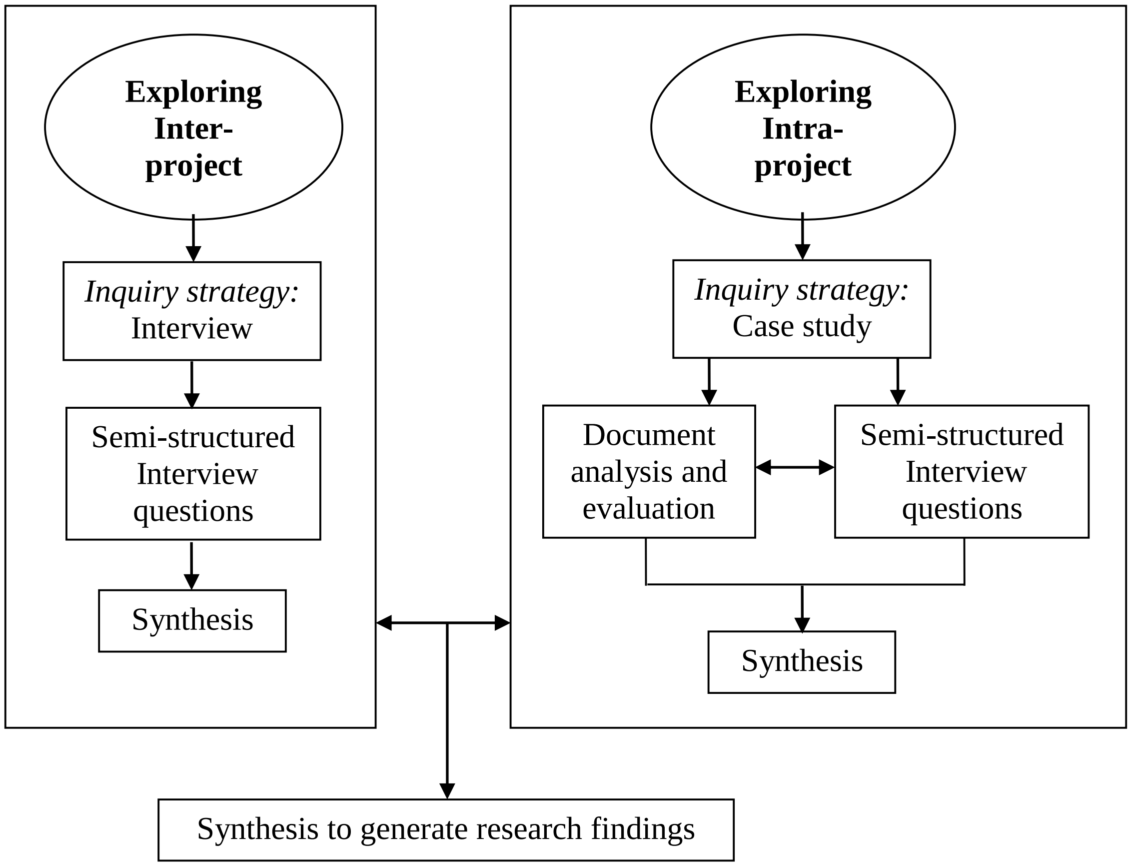

Figure 4.3 Inquiry Strategy of Data Collection

The inquiry strategy has two-components. First, in exploring inter-project perspective, the data inquiry strategy is to use semi-structured face-to-face interviews with the construction professionals who are involved with project decisions and contemplated adopting IBS technology. Second, in exploring intra-project perspective, the data inquiry strategy is to make multiple case studies of project supply chains that deal with IBS decisions and mandated to adopt IBS technology. The current study used semi-structured face-to-face interviews to collect the qualitative data for both inter-project and intra-project perspectives. However, for the case study of intra-project perspective is also involved document analysis and evaluation. These qualitative techniques are used to determine how IBS decision-making is influenced as part of particular construction contexts or perspectives. Further explanation of the inquiry strategies of this study is as follows:

i) Interview

The face-to-face interviews for the current study were semi-structured interviews. Constructively, the interviews could be conducted with a number of participants in a short time and were cost- and time efficient (Denscombe, 2010; Gubrium and Holstein, 2002). The interviews followed the normal research process and used several questions to ensure that important issues were addressed (May, 2011; Seidman, 2012). These face-to-face interviews provided opportunities for this research to gain a better understanding of the participants' perceptions of a variety of factors. It indicated how they view and assess IBS decision-making and identified those factors that they perceived to have important implications on IBS decision-making.

A semi-structured interview has been recognised as a useful method for collecting qualitative data for several reasons (Noor, 2008; Schatz, 2012). It allows this research to reorder questions during an interview to enable the participant to reflect or elaborate on their views (Roulston, 2010). It also allows the wording of questions to be flexible and the language level to be adjusted to suit participants from different backgrounds (Phellas et al., 2011). Finally, it provides an opportunity for the researcher to clarify the meaning of the participants' answers (Kvale, 2007). Therefore, the semi-structured face-to-face interview was an effective method for the current study. Consequently, this enhanced the quality of the information obtained (Frost, 2009).

The questions used for the semi-structured face-to-face interviews emerged from the theoretical framework developed in Chapter 3. The questions were predominantly open questions, although some were more structured. Semi-structured and open-ended questions allow the participants to answer on the basis of their knowledge and understandings (Chan et al., 2013; Turner, 2010). The semi-structured face-to-face interviews were designed to take approximately 50 minutes for each session but the actual length varied. The questions of the semi-structured face-to-face interviews consist of fourteen questions (see Appendix 1).

ii) Case Study

This section provides the next inquiry strategy that was used in this study. A case study has been selected as the research strategy for obtaining the data collection. The case study approach is considered as useful for the current study because it has been suggested to be suitable for the research questions of 'what' and 'how' and provides an in-depth contextual understanding of a particular group or individuals (Yin, 2011). This section then provides criteria for judging the quality of the case study design.

A case study provides a rich explanation of "who" and "how" for problems under investigation, which sometimes cannot be explained through statistical approaches. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2009). According to VanWynsberghe and Khan (2008), case study is a trans-disciplinary heuristic that involves the careful delineation of the phenomenon for which evidences such as event, concept, program and process are being collected. Stake (2013) clarifies that for multiple case studies, the case records are often presented intact, accompanying a cross-case analysis with some emphasis on the binding concept or idea. Moreover, research in decision-making involves the study of human which contains a unique element of a person, group and organisation based on a case study method (Cooper and Schindler, 2003; Zikmund et al., 2012).

b) The Participant Recruitment Strategy – Qualitative Selection Strategy

The study is limited to construction firms involved in building projects, excluding highway contractors, landscape firms, mechanical- and electrical contractors. The target participants for the current study were also selected from two particular groups of project perspectives, namely inter-project, which consists of construction-profession stakeholders and intra-project, which consists of the supply-chain members of IBS projects. These two groups were chosen because they had different levels of knowledge about their role in decision-making, and to provide multiple perspectives based on different contexts. The participants from the construction-stakeholder group had been involved in their building or other construction projects for long enough to have developed some knowledge and understanding of the development associated with IBS building technology. Meanwhile, participants from the group of IBS project supply chains (each group treated as separate case study) have context-specific IBS technology adoption experience from their involvement with specific IBS building projects. This study does not seek to compare various project perspectives towards IBS decision-making. Rather, it seeks to collectively identify a variety of factors associated with IBS decision-making and provide insight into how these factors impacted upon IBS decision-making.

As has been indicated, this research collected data from construction professionals. The recruitment of participants for inter-project perspective was based on a face-to-face interview approach. As the focus of this study, the participants were selected from the Malaysian construction-profession stakeholders group. Meanwhile, the recruitment of participants for intra-project perspective was based on a case study approach with multiple cases. As a result, participants for the case study were recruited from three IBS building projects, as the members of the supply chain. Multiple-case study a method whereby empirical results are obtained from a selection of specific groups or a small number of individuals (Merriam, 2009; Stake, 2013). Thus, the current findings provide detailed information about IBS decision-making based on three specific IBS building projects but they cannot be generalised to other Malaysian building projects.

The phases of the data collection process are presented in a systematic order. The research will proceed through non-sequential phases as shown in Figure 4.4.

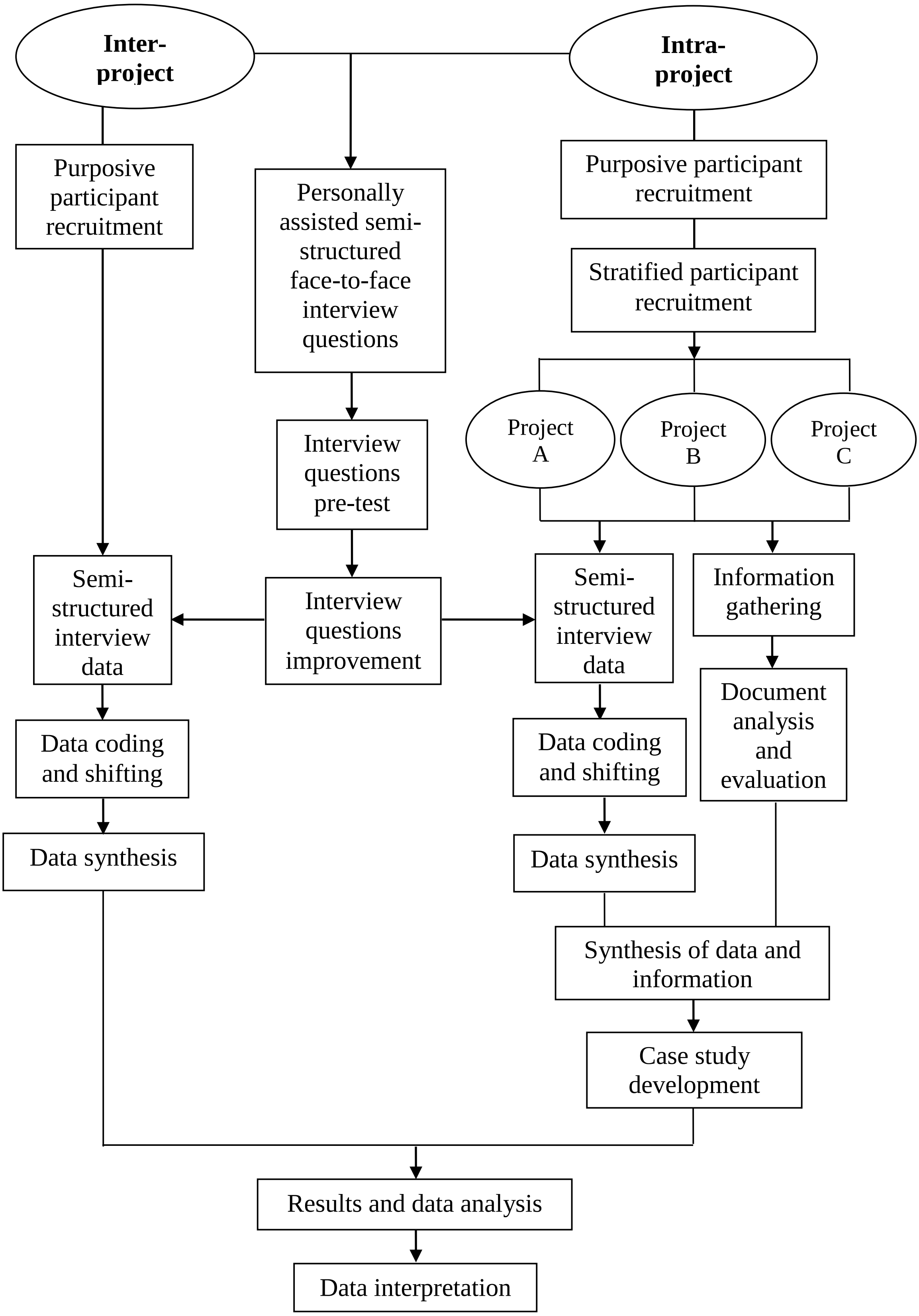

Figure 4.4 Participants Recruitment Strategy and Data Analysis

Figure 4.4 shows how two components of the study–the interview method for the inter-project perspective and the multiple case study for the intra-project perspective, conducted non-sequential phases and were then integrated during the interpretation phase. Qualitative results, as occurred in this study, are commonly used to assist in explaining and interpreting the findings from the decision research or study (Appelt et al., 2011; Cozby and Bates, 2011). This non-sequential explanatory design was an appropriate strategy for the current study because it provided a clear research process and was straightforward to implement (Maxwell, 2012). The major strength of the design is that it does not require substantial time for data collection as it involves a non-sequential process besides having two separate studies (Kantardzic, 2011).

In order to find a more closely defined group for whom the research question will be significant and more relevant, a purposive recruitment technique was used in this study. The purposive selection technique is a type of non-probability participant recruitment that is most effective when one needs to study a certain domain comprising knowledgeable experts and is fundamental to the quality of data gathered (Tongco, 2007). The purpose of information-oriented selection is to maximise the utility of information on the basis of expectations about the information content, to be problem driven and help answer the research question (Lohr, 2010).

The study used semi-structured face-to-face interviews to obtain the qualitative data. The qualitative study therefore used a combination of 'purposeful' and 'stratified' participant-recruitment strategies to recruit participants. The participants were purposively recruited from the construction industry. It was purposeful because the target participants for the semi-structured interviews were from the construction-profession stakeholders group. Once the process of selecting participants was completed, this research used a stratified way of classifying the selected participants. This research used a stratified way of recruiting participants to select participants from a variety of learning- and work-skill backgrounds in a selected IBS building project. Stratified participant recruitment is a strategy that assigns participants to different subgroups by using specific criteria, when the participants for each subgroup are available (Bailey, 2008). The current study divided the purposeful participant groups into different subgroups that are three IBS projects, for inter-project perspective, and a group of the construction-profession stakeholders for intra-project perspective, as indicated in Figure 4.4.

Later in this chapter, the multiple-perspectives research approaches are presented as two separate studies: the inter-project perspective and the intra-project perspective. Each section provides specific discussion on the project context, participants' recruitment technique, unit of analysis, data collection method and data collection procedure.

4.5 Exploring Inter-project Perspective

The focus of the face-to-face interviews in this research is on understanding the fundamental nature of perception, from an inter-project perspective, about IBS decision-making and its influencing factors. A theoretical understanding of the research interview means conceptualising what goes on in the situation and how the outcomes can be understood (Kvale and Brinkmann, 2009). Thus, in this research, the face-to-face interview method is an instrument for tapping the participants' perception towards various influences on IBS decision-making based on their subjective views.

The face-to-face interview method in this study is used to explore the inter-project perspective of professionals and individuals on IBS decision-making across the construction industry. This method is based on an integrated conceptual framework as presented in Chapter 3, based on the literature reviews in Chapter 2. The data from these interviews are based on the perception of the construction-profession stakeholders group and have provided a comprehensive view about various influences on IBS decision-making.

4.5.1 Inter-project Context

An inter-project context has been explored as a research perspective associated with knowledge exchange across the industry when the adoption of new technologies, or development of new project routines, could be used and applied elsewhere in other projects (Di Vincenzo and Mascia, 2012). This section provides a more detailed explanation of an inter-project context in the current research, covering the perspectives of the construction-profession stakeholders group in the construction industry. This inter-project perspective was selected because it was considered important to interview construction professionals who had gained practical knowledge and work involvement in building projects across the construction industry. This may not have been the case for any particular building projects as the inter-project context is only contemplated to adopt IBS technology.

It was considered that these construction professionals were the most suitable participants as the construction stakeholders because they had developed knowledge and skills from working in the construction industry (Dainty et al., 2003). As a result they were able to provide, and elaborate on, information associated with the decision-making of IBS technology and its influencing factors.

4.5.2 Participant Recruitment Technique

Participants for the group of construction-profession stakeholders were selected according to the positions they had during work-placement, for example project managers, design architects, quantity surveyors, civil engineers and project consultants. This participant recruitment strategy was used to provide in-depth information about the way in which construction professionals across the construction industry, from a variety of learning, involvements and work backgrounds, perceive IBS decision-making.

In order to recruit the participants, the information of their organisations was obtained from the Malaysian Builders Directory (2011/2012). For the inter-project perspective, 27 participants were interviewed, representing the group of construction-profession stakeholders. Three participants were recruited for the semi-structured face-to-face interviews as the representative number from each type of construction professional. Table 4.3 illustrates the participants' recruitment of this study for the inter-project perspective.

Table 4.3 Inter-project Perspective: Participant Selections for Face-to-face Interview

The group of construction-profession stakeholders	Design architect	Quantity surveyor	Developer	Consultant	Contractor	Civil Engineer	Project Manager	Manufacturer	Clients/ Owner
No. of Participants	3	3	3	3	3	3	3	3	3
Total	27 Participants								

The purposive participants recruitment method fits the yield of suitability as this study intends to explore and analyse in detail how the group of construction-profession stakeholders perceive and make sense of contextual, structural and behavioural factors influencing IBS decision-making. Therefore, in order to verify the decision-making competences of the construction professionals and to gather a broad cross-section of perception and opinion across the construction industry, the following criteria for participants recruitment were adopted, namely; hierarchical level, functional responsibility and area of responsibilities. All information on participants is assured confidentiality.

4.5.3 Unit of Analysis

For the group of construction-profession stakeholders, selected organisations were requested to identify organisational members to participate in the research as the unit of analysis that includes design architects, quantity surveyors, developers, consultants, contractors, civil engineers, project managers, manufacturers and clients. Organisations were required to grant permission for the recruitment of their employees. The individuals would then be contacted with information statements, consent forms and interview schedules.

The unit of analysis from an inter-project perspective in this research is the group of construction-profession stakeholders across the construction industry. The observation units are based on their IBS involvement, understanding and know-how in building projects. Perception on the decision-making of IBS technology adoption represents the manner by which construction professionals define themselves as an entity of the construction-profession stakeholders, in relation to their environment. Additionally, they also identified themselves as decision-makers based on their project involvements according to the inter-project perspective. When an individual is performing decision-making tasks in a project, he or she may have a rather different view of it than others performing the same task and thus, the 'fit' will differ for different decision-makers (Fan and Fox, 2009; Peldschus et al., 2010).

4.5.4 Data Collection Method

In this research, semi-structured face-to-face interviews were conducted as the data collection tool. After the participants had been categorised into the required subgroups, the researcher arranged a suitable time for the face-to-face interviews. Besides voice recording, note-taking was used to record the information obtained from the face-to-face interviews when they were carried out, and detailed notes were made.

Rapley (2011) and Turner (2010) suggest that note-taking is likely to make a researcher listen more carefully to what an interviewee is saying in order to determine what words, phrase or ideas should be recorded. It also allows the researcher to record tone and speech patterns from the face-to-face interview, which can help the researcher to clarify or recall the meaning of words, phrases or ideas from the interviewee. One criticism of note-taking is that it can be difficult for researchers to interact with interviewees while information is being recorded during the face-to-face interviews, so the researcher tried to ensure that rapport was maintained during the face-to-face interviews.

This research employed several strategies to ensure the semi-structured face-to-face interviews could collect all relevant data. These included, ensuring the questions asked were unambiguous and the researcher clarified words or ideas with the interviewees to ensure responses were recorded accurately. Interview procedures were based on good preparations with a format and using participants' own language depending on participants' own processes, interpretations and understandings (Anderson, 2011; King and Horrocks, 2010).

The semi-structured face-to-face interview method attempts to understand the ways construction professionals across the construction industry perceive various factors that impact on IBS decision-making. Using the face-to-face interview was a preface to a systematic classification of contextual, structural and behavioural influences on IBS decision-making. Structuring the face-to-face interview according to the literature review and the integrated conceptual framework of this study is based on the determination of loops which are not clarified in the literature review. The advantages of the semi-structured face-to-face interview are reliability, control and speed because the same format will be used with each respondent (Irvine et al., 2010).

An interview session took about 50 minutes on average and it was recorded or taped. On reviewing the face-to-face interviews, after a few interview sessions, the researcher recognised if they contained a considerable amount of data that was remarkable to IBS decision-making, and in particular the basis on which the construction-profession stakeholders construct their perception towards IBS decision-making. Potential influencing factors of contextual, structural and behavioural elements which had been unidentified earlier were then identified throughout the semi-structured face-to-face interview.

4.5.5 Interview Procedure

The semi-structured face-to-face interviews were used to probe further into how contextual, structural and behavioural factors impact on the decision-making of IBS technology adoption. The researcher also encouraged interviewees to provide information that was relevant to the research questions and the theoretical framework. At the close of an interview session, the researcher summarised the information obtained from the face-to-face interview and read back some direct quotes or words to the interviewees, to further ensure the information provided had been correctly recorded, and accurately expressed the participant’s ideas.

Participants were asked several questions to elicit further information regarding those characteristics underpinning the current study, in terms of their background in the construction industry. The semi-structured face-to face interview was developed with a complete script that was prepared beforehand and required fewer actions. Before conducting the face-to-face interviews, coding frames were developed to reflect the emerging theme of the study. As designed for the interview method, the questions were short, specific and based on order with pre-coded response categories. This enabled the interviewer to match what the respondents said against one of those categories.

Besides that, the respondents were allowed free responses, which could then be categorised. In this study, the structured face-to-face interview is like an actual questionnaire but allows more elaborate answers. This mode is just like going through a set of questions in the presence of a respondent with the interviewer filling in the answers based on what the respondent says. An Interview with semi-structured questions as guidance still requires a more genuine human interaction in order to explore the 'inner world' (feelings, attitude and perception) or psychological reality of the respondent (Knapp, 2012; Stanton et al., 2012). Additionally, Myers and Newman (2007) recommend that a dramaturgical model can assist researchers prepare for interviews, can aid disclosures and should improve the amount and quality of data gathered.

Although the study sets out to focus on contextual, structural and behavioural factors, no questions were asked which directly addressed the issue, for example the word 'behaviour' did not appear in the interview questions and it was only mentioned explicitly during face-to-face interview. Questions in the semi-structured face-to-face interview that were asked, on reflection, were leading to responses relevant to the study of IBS decision-making. A key objective of not asking the respondents direct questions about IBS decision-making was that the interviewer was unable to steer respondents directly towards major research themes, thus minimising the potential for social reporting or imposing an awareness of behavioural aspects which might otherwise be absent.

4.6 Exploring Intra-project Perspective

In exploring intra-project perspective, the qualitative study used a case study approach to collect data. The study used a case study approach to investigate factors influencing the decision-making of IBS technology adoption with its empirical results obtained from a selection of specific IBS building projects that were mandated to adopt IBS technology.

The frames of reference of exploring intra-project perspective are different from those of inter-project perspective. Specifically, an intra-project perspective represents the group of supply-chain members in selected IBS building projects. These projects are mandated to adopt IBS technology and therefore, the frame of decision-making outlooks and situations are viewed differently to those in an inter-project perspective. Exploring intra-project perspective involves an outlook across IBS building projects, on IBS decision-making and its influencing factors. This perspective refers to specific IBS building projects, thus applies norms and specific criteria in the building projects, IBS technology adoption and IBS decision-making.

The focus of the case-study approach in this research is on developing an in-depth analysis of multiple cases that explore intra-project perspective on IBS decision-making and its influencing factors. Case-based research intends to examine the interpretations and explanations across cases, to establish external validity from a research setting to real situations (Stake, 2013; Swanborn, 2010). In the current research of IBS decision-making, the perspectives of numerous IBS project types could reveal the entire pattern of IBS decision-making. Case study is designed to bring out the details from the viewpoint of participants by using multiple sources of data and each individual case study consists of a “whole study”, in which facts are gathered from various sources (Bell, 2010; Yin, 2009).

In order to explore and understand the impact of contextual, structural and behavioural factors on IBS decision-making in building projects from an intra-project perspective, this research is based on the perception of supply-chain members in IBS projects. It was necessary that the research method segment vertically through the projects, obtaining data from the multiple perspectives of construction professionals from different IBS building projects. Thus, the method of this case study was not limited to a single case as multiple-case perspectives offer a wider outlook on IBS decision-making in the supply-chain context across IBS projects. According to Yin (2011), case study is usually used to answer questions like “how” and “why” when there are no clear evidences and when the researcher has little or no possibility of controlling the events. Therefore, a multiple-case-study approach was appropriate and used.

4.6.1 Intra-project Context

Where an inter-project perspective simply views an issue across an industry, an intra-project perspective indicates the activities within a project, based on more specific project context with specific requirements (Senaratne and Sexton, 2008). In addition, intra-project context involves an understanding on specific project conditions with detailed instructions (Aouad et al., 2010b; Gil, 2007). The supply-chain members of IBS building projects in this study had more developed insights on IBS decision-making as they were involved in, and practising, IBS technology adoption based on their own set of project criteria.

Since an inter-project perspective framed decision-making as needing to make the right decision, more specific project context sought optimal decisions given the circumstances (Sears et al., 2010). More skilled construction professionals were also more capable of managing the context, being more aware of the influences and better able to pragmatically interact with, and manipulate, contextual factors to achieve optimal decision outcomes (Langford and Male, 2008). The knowledge base of decision-makers has been found to extend beyond project operations, to include knowledge of their work context in terms of the physical environment and organisational structures (Harris and McCaffer, 2013; Rondinelli, 2013).

The current research from an intra-project perspective was focused on Malaysian building projects that had adopted IBS technology, with a wide range of IBS project supply-chain members. The concept of IBS technology adoption in the construction industry is technically appealing but its implementation in building projects poses substantial managerial, organisational, decisional, technical and environmental challenges (Goulding et al., 2012a; Kamar et al., 2010b; Meiling et al., 2012).

Three IBS building projects were selected so as to deliberately vary the outlook of IBS decision-making and its influencing factors, based on the perception of their supply-chain members. Case study is appropriate as a natural basis for generalisation in the understanding of a phenomenon and a situation of complex description based on essential similarities, universality and experiential understanding (Baxter and Jack, 2008; Noor, 2008; Siggelkow, 2007). The selected case studies were based on the three circumstances of building projects, namely, a successful, a non-performing and an unsuccessful IBS project.

In this research, the successful IBS project is determined according to its performance in standards by which project outcomes are fully achieved within a set of project specifications. Meanwhile, the non-performing IBS project does not produce the expected performance as the project's outcomes, standards and specifications are only partially met. As for the unsuccessful IBS project, it fails to meet the project standards and specifications, besides not producing the expected outcomes. In order to explore IBS decision-making from the intra-project perspective, the selected IBS projects had to fulfil the following criteria:

a) The IBS technology adopted had passed some baseline tests of technical feasibility.
b) IBS technology altered the project work environment in some obvious way, for example work and workforce efficiency at the construction site.
c) All projects focused on the time from the first establishment of technical feasibility until the project adopted the IBS technology in full implementation mode.

This three-conditions set binds the adoption situation, confining it to a series of transactions between IBS technology developers and users, thus providing additional control over undesired variation among cases.

4.6.2 Participant Recruitment Technique

In order to select the IBS projects, the information of their organisations was obtained from the Industrialised Building System Centre, Malaysia, available from the public domain, http://www.ibscentre.com.my/ibsweb which contains information on an IBS project list with supply-chain details, general project performance, project value and IBS score. For the intra-project perspective, three building projects that dealt with IBS decisions were chosen as case studies. The projects in this case study were named as Project A (successful IBS adoption), Case study B (non-performing IBS adoption) and Case study C (unsuccessful IBS adoption) as illustrated in Figure 4.4. To maintain confidentiality, case study projects, participating organisations and any individuals were de-identified and referred to via codes and pseudonyms.

There were nine participants from each IBS supply chain, totalling 27 participants across three case studies (thus, in total 54 participants were recruited for this study). Participants for the construction supply-chain group were selected according to the positions they had during the selected IBS building projects, for example as project manager, design architect, quantity surveyor, civil engineer and project consultant. This participants recruitment strategy was used to provide in-depth information about the way in which construction professionals across the IBS building projects, from a variety of learning, involvements and work backgrounds, perceive IBS decision-making. For the case study development in exploring intra-project perspective in IBS decision-making and its influencing factors, the recruitment of research participants is illustrated by Table 4.4.

Table 4.4 Intra-project Perspective: Participant Selection of Face-to-face Interview for Case Study

The group of IBS project supply chain members	Design architect	Quantity surveyor	Developer	Consultant	Contractor	Civil Engineer	Project Manager	Manufacturer	Clients/ Owner	**No. of participants for each IBS building project**
Project A	1	1	1	1	1	1	1	1	1	9
Project B	1	1	1	1	1	1	1	1	1	9
Project C	1	1	1	1	1	1	1	1	1	9
Total	27 Participants									

As stated by the research strategy of this study, it is a multiple case study approach and three IBS building projects were researched: Project A, Project B and Project C. The choice of these three IBS projects was based on two fundamental criteria. First, relevance; all of them were considered capable of contributing to the study and fitted the selection criteria. Second, possibility; the organisations were willing to take part in the study, provide information and allow face-to-face interviews to be held with their staffs. Projects members who were directly or indirectly involved in decision-making process within the project were assumed to be influenced by various factors in the IBS decision process.

In this study, the focus was on case-selection principles based on cross-case features of a building project in terms of how projects or cases fit into the theoretical specifications of IBS decision-making, based on intra-project perspective. In case selection and analysis, the diverse technique of cross-case method requires the selection of a set of cases, two being the minimum, as the researcher simply chooses one case from each category with both extreme values, high and low, to achieve the maximum variance among relevant factors (Seawright and Gerring, 2008).

The selection of building projects in this study clarifies the diverse performances of IBS building projects in terms of successful IBS adoption, non-performing IBS adoption and unsuccessful IBS adoption. The diversity of cases in the study was computed based on three conditions. First, the three categorical performances of IBS building projects. Second, the characteristics of those three projects and third, perceived influencing factors on IBS decision-making based on the combination of those projects for qualitative analysis and cross-case analysis.

4.6.3 Unit of Analysis

According to Zikmund et al. (2012), unit of analysis specifies whether the level of investigation will focus on the collection of data about organisations, departments, work groups or individuals. Moreover, Babbie (2012) identifies a unit of analysis as the kind of case to which the variables or phenomena under study and the research problem refer, and about which data is collected and analysed. In exploring the intra-project perspective on IBS decision-making and its influencing factors, there are two units of analysis in the case study, namely: i) IBS building projects ii) construction professionals as the supply-chain members of IBS projects. Qualitative data on IBS building projects and their members from an intra-project perspective were analysed to investigate how IBS decision-making and its influencing factors were perceived and expressed. The first unit of analysis investigated in the current research is IBS building projects.

The second unit of analysis from an intra-project perspective is the supply-chain members of IBS projects including a group of construction professionals across the IBS building projects. The group of supply-chain members in IBS building projects is identified as having an important team role in the projects. They were directly involved in the selected IBS building projects and therefore had a decent level of knowledge and understanding on the decision-making of IBS technology adoption. This group also comprises of design architect, surveyor, developer, consultant, contractor, project manager, civil engineer, manufacturer, installer and clients.

The observation units are based on their IBS involvement, understanding and know-how. Perception of the decision-making of IBS technology adoption represents the manner by which construction professionals define themselves as a member of the IBS project supply chain in relation to IBS building projects. Additionally, they also identified themselves as decision-makers, based on their project involvements according to the intra-project perspective. It was assumed that construction professionals, as the supply-chain members of IBS projects, shape and are shaped by contextual, structural and behavioural factors pertaining to IBS decision-making.

4.6.4 Data Collection Method

A case study method was performed to obtain a better understanding of IBS decision-making, to clarify the contextual, structural and behavioural influences and to illustrate the framework of IBS decision-making in the supply chain context across IBS building projects. According to Bell (2010), a case study focuses on one or two issues that are fundamental to the understanding of the system being examined, based on the multi-perspective analysis of a relevant group of actors. As a data collection tool in this research, case study tries to explain the verification of contextual, structural and behavioural factors or influences on IBS decision-making.

Multiple case study design is appropriate when seeking literal replication of results across cases. The rationales for choosing the multiple case study method are two-fold. Firstly, the cases provide various performances of IBS adoption. Secondly, the case study is the representative of the individual firms or projects of the construction industry. Moreover, there is also a strong tendency that data can be obtained from a variety of sources and therefore provide the ability to select a multiple case study design.

The case study performed in the current research is exploratory in nature. It is exploratory because it explores unknown variables that are the contextual, structural and behavioural influences on IBS decision-making from the inter-project perspective. The impact of the factors or the combination of these factors on IBS decision-making has not been empirically examined. The case study is employed because it seeks a better understanding of unknown variables that are linked to each other from the intra-project perspective. Therefore, qualitative data collected through a case study method is preferred, to obtain a rich and deeper project understanding of the IBS decision-making in building projects.

The main goal of qualitative research is to gather data which can stand independently so that others can analyse the same data in the same way, in order to produce a plausible and coherent explanation based on systematic research design, data collection and interpretation (Flick, 2009). Besides face-to-face interview sessions as the primary source of this research for the multiple case study development, data was also gathered from multiple secondary sources such as firm's annual reports, newspaper articles, marketing brochures, archival records and press releases.

4.6.5 Case Study Procedure

For the case studies, a lead organisation was determined and was requested to identify project team members to participate in the research that included design architects, quantity surveyors, developers, consultants, contractors, civil engineers, project managers, manufacturers. The lead organisation then sent information statements, consent forms and face-to face interview schedules to the construction professionals of the selected IBS building project. If participants decided to take part in the research, they were requested to participate in a face-to-face interview that took approximately 50 minutes on average. Therefore, the entire session required about an hour's commitment from participants.

A case-based study starts in a step-by-step approach and the value assessment and consequence of each step depends on the validity of the following steps. This study is generally based on case study protocol developed by Yin (2009). Based on these steps, during data collection process, preventive measures must be taken to ensure that raw data are authentic, valid and free from bias effects and preference outcomes. Authenticity indicates that while the link between conceptual frameworks , questions and findings may not lead to a single valid truth, rigour and reflexive practice has assured that conclusions are justified, credible and trustworthy (O'Leary, 2004). According to Bennet (2005), case study is the detailed examination of an aspect, to identify and measure left-out variables, with the consideration of contextual factors.

A semi-structured face-to-face interview for a case study has allowed a session of dialogue with introductory questions that were modified in the light of the respondents' responses, with specific IBS project references for further explanations. A set of questions was used as guidance so that the interviewer was able to probe interesting issues or matters that arose regarding IBS decision-making, IBS technology adoption and its influencing factors. Questions in the semi-structured face-to-face interview were used to guide and facilitate rather than to dictate exactly what was happening during the session. As technology is dynamic, technology adoption requires methods like case study which can capture technology characteristics within particular contexts, to investigate technology adoption issues (Choudrie and Dwivedi, 2005).

Other areas of interest in this study were highlighted during face-to face interview sessions for the case studies development. Accordingly, some questions were asked based on the background and performance of IBS building projects, as this study wishes to explore IBS decision-making and its influencing factors, in the intra-project perspective of IBS projects. By using semi-structured face-to-face interviews in case studies, it creates rapport and allows a greater flexibility of decision-making coverage in IBS technology adoption.

Semi-structured face-to-face interviews generate the exploration of novel ideas, besides gathering information of a particular IBS building project. Additionally, this method tends to generate richer data. Besides that, the case study developments were also supplemented by archival and observational data. According to Newell and Bröder (2008) and Morse et al. (2008), case research typically involves qualitative methods ranging from informal to somewhat more formal, and often utilises face-to-face interviews with key actors and other informants, on-site observations of events, the collection of written documents, library research, reading personal papers, biographers' reports and other sources of information.

The contents of case study development in terms of IBS decision-making are as follows:

a) Information on background, type and performance of the studied IBS building projects.
b) Discover the decision-making nature of IBS technology adoption in each building project.
c) Explore IBS decision-making and its influencing factors based on the multiple perspectives of construction professionals as the IBS project supply-chain members of a particular IBS building project.
d) Determine, evaluate and diagnose the impacts of contextual, structural and behavioural factors on IBS decision-making.

4.7 Data Analysis

In order to analyse the qualitative data, the current study followed the principle of the content analysis to provide guidelines and a systematic framework for analysis. For this research, the unit of analysis is divided into two units as illustrated in Figure 4.5

LEVEL OF INVESTIGATION	UNIT OF ANALYSIS: *Inter-project Perspective:*	UNIT OF ANALYSIS: *Intra-project Perspective:*
Project →		3 IBS Building Projects
Individuals →	Construction professionals as the stakeholders of the construction industry.	Construction professionals as the members of IBS project supply chain in these particular projects.

↓ ↓

DATA ANALYSIS	**INTER-PROJECT PERSPECTIVE** (the group of construction-profession stakeholders)	**INTRA-PROJECT PERSPECTIVE** (the group of IBS project supply-chain members)		
Data Types:	Primary Data	Primary and Secondary Data		
Research Approaches:	Interview	Case study		
Data Collection Method:	Semi-structured face-to-face Interview	Multiple case studies: semi-structured face-to-face interview and information gathering.		
Research Participants(size): (*Total:* 54 participants)	Individuals as the construction professionals (27 participants)	Project A	Project B	Project C
		Individuals as the construction professionals (9 participants for each IBS project, total 27 participants)		
Data Processing:	Data coding, grouping and analysis	Data coding, grouping and analysis	Document analysis and evaluation	
Nature of Data Analysis:	Synthesis of data and information ↓ Results and Data Analysis ↓ Merging of Results ↓ Data Interpretation ↓ Conclusions			

Figure 4.5 Level of Investigation, Unit of Analysis and Data Analysis

As Figure 4.5 shows, the main unit of analysis for inter-project perspective is a group of construction professionals. For intra-project perspective, the unit of analysis is three IBS building projects and within the projects, the level of analysis includes individuals as construction professionals.

As illustrated by Figure 4.5, the unit of analysis for this research refers to the relationship between the level of investigation and the analysis. First, three IBS building projects were selected as the projects to be investigated, namely Project A, Project B and Project C. Second, the individual level was divided into two areas: the group of construction professions stakeholders and the supply-chain members of IBS projects. At this level, semi-structured face-to-face interviews were focusing on exploring IBS decision-making and its influencing factors, as perceived by the construction professionals of these groups.

Conditions for interpreting the quality of research designs are also essential. The logic linking the data to the research questions and conditions for interpreting the finding is obtained from the case study approach. Yin (2011) highlights that a good case study is expected to show its effectiveness in terms of linking data and establishing a set of criteria for interpreting the findings. In particular, the unit of analysis is discussed and determined with reference to the project and construction professionals in Malaysia.

Generally, content analysis involves two major procedures: coding the data and constructing the relationships amongst the coded data. Coding involves generating descriptions or categorising the data, so that later the relationships between the coded data can be determined or constructed (Maxwell and Miller, 2008), and hence qualitative data can be coded based on words, concepts, sentences and themes (Saldaña, 2012).

The next step is to construct the relationship amongst the obtained coded data and make sense of the data. Grbich (2012) suggests that the construction of relationships of qualitative data should be based upon the theoretical framework of the study. As a result, after the data coding, the researcher constructed the themes from the obtained coded data and made extrapolations (Duriau et al., 2007; Fereday and Muir-Cochrane, 2008). Content analysis has been described as a useful qualitative analysis technique that can systematically and comprehensively generate a summary or overview of the data set (Corbin and Strauss, 2008; Hsieh and Shannon, 2005). Therefore, the current research followed the above content analysis procedures to analyse the qualitative data and to provide a greater understanding of the quantitative results.

Prior to data analysis, the researcher used Bryman's (2012) suggestions as a guideline for data preparation. This involved organising, arranging, and having a general sense of the information that had been collected. The researcher read through the face-to-face interview record as soon as each face-to-face interview was completed, to ensure that information was written legibly. Later the information was divided into four data sets: construction-profession stakeholders group, Project A, Project B and Project C. Then within each data set, the information was grouped according to the roles and positions that the participants had during their work-placement in each IBS project. The researcher then read through all interviews to gather a general sense of the information from each data set.

4.7.1 Qualitative Data Analysis

Recorded face-to-face interview sessions were transcribed and analysed after each face-to-face interview, to identify saturation points and to determine any under-developed categories or gaps that required further probing. The analysis of qualitative data in this research was facilitated by the use of NUD*IST (Non-numerical Unstructured Data Indexing Searching and Theorising) Vivo or commonly known as NVivo (Bazeley and Jackson, 2013). Coding and other data analysis tasks were performed by a computerised approach using the QSR Nvivo Version 10 program. For this research, NVivo software is used in producing nodes and patterns according to various coding, especially of the variables of influencing factors on IBS decision-making, within the interview data before frequency counts or percentage distributions are determined to support the themes of interest and emerging factors to the research.

According to Hutchison et al. (2010) and Leech and Onwuegbuzie (2011), the program provides a systematic way of organising, keeping and modifying all data, topics, categories, results and research notes. The document file holds all the documentary data and interview transcripts. A sample of the interview transcript for inter-project perspective and intra-project perspective in this research, is attached in Appendix 2 and

Appendix 3 respectively. The nodes represent categories of data that are important to the research. NVivo works with text documents and facilitates the categorising and indexing of these documents. This software is able to search for words and phrases very quickly and can support theorising through enabling the retrieval of indexed text segments, texts and index searchers. Accordingly, the data is categorised through the development of a hierarchically structured arrangement in order to index categories.

It should be also noted that when presenting the qualitative results, this research used a combination of approaches. These included classifying verbal data such as quotations and themes provided by the participants who responded to particular themes or issues, as well as project data that was provided by the participants. Using numerical data in qualitative studies can be controversial because it is common practice in quantitative research. However Maxwell (2010) and Merriam (2009) suggest that using numerical data is also a valuable strategy for qualitative research as it can provide supplementary support for the evidence from the quantitative data. It was seen to be particularly appropriate for the current qualitative study because it involved a relatively large number of participants (54 participants) and the data analysis involved identifying themes or issues associated with the influencing factors of IBS decision-making.

Across the IBS projects, due care were taken to de-identify the data. This includes removing key identifying information such as participant's name from primary data (i.e. face-to-face interviews and background information) and secondary data (i.e. documentation, project information). Only background information on participants was used such as organisation type, position title, age group and academic qualifications. Initially separate coding and abstractions were made at individual and project levels. Subsequent synthesis of both individual and project perspectives would contribute to build well-evidenced research findings.

4.7.2 Qualitative Coding

Qualitative coding gathers all the material about the topic or category of the interview text, then assesses and uses it (Saldaña, 2012). For this research, the categories are mainly coded under nodes and stored on hierarchical catalogues and cases. The categories that emerge from the code-node headings of the interview form the basic framework that constitutes core materials answering the research question of this study.

Data were analysed at different levels, in terms of inter-project and intra-project perspectives, using rigorous qualitative methods. Coding was carried out in order to produce some recognisable patterns in the semi-structured face-to-face interview responses. In order to make full use of the richness of the data and to increase the robustness of the analysis on the influencing factors of IBS decision-making, a coding method was adopted with three levels of coding namely:

a) Basic coding – classifying of responses from participants into general groups or themes.

b) Intermediate coding – grouping participants' responses into narrower categories.

c) Final coding – categorising participants' responses into more specific types.

This research intends to create a new understanding of IBS decision-making and its influencing factors by exploring and interpreting complex data from the semi-structured face-to-face interviews. This task involves the examination of texts, coding task, revising coded matters, searching for patterns and developing models. In order to achieve these, NVivo is used to assist in these tasks. Cases in NVivo are grouped at case nodes, where all the sections of sources can be coded and assessed accordingly. The node headings and categories of this research can be summarised as shown in Table 4.5 below. Explanations of the codes of this research are presented in Appendix 4, for behavioural factors, Appendix 5, for contextual factors and Appendix 6, for structural factors.

Table 4.5 Codes for Factors Influencing IBS Decision-making Using NVivo 10 Content Analysis

BASIC CODE (THEME)	INTERMEDIATE CODE (CATEGORY)	FINAL CODE (SUB-CATEGORY)	NODE CATEGORIES
BEHAVIOURAL	Attitude	Negative attitude	Conceptual and Exploratory (Analysis: contents and phrases)
		Positive attitude	
	Awareness	Culture	
		Personality	
		Support	
		Values	
	Experience	Failure experience	
		Success experience	
	Bounded Rationality	Choice	
		Cognition	
		Justification	

		Learning	
CONTEXTUAL	Economics	Business	
		Competition	
		Demand	
		Opportunity	
		Uncertainty	
	Government	Promotion	
		Policy	
		Requirement	
		Rules	
	Stakeholders	Opinion	
		Partnership	
	Sustainability	Efficient	
		Environment	
		Trends	
		Waste	
	Technology	Creativity	
		Innovation	
		Productivity	
		Quality	
STRUCTURAL	Communication	Formal	
		Informal	
	Decision	Group	
		Individual	
		Nature	
	Management	Goals	
		Leadership	
		Planning	
		Process	
		Strategy	
	Procurement	Costs	
		Clients	
		Resources	
		Supply chain	
	Project	Development	
		Information	
		Operation	
		Risk	

4.7.3 Content Analysis

For this research, NVivo was mainly used to facilitate indexing and studying the patterns and order of categories, to determine the prominence of various factors' impact on IBS decision-making, namely contextual, structural and behavioural factors. The content analysis was performed for the interviews to ascertain patterns of responses amongst the participants relating IBS influencing factors to the research questions. The extent or emphasis placed by each respondent within the two participant groups, from inter-project and intra-project perspective, for each factor category previously defined was studied in terms of the amount of information gathered and frequency of occurrences within the interview text documents.

Therefore, this research used the numerical data primarily to indicate the extent of the support for the qualitative results rather than making conclusive statements based on general interpretations. This research then applied content analysis and coded the data by focusing on individual words, sentences and themes. Once the coding was completed, as presented in Table 4.5 above, this research followed the integrated theoretical framework of this research to determine how contextual, structural and behavioural factors impact on IBS decision-making, hence answering the research question.

The data were then compared and categories were merged and revised, to allow for an emerging pattern to be captured within a smaller number of categories, so as to facilitate exploration of relevant issues or factors of IBS decision-making without undue complication. The key categories or themes for this phase of research are mostly determined by the research question and areas that emerge during the conceptual formulation stage of the research. The key categories analysis involves the main areas of major factors that influence the decision-making of IBS technology adoption from an inter-project and intra-project perspective, including sub-categories of the detailed aspects of contextual, structural and behavioural factors, to further support the interpretation of data.

The analysis involves the synthesis of face-to-face semi-structured interview data from inter-project and intra-project perspectives to make sense of the various dimensions of decision-making in these contexts, to uncover the way contextual, structural and behavioural factors impact on IBS decision-making. Moreover, analysis of secondary data is included to review publicly available information or other documentation provided by the interviewees relating to the projects (e.g. annual reports, newspaper articles, marketing brochures, archival records, press releases and web resources).

4.7.4 Data Integration, Synthesis and Interpretation

Two data sets were analysed in this study. First, the inter-project perspective of IBS decision-making, based on face-to-face personal interviews. Second, the intra-project perspective of IBS decision-making, based on face-to-face personal interviews and project information to develop multiple case studies on IBS building projects. Analysed data from both perspectives are then integrated and the findings from this integration are used to elaborate and extend the analysis of results of both perspectives in this research. Results of both perspectives are presented in Chapter 5. The process of synthesising and integrating the results of both phases is also discussed, and placed in context with the literature review previously described, concerning factors influencing IBS decision-making. This data integration phase, including the results and findings of inter-project and intra-project perspectives will be further explained in Chapter 6 of the thesis.

Data synthesis was performed to determine the similarities and differences of IBS decision-making and its influencing factors between various participants from the group of construction-profession stakeholders and supply-chain members from selected IBS projects, for the multiple case studies. These different elements were brought together to convey the idea that construction-profession stakeholders construct a common or different perception of the decision-making of IBS technology and its influencing factors.

Meanwhile, in varying circumstances, the project members of the case studies were distinctive or similar from one project to another in IBS technology adoption over a period of time, with different or common perceptions of IBS decision-making and its influencing factors. By synthesising the data, there is the potential of making predictions, identifying relationships, obtaining correlations, and describing differences, if these exist, between the inter-project and intra-project perspective or substantiating that they do not.

Conclusions about face-to-face interview data were not drawn until the multiple case studies were completed. Thus, it is essential to separate out the different stages of both personal face-to-face interview and case study throughout the whole research process. The study is clearly focused theoretically and conceptually, with the intention of producing a satisfactory outcome from all methods. May (2011) discovered that no data collection method is superior to all other methods because each data gathering method is best under certain conditions. Research conclusions are made based on the combination or merging of results that will be derived from data on individual perspective and project perspective, as illustrated by Figure 4.5.

4.8 Justification of Research Method

Considering the nature of this research, the qualitative research paradigm has been selected because qualitative research is more relevant to this study as the research question is best answered in the context of semi-structured face-to-face interviews and case studies, as opposed to drawing conclusions from statistics. Moreover, this research is dedicated to using qualitative approaches on the interview- and case-study research methods. Qualitative researchers stress the socially constructed nature of reality, the relationship between what is studied and the situational constraints. Such researchers emphasise the value-laden nature of inquiry. They seek answers to questions that stress how social experience is created and given meaning. In brief, qualitative research provides a closer, less abstract framework for research and so is appropriate for this research.

Qualitative research is subjective in nature (Silverman, 2013). This approach does not use rigorous mathematical analysis (Ketokivi and Mantere, 2010). It employs methods that look for quality, including feelings, perceptions, viewpoints, meanings, relationships, stories and dynamic changing perspectives (Hennink et al., 2010). Moreover, Fellows and Liu (2009) point out that qualitative research seeks to find out why things happen as they do, and uses data regarding people's perceptions as well, to investigate aspects of their world to determine their perceptions on project performance. Qualitative research is essentially an investigative process that focuses more on words than on the numbers that are important to quantitative research (Bernard and Ryan, 2010). Additionally, Maxwell (2012) identifies that qualitative research is primarily concerned with meaning and belief in the uniqueness of each case, because of the belief in the importance of the individual perspectives of each participant.

On the other hand, the phenomenology paradigm is the science of phenomena (Stewart et al., 2010). A phenomenon is a fact or occurrence that appears or is perceived (Willig, 2013). Thus, the phenomenology paradigm is concerned with understanding human behaviour from the participant’s own frame of reference and also the qualitative approach stresses the subjective aspects of human activity by focusing on the meaning, rather than the measurement of social phenomena (Von Hippel, 2009). Moreover, the phenomenology paradigm has several perceptions of that reality and researchers should triangulate different evidence to develop a better understanding (Finlay, 2009; Gray, 2009; Zahavi, 2010).

Thus, for this research, exploratory research through case study analysis is the appropriate research strategy as the case study method can be useful (Babbie, 2012; Smith et al., 2009; Yin 2011). Its ability to study problems in depth, place them in context and understand the stages in the process is of benefit, particularly in a professional area (Stake, 2013). Observation, description and comparison provide a greater insight into the problem (Baxter and Jack, 2008; Flyvbjerg, 2006; Gerring, 2007; Yin, 2009), as does the case study’s ability to understand situations in context and the stages in processes (Fellows and Liu, 2009; Sundström and Zika-Viktorsson, 2009). The ability to utilise an interview approach allows the researcher to investigate the participants’ own involvements in relation to the research project (DeWalt and DeWalt, 2010; Morse, 2010).

4.9 Ethical Consideration

Finally, ethical concerns of the respondents were covered by following the guidelines set down by The University of Newcastle Human Research Ethics Committee which involves the approval and clearance for the research topic, data collection methods, the information required, the selection of participants, treatment of data, confidentiality issues and dissemination of results and findings. All research endeavours must abide by the standards of professionalism to ensure that it is performed in the most ethical way possible.

It was emphasised that no persons involved in the study would be identified either directly or indirectly and that results of the research will not be released to any third party without permission. One of the important elements of ethical considerations is informed consent, which is the right of the participants to be fully informed about all aspects of the research. All participants were advised that involvement in this study was purely voluntary and that they could withdraw at any time they chose. Official permission to conduct the study was obtained from the management of the organisation involved in the study.

Participants in the research were recruited by the provision of cover letters giving information about the research, providing assurance of confidentiality, outlining the possible benefits of the research and soliciting voluntary participation from the identified group. In this research, information sheets were given to these two major groups, namely the group of construction-profession stakeholders, for exploring the inter-project perspective (Appendix 7) and the group of supply-chain members in IBS projects, for exploring the intra-project perspective (Appendix 8). For the interview phase, the participants were also requested to sign optional consent forms reinstating their voluntary participation for the inter-project perspective (Appendix 9) and the intra-project perspective (Appendix 10).

4.10 Summary

This chapter describes the research methodology utilised in this research based on an interpretative phenomenological analysis (IPA). This chapter outlines the procedures followed in collecting data with consideration of multiple perspectives, based on a holistic concept. Further, this chapter outlines the qualitative methods used for the data analysis of this research. Interviews and case studies have been used for this research. Data collection is based on multiple sources of evidence. Based on qualitative data, the research uses a face-to-face personal interview method in exploring IBS decision-making and its influences, for inter-project perspective, and a multiple case study research method, for intra-project perspective. Qualitative methodology was discovered to be an appropriate methodology to explore "How contextual, structural and behavioural factors impact on the decision-making of IBS technology adoption?" This approach is necessary to ensure a vigorous and diverse collection of information. The final aim of this research framework is to ensure meaningful conclusions are made from the data. Finally, justifications of the research methodology and ethical issues have also been considered.

CHAPTER 5 – ANALYSIS OF INTER-PROJECT AND INTRA-PROJECT PERSPECTIVES

5.1 Introduction

This chapter describes the detailed qualitative analysis of two perspectives of data collection for the research, namely inter-project and intra-project perspectives, which are based on the semi-structured face-to-face interviews/case studies. In this research, inter-project perspective explores the perceptions of the construction-profession stakeholders of the impacts of contextual, structural and behavioural factors on IBS decision-making. Meanwhile, the perspective of intra-project explores the impacts among the supply-chain members of IBS projects in the Malaysian construction industry.

The aim of this chapter is to describe an interpretative phenomenological analysis (IPA) in the decision-making of IBS technology adoption, obtained from qualitative data of semi-structured interviews with the group of construction-profession stakeholders and the supply-chain members of IBS projects. In this multiple-case-study research, the purpose of data analysis is both to uncover phenomena that may describe, or be related to situation in some manner, and to look at the possible way contextual, structural and behavioural factors impact on IBS decision-making. Data will become meaningful only after analysis has provided a set of descriptions, similarities, differences, categorisation and sequence that are of use in addressing the research objectives. The qualitative methodology chosen to identify how construction entities perceive IBS decision-making was described in Chapter 4, whereas this chapter focuses on case studies of IBS decision-making, analysis and interpretation.

As mentioned earlier in Chapter 4, after data is collected, the pre-analytical process is performed, where data is reviewed to check for readability, consistency and comprehensiveness of the interview transcripts. Accordingly, the data is inputted with the appropriate data coding, into QSR NVivo, for the interviews. The qualitative type of data that has been gathered through the semi-structured face-to-face interviews is based on values that are the arbitrary numbers that represent categories. In this circumstance, only calculations based on frequencies of occurrence or reference are valid; therefore the data may not be treated as quantitative (Erickson, 2012). However, Saldaña (2012) acknowledge that frequency of occurrence is not necessarily an indicator of significance, as this analytic approach requires reflections and conceptualisation.

Patterns emerging from a preliminary thematic analysis of the interview transcripts evolving around the research's main topic were classified into key areas, which were then further investigated through content analysis. The emphasis placed by each participant on key phrases, previously identified through the preliminary analysis, was studied in terms of the frequency of occurrence or references in the interview text document and within the context of the information gathered. The outstanding concepts were then ranked according to importance and cross-referenced with extracts from the interview containing the relevant phrase, in a hierarchical way to enable the relevant facts or opinions to be extracted accordingly.

This chapter will establish the perspectives from which the supply-chain members of IBS projects and the stakeholders in the construction industry, perceived and considered the influencing factors on IBS decision-making. This chapter is divided into five sections. Section 5.1 provides the background of this qualitative analysis with an overview of the data collection and preparations for the quantitative data analysis. The second section (5.2) presents the Malaysian construction industry. This is followed by section 5.3 which presents the qualitative results of the semi-structured face-to-face interviews with the description of the overall results of influencing factors on IBS decision-making, from inter-project perspectives. The following section (5.4) presents the detailed findings of the analysis on multiple case studies from intra-project perspectives, namely Project A, Project B and Project C. Section 5.5 presents the overall results on structural, contextual and behavioural factors that impacted upon the decision-making of IBS technology adoption. The chapter concludes with a discussion of the findings (section 5.6).

5.2 The Malaysian Construction Industry

Malaysia is now emerging as one of the Asian growth engine which attracts the attention of global investors. The economy grew at 4.7% in 2013 (World Bank, 2014) placing it in the top five of the Asian region. The construction sector is one of the driving forces of the economy, growing at 4.3% annually (Bank Negara, 2014). The sector has been supported mainly by the strong performance of the construction related cluster underpinned by various domestic activities.

Malaysian construction sector provides many opportunities for architectural, engineering or construction (A/E/C) firms because economic growth leads to the need for building facilities. There is a strong demand for infrastructure projects such as office building, schools, housing, hotels, business and commercial complexes. The demand for residential buildings is also high due to Malaysia's growing affluence. There is an increased demand by both local and foreign investors for well-planned industrial and commercial areas, quality building and facilities (World Bank, 2014).

In addition, Malaysia's membership of the World Trade Organization (WTO) means that it has to allow WTO members countries A/E/C firms to operate in its construction industry, albeit in a controlled way. Its WTO membership brings a new dimension of competition to Malaysian A/E/C firms that are only used to operating under a protected setting and may now face greater challenges competing in the globalized business environment. This situation suggests that Malaysia is a unique market to operate it as it is at the crossroad of open market competition, globalization and growth.

Therefore, there are always challenges to keep up with the dynamics of construction industry through technology innovation, creativity and adoption in the building sector. The Malaysian construction industry plays a key role in contributing to the country's economic development process (World Bank, 2014). The industry also establishes buildings and infrastructures required to fulfil the demand of socio-economic development which contribute to the overall economic growth.

5.3 Inter-project Perspective: Construction-Profession Stakeholders

In practice, although not all construction-profession stakeholders are directly involved in the IBS projects, they would directly or indirectly influence the decision-making of IBS technology adoption as a stakeholder. Therefore, it was necessary to obtain their perceptions on the influencing factors of IBS decision-making and IBS technology adoption from a non-IBS project perspective that are contemplated to adopt IBS technology. This group of construction-profession stakeholders consists of the construction professionals, for the purpose of exploring IBS decision-making and its influencing factors from inter-project perspective. Against the background of situations such as these, it was important to view the construction market as made up of the whole industry, despite the existence of various public and private building projects across the construction industry.

In this research, there are several possible reasons for views such as these, although in the case of building projects with broadly proactive or reactive principles, it was often due largely to a degree of projects inertia, which could lead to the project being content to stay in the same sector of the construction market for some considerable time. It was only when the effects of a changing construction surrounding became overwhelmingly evident that serious consideration was given to the need for adopting IBS technology in order to meet project specifications, keep up with the competitive business and appeal to new building sectors of the construction industry.

For other IBS projects and the members of the IBS supply chain, a well thought out policy of IBS technology has played a vital role in the determination of relevant influencing factors on IBS decision-making. However, exploring the inter-project perspective was the process of understanding a varied and differing group of potential IBS adopters within their broad perceptions towards IBS decision-making and IBS technology adoption. Having done this, this study was attempting to break the industry into more strategically understandable, the parts which could then be explored in terms of IBS decision-making in different projects across the construction industry and with various construction-profession stakeholders' views, far more precisely.

5.3.1 Profile of Participants

The descriptive data on the participants of inter-project perspective are presented here to provide focus in the content analysis. In order to assist in further analysis of the influence of structural, contextual and behavioural factors on IBS decision-making, supporting data on the participants from inter-project perspectives is presented in Table 5.1 which consists of the participants' profiles in terms of background and their nature of decision-making.

Table 5.1 Participants' Profiles of the Inter-project Perspective

PERSPECTIVE:	**INTER-PROJECT PERSPECTIVE**	
Types of participants	Construction-Profession Stakeholders	
Number of Participants	27 participants	
Type of Decision-making	Mostly Routine and Non-Routine	
Priority of Decision Category	Both Group & Individual	High
	Group Only	Medium
	Individual Only	Low
Working Experience of Construction-Profession Stakeholders	More than 20 years	9 participants
	10 to 20 years	13 participants
	Less than 20 years	5 participants
Qualifications/ Academic Background	PhD	-
	Masters	5 participants
	Degree	20 participants
	Diploma	2 participants
	Others	-

Table 5.1 illustrates that construction professionals participating in the semi-structured face-to-face interviews came from a wide range of backgrounds in terms of their working experience and academic qualifications. It was acknowledged that the very real strategic important to determine the perception of construction-profession stakeholders towards the influence of structural, contextual and behavioural themes on IBS decision-making, in particular, the way in which it enabled the exploration of their views, opinions, experience, knowledge, understanding and aspiration concerning IBS

technology adoption. The next section presents results from the semi-structured face-to-face interviews and explores these construction professionals' views on factors related to IBS decision-making, across the construction industry.

5.3.2 Content Analysis of Influencing Factors on IBS Decision-making

In the case of construction-profession stakeholders' perception of the influencing factors of IBS decision-making, the results were based on the inputs of 27 participants consisting of three representatives from each of these categories: project managers, architects, quantity surveyors, manufacturers, clients, civil engineers, developers, contractors and consultants. Extracts of typical comments made by the participants in this perspective are presented below, with the purpose of providing an indication on the emphasis placed by them on each of the major factors, and the substance that has emerged from the content analysis. The analysis of these results was performed based on frequency of occurrences or references based on the perception of the construction-profession stakeholders towards IBS decision-making factors which also reflect the level of relevancy for each theme, factors and aspects. The profile and coding of the participants in the construction-profession stakeholders group are presented in Appendix 11 for quotation referencing.

a) Structural Factors

The construction-profession stakeholders perceived that structural theme was the most relevant core factor in the decision-making of IBS technology adoption. Although in construction markets, it was often a relatively simple process to determine a whole series of macro influences on IBS decision-making, compared with the structural factors or micro environment of building projects. Therefore, it was essential to evaluate the influence of structural factors or project related factors on IBS decision-making as perceived by the construction professions stakeholders. One participant stated:

> *"Decision-making begins early in the design or build process so make every effort, if necessary, to collaborate with a project manager, architect, engineer, suppliers..." (SH/QS/10)*

Each structural factor was evaluated based on the participants' perceptions, according to their opinions and interpretations pertaining to IBS technology adoption and building projects, respectively. Definitely, not all of these structural factors were of equal importance, either in an absolute sense or when it came to succeeding with a specific building project opportunity. By evaluating these structural factors, a general picture of project and principals and concerns in IBS decision-making has emerged.

i) Project Condition

The construction-profession stakeholders perceived that they were in the position to turn their attention to the way in which they viewed project conditions as the most relevant factor in IBS decision-making, based on the issues of project growth. It was recognised that the practical value of analysing project conditions was essential as they became inputs in IBS decision-making, due to both the relevancy and impact of those factors. As claimed by a participant:

> *"…more involved in the operational decisions, some are technical and some are on the management side. We also act on behalf of the owner to oversee the project implementation during..." (SH/DA/19)*

Therefore, in an attempt to give specific recognition to a broader spectrum of project factors, the participants acknowledged project-development aspects as the most relevant consideration in IBS decision-making. They also perceived that project-development aspects were also related to construction industry attractiveness and business position, which could influence IBS decision-making as an investment opportunity. Examples of this include:

> *"In projects, I think, the task that is related to costs is central to the decision-making process throughout the development of a project from initial inception to final completion…" (SH/QS/14)*

> *"Project development in urban area for example is not exactly the same with suburbs developments…" (SH/CT/12)*

As the next relevant project factor, the aspects of project operations were perceived as essential in IBS decision-making with an understanding of several important strategic considerations in project operations, such as measuring performance , control of time, control of resources, control of site activities and control of quality. As indicated by a participant:

> *"The operations division handles the operation of construction and other facilities which require routine attention and…" (SH/PM/18)*

Therefore, in order to ensure the efficiency of project operations which became an important consideration in IBS decision-making, the participants perceived that the aspect of risk management in building projects was a complementing aspect in project operation and development. The aspect of risk was perceived as fundamental because it became a necessary and useful tool in the examination and assessment of project issues and uncertainty. As revealed by a participant:

> *"So, in approaching the problem of uncertainty, it is important to recognise that incentives must be provided if any of the project members is expected to take a greater risk…" (SH/CR/23)*

It was generally acknowledged, however, that while the consideration of project development, operation and risk aspects was undoubtedly of significant value for IBS decision-making, the participants commented that in the majority of building projects, insufficient project information was another consideration. One participant noted that:

> *"…we find out that once you have all the information and data you need for the solution, the idea itself..." (SH/QS/10)*

Although the project-information aspect was perceived as the least relevant factor in IBS decision-making, it was regarded as truly worthwhile decision inputs in IBS technology adoption

ii) Procurement Setup

More specifically, the construction-profession stakeholders perceived that procurement factors or setup were the next relevant factor in IBS decision-making, from the structural perspective. Although more project members are typically involved in the procurement activity of an IBS project, especially in major issues, the participants perceived that decision-makers usually have different project responsibilities and applied different criteria to the procurement decisions. Examples of this include:

> *"Another thing that I would like to point out here is that IBS decision has to be fit with project nature and its procurement too…" (SH/QS/20)*

> *"So, procurement is also important to decide on IBS in the construction industry..." (SH/QS/10)*

More specifically, the participants also highlighted that the cost aspect of procurement setup was the most influencing element on IBS decision-making. The majority of participants saw the need for some form of cost consideration in IBS decision-making:

> *"In fact, IBS project proposals are often rejected solely on the basis of cost…" (SH/DA/4)*

> *"In this case, we should come out with the total cost first in order to proceed with the next procurement process…" (SH/QS/10)*

Often, factors other than project or organisational growth and competitiveness, such as cost and its related factors like profit, price and return, have played a significant role in influencing IBS decision-making. The participants acknowledged that cost aspects may be viewed as being of major significance in IBS decision-making, together with project cash-flow and return on investment (ROI), as a means of comparing the attractiveness of investing in one IBS project rather than another. Note the following:

> *"It is more on cost effectiveness because we want to get the most out of the cost spent…" (SH/DR/21)*

> *"Our decisions also control the cost planning and value management include the evaluation of alternative design against our value criteria for function, quality and durability…" (SH/CL/50)*

Besides cost factors, the participants perceived that the aspect of clients' requirements was another relevant factor in IBS decision-making. In this case, clients' requirements could also provide real insight into how a building project or an IBS project could be compared with one another. This was perceived as essential in terms of the capacity of fulfilling project requirements and a better opportunity for building technology investment. One profound observation captured this idea:

> *"However, in construction industry clients are often observed to be very demanding…" (SH/CE/24)*

Moreover, the thinking behind the fulfilment of clients' requirements was based on resources availability, as the scarcity of project resources inevitably meant that building-technology choices must be made in rationing available resources such as funds, management of time, human skills and materials. Thus, project resources were perceived as the next relevant aspect of procurement factors. Finally, the least relevant factor influencing IBS decision-making, as perceived by the participants, was supply-chain aspects. Note these comments:

> *"…when we decide on what new project to start, what business to start or to abandon, how to allocate resources, whether to expand operations or diversify..." (SH/CL/51)*

> *"... IBS knowledgeable labours are still very much needed for design, fabrication and installation works. So, it the industry can ensure the availability of skilled workers in all these three areas…" (SH/QS/10)*

Having analysed the costs, clients and resources of the project, the participants anticipated that the supply of IBS components must be easily available to contribute towards building project performance when deciding on IBS technology adoption. A participant acknowledged:

> *"...we support IBS because we have our production management with IBS process, business set up that tailored to IBS; we are also into the IBS supply chain and we lead our people..." (SH/MR/28)*

The participants also acknowledged the important aspects of the supply chain such as the procurement of the various IBS components, logistic issues, materials handling and the costs of these activities.

iii) Management Approach

In IBS decision-making, there was a strong concern for the aspects of management approach that were tailored to the particular activities of different building projects in the construction industry. As the next relevant factor of the structural theme, the participants perceived that management approaches influenced IBS decision-making because these aspects were necessary as controllable factors relevant to a certain level of project authority and could be presented to aid in IBS decision-making at this level. As these participants acknowledged:

> *"…issues, of course we refer to those experts but when comes to non-technical like management issue, then this is the challenge…" (SH/DA/6)*

> *"Decisions that I make in my routine work are more related to project integration management to ensure that the various project elements are well coordinated..." (SH/PM/18)*

Specifically, the aspect of management process was perceived as the most relevant element in IBS decision-making within the management approach, involving activities such as organising, controlling, evaluating and forecasting. In each activity, it was necessary for any decisions that needed to be made, to refer to the project tasks and the way in which the responsibility could be performed. Note this critical observation:

> *"Designers, engineers, building material producers and contractors thus need to bring about design concepts, building elements and components as well as adaptations in the building processes by integrating the managerial aspects in order to achieve the optimum application of the efficient principles ..." (SH/CE/13)*

Further, as perceived as the next relevant aspect of management factors, planning mechanism was an essential consideration in the decision-making of IBS technology adoption. The participants acknowledged that the time dimension that was of major relevance in any project planning must be based on resource allocation, demand of the building project and the changing nature of the industry, in order to achieve organisational or project objectives. The following quotes reflect this situation:

> *"…the need to improve the integration, planning and control of IBS not only its design but also IBS production and logistics…" (SH/CR/8)*

> *"...we have to make sure we cover a range of activities which may include cost planning, feasibility studies, cost benefit analysis, life-cycle costing…" (SH/QS/20)*

Therefore, the consideration of project goals was perceived as another relevant aspect which influenced IBS decision-making. By considering specific project goals pertaining to IBS technology adoption, decision-makers could support the decision with a clearer sense of direction as well as create a benchmark against which project performance and the effectiveness of IBS technology adoption could subsequently be measured. For example:

> *"...they are but projects goals are still the major influences in IBS decision…" (SH/DR/15)*

> *"Usually, the owner provides the design team with detailed functional requirements and project goals for the proposed building…" (SH/DR/11)*

Hence, recognising the validity of this point, the participants also highlighted the importance of project strategy, perceived as another relevant element of management aspects, by specifying a clear and meaningful competitive strategy and the ways to achieve the strategy, when deciding on IBS technology adoption. As noted by two participants:

> *"We do benefits analysis to determine whether or not to go forward with each strategy…" (SH/DA/19)*

> *"...we purposefully adopted a strategic policy to outsource engineering and construction services…" SH/CT/12*

As a part of this, the aspect of leadership was perceived as the least relevant factor in IBS technology adoption as the leadership aspect was not the major source of influence, provided the leaders could demonstrate their level of commitment, initiatives, directions and support towards IBS technology adoption. One participant noted that:

> *"The big influence here is that the leadership, including the board of directors and the management leadership…" (SH/DR/21)*

In order to achieve this, it was essential that the interrelationship which existed both internally, between all management functions of the building project, and other project members, must be clearly defined as their related factors to a certain extent have impacted the decision-making of IBS technology adoption.

iv) Communication Process

As the next relevant factor of structural themes, communication was perceived by the construction-profession stakeholders as an influencing factor on IBS decision-making, based on the importance of interacting, messaging, documenting, reporting and meeting activities in a project and organisation perspective. As identified by a participant:

> *"…we can control the project development through communication…" (SH/CL/49)*

For this reason, the participants specifically acknowledged that project members were still the most effective source of information, as in IBS decision-making, communication with a technically competent member from the management or administration team was important. Moreover, communication is being performed formally and informally to gain various inputs as a source of information to assist the decision makers. For example:

> *"I always believe that cooperation and communication between the parties are encouraged to discuss on project development…" (SH/CT/12)*

The aspect of formal communication was perceived by the construction-profession stakeholders as the most relevant factor in the decision-making of IBS technology adoption. In this manner, formal communication was regarded as vital in this decision process based on the participants' perception of the benefits to be gained, inputs from a formal communication channel and the extent to which the channels were commonly used. As emphasised by a participant:

> *"Of course we mostly rely on formal documentations in our communication…" (SH/CL/49)*

Moreover, the participants perceived that formal communication channels could be able to accommodate the path and source of information, not only for any project decision-making but also for future reference. In addition, information source through formal communication was the major determinant of IBS decision-making, as formal communication channels could link the internal and external parties effectively for the purpose of discussing project developments and technical performance. For example:

> *"When dealing with authorities, again we have to be formal with a lot of written works…" (SH/DR/11)*

However, informal communication was perceived as the least relevant factor in IBS decision-making due to do nature of linking individuals for personal contacts but in some circumstances, outside information or could be delivered to the project albeit by an informal communication. One participant noted:

> *"...it has to be communicated through telephone only. Its sounds informal but it has to be that way…" (SH/CR/23)*

v) Decision-making Style

The perception of construction stakeholders of the decision-making style of IBS technology adoption stated that there were differences in the focus of decision-making. As the least relevant factor of the structural theme in IBS decision-making, the participants perceived that IBS decisions were based on judgments on critical issues. IBS decisions were also based on group and individual decision-making, besides considering the decision nature itself.

In terms of group decision-making, the participants perceived that this decision style was the most influencing decision aspect in IBS decision-making. Decision-making style was important to gather real time information in various ways such as project operational measures, project performance and the expert advice from experienced team members. As acknowledged by a participant:

> *"When comes to decisions, this decentralised set-up is referred to as the project oriented firm as each project manager has autonomy in managing the project..." (SH/PM/18)*

Consequently, the majority of participants perceived that group decision-making was considered as vital, because the collective and consensus style with continual information- and decision tracking, has enabled project decision-makers to identify opportunities and problems related to IBS technology adoption, earlier. Therefore, in IBS decision-making, group decision-making could offer proactive conflict- or issues resolution on IBS technology, with various ideas and options. The following are examples:

> *"...our decisions are not all ours. May be we can decide on IBS, but it is not really agreed by other project members, unless you want to go into the government projects or tendering…" (SH/DR/21)*

> *"…most of the decisions have to be based on our clients, unless it is related to the internal operation of our company…" (SH/DA/19)*

Next, the construction-profession stakeholders perceived that the decision nature of an organisation or project was the least relevant aspect which influenced IBS decision-making. As a common practice across the industry, the participants noted that it was necessary to integrate the IBS decision with other project decisions and strategies in order to cope actively with technology choices, when project- or technology information was scarce and stakes were high. As clarified by these participants:

> *"So, in terms of decision-making, whatever we propose, we have to bring all these matters to our board. So the board will decide whether we will go ahead with this project or not…" (SH/PM/1)*

> *"Project boards should be advisory only, addressing strategic issues and major points of difficulty…" (SH/CL/49)*

Although individual decision-making was perceived by the participants as the least relevant factor in IBS decision-making, this type of decision was based on authority to resolve conflicts. Besides this, individual decision-making could reduce the requirements of project or IBS information, the number of information sources, and the depth of project analysis to accelerate choices or final decisions.

b) Contextual Factors

Despite the highlighting of structural themes in IBS decision-making, the participants perceived that the contextual theme was the next relevant factor influencing the decision-making in IBS technology adoption. The construction-profession stakeholders discovered that the concern for contextual factors could provide an objective basis of qualitative information about the construction industry's assessment. The following quotes reflect the general consensus of most participants:

> *"…some place more emphasis on price factor which focuses on the cost information…" (SH/QS/20)*

> *"The matter of fact is that the construction industry is a collection of diverse fields and participants that have been loosely lumped together as a sector of the economy." (SH/MR/26)*

The consideration of contextual factors involved a process which covered the full spectrum of external project perspectives in order to understand industry changes, dynamics and their implications on IBS decision-making. In practice, the construction-profession stakeholders realised that their perceptions of contextual factors were typically based on project expectations. This in turn, was often a function of the nature and size of the project's insights on the complexity of economic, government, stakeholders, sustainability and technology factors which will be discussed according to their relevancy.

i) Economic Conditions

In general, the construction-profession stakeholders perceived that the most important factor of the contextual perspective was economic conditions, which influence IBS decision-making. They acknowledged that it was necessary to understand and evaluate the performance of the construction industry in terms of its growth, progress and expansion, then match these with the project circumstances when considering the IBS technology to be adopted in building projects. As one participant claimed:

> *"...economic development leading to a stronger purchase market, rise of 'buy-to-let' market…" (SH/DR/11)*

Despite the consideration of the industry performance as a whole, the participants noted that specifically, it was essential to determine and assess economic growth rates and income levels that were forecasted both for the construction project and other potential markets pertaining to IBS technology adoption. These participants stated:

> *"So the same goes for IBS where it also impacts on the national economy although it cannot be directly measured by the value of its output or the number of IBS projects alone…" (SH/MR/26)*

> *"But I think there is an increased perception of the negative impact it could have on IBS project and economy growth in the year ahead…" (SH/CT/22)*

Consequently, business dynamics were perceived by the participants as the most relevant elements in IBS decision-making. According to the participants, the stakeholders' perception of the construction business was implicit in the terms of various analysis on technology strategy, project development and project procurement. Consider these responses:

> *"There were some projects that wanted our decisions to be more of a business-minded, I mean business approach…" (SH/CR/9)*

> *"There are other considerations for a project, it is not always business goal but business come with your real expertise too…" (SH/DA/19)*

In IBS decision-making, the dynamics and structure of the construction industry must be anticipated. As the participants also noted in IBS technology adoption, the focus of business aspects was on the number of IBS suppliers or manufacturers, the clients or ownership of IBS projects, cost structures, IBS technology transfer, market share and the existence of joint ventures. Having identified these business aspects, the decision-maker was able to figure out whether the project's position within the construction industry or the overall construction market was favourable, strong, dominant, weak or non-viable. From this, it could be noted that business dynamics were related to the conditions of demand and supply. As noted by a participant:

> *"…demand for an industrial product may be short-lived, and if a company does not hit the market first, there may not be demand for its product later." (SH/DR/21)*

The participants also perceived that the demand aspect of building technology was the next relevant factor of economic perspective in IBS decision-making. This in turn could determine the construction industry structure, which then influenced the industry conduct and subsequently, the industry performance. As one participant acknowledged:

> *"…the decision-making process shifts from the simple needs and wants of the client to create a design for example to more complex decision assignment." (SH/DA/4)*

Moreover, the participants also acknowledged that demand projection and forecast for IBS building or projects could have implications on IBS decision-making, such as demand for rapid-build projects, demand for higher levels of building quality and demand for a higher rate of building innovation in the society. One participant revealed that:

> *"…that continuous demand and repetition of works are very important to ensure all the IBS players can be sustained for a much longer period…" (SH/DA/6)*

Consequently, the principal implications of these were seen by the participants as the need for tracking economic trends and development in order to explore IBS project opportunities which could offer the greatest scope. Therefore, the aspect of project or business opportunity was perceived as the participants of another relevant aspect of economic factor which has impacted on IBS decision-making. As advocated by these participants:

> *"...a contracting firm may see their advantage in new technologies and emphasise profit opportunities from the new technology." (SH/PM/18)*

> *"With the government support, IBS market is likely witness more opportunities…" (SH/DR/21)*

The next pertinent factor, the aspect of uncertainty, was perceived by the participants as essential in carrying out evaluations on economic factors when deciding on IBS technology adoption, where a variety of decision outcomes was possible but economic probabilities could not be assigned. Examples of this include:

> *"…they experience some degree of uncertainty and some uncertainties can create risks to achieving the project objectives…" (SH/CL/51)*

> *"Meaning to that, by having this, it is less prone to future changes caused by economic uncertainty…" (SH/MR/26)*

The final area that the decision-makers had to consider, as perceived by the construction-profession stakeholders, when deciding on IBS technology adoption, was the aspect of competition. Note the following observations:

> *"…the need to achieve IBS goals is another important consideration in the procurement process and to acquire goods and services by competition…" (SH/CL/51)*

> *"In this environment of heightened competition, good project management and improved productivity are more and more important than the cost issue only…" (SH/MR/26)*

This perception was based on the rationale that competition within the construction industry was due to a very high degree by the nature of building projects and their dynamics. Therefore, the character of competition did not only take many forms but was also likely to change over time and finally could influence IBS decision-making.

ii) Technology Development

The next relevant factor of the contextual theme, as perceived by the construction-profession stakeholders, was that of the seemingly ever faster change of technology in the construction industry. In deciding on IBS technology adoption, the participants acknowledged that it was necessary to identify changes that took place in the area of IBS technology adoption, in terms of its future growth and improvements, in a more specific and knowledgeable away. As noted by a participant:

> *"IBS is not only about technical issues but also about social, political and cultural characteristics that are clearly important for the IBS development in the future projects, its improvements are essential…" (SH/DA/6)*

In terms of the implications of IBS technology developments for IBS decision-making, the participants believed that it was apparent that there was a need for building projects to adapt to these developments, perhaps significantly, or remain with the consequences of their current position. As discovered by a participant:

> *"If the technology transfer of IBS can be run smoothly, then this will lead to information sharing with others..." (SH/MR/28)*

Further, it was discovered that the potential growth in patterns of IBS technology evolution was a rationale for attempting to use IBS technology assessment in building project performance, as a part of the IBS decision-making process. In particular, the participants perceived that the aspect of technology productivity was the most influencing factor on IBS decision-making. One participant commented:

> *"Another thing is concerning IBS productivity itself. IBS projects must have a ratio of the production output volume to the input volume of resources..." (SH/QS/20)*

It was apparent that if the utilisation of resources across various activities in building projects using IBS technology could be measured and related to the revenues and other outputs generated by the IBS technology, it was possible to determine IBS productivity which could, in turn, influence IBS decision-making. As one participant argued:

> *"Besides requiring minimal labour, IBS offer better quality, increased productivity and faster completion, less wastage with safer and cleaner construction sites..." (SH/CE/24)*

In relation to this, as the next relevant aspect of technology factors, technology quality was perceived as influencing IBS decision-making, based on certain criteria that could be satisfied by IBS technology adoption. Technically, in building projects the quality aspects of IBS technology adoption were related to the reflection of low defects, ease of installation or implementation, the achievement of building standards, technology results, minimal time delays and the overall performance. Note the following comments:

> *"Our decisions also control the cost planning and value management include the evaluation of alternative design against our value criteria for function, quality and durability…" (SH/CL/50)*

> *"The quality of the IBS is more secured because the manufacturer imposed strict quality control over the materials, production process, the curing temperature and etc…" (SH/CL/49)*

As the next relevant feature of technology factors, innovation aspects concerning IBS technology adoption also involved building solutions through continuous improvement and modifications or improvements of existing IBS technology. These aspects were influencing IBS decision-making in such a way that IBS technology innovation could attract more building projects to adopt IBS technology. This attraction was due to the new insights of IBS technology which construction innovation could contribute to problem solutions and positive outcomes in building projects, as demonstrated by the following comments:

> *"Therefore collaboration among stakeholders in IBS is vital towards a success of innovation in construction…" (SH/DR/11)*

> *"….without these technological innovations, IBS wouldn't have been possible…" (SH/MR/27)*

Lastly, although the aspect of creativity was perceived as the least relevant element in IBS decision-making, the participants perceived that creativity had to be considered, to discover new possibilities in IBS technology as the project unfolded. Note these comments:

> *"…that may require considerable initiative and creativity to overcome or exploit…" (SH/QS/20)*

> *"…they can reinforce each other as they both are included in the construction process, provided that creativity and innovation instead of routine practice are emphasized…" (SH/PM/18)*

The participants also noted that not all the building projects have to be of equal specifications, size or value, thus, in IBS decision-making, the consideration of creativity aspects was important to create a project practice or environment that could encourage the generation of new and different ideas for different building projects.

iii) Government Involvement

The construction industry is moving towards becoming a technology driven sector through IBS technology adoption and the government is forging ahead with this agenda. As the next relevant factor in IBS decision-making, the construction-profession stakeholders perceived that government involvement was another influencing factor on building-project issues and also had an impact upon the decision-making of IBS technology adoption. Examples of this include:

> *"Looking at this situation, definitely, the government's role in IBS is very important but we cannot just depend on the government…" (SH/QS/14)*

> *"For public projects, we know that the government can play its roles there, but the challenge is in private projects, especially housing projects…" (SH/CT/12)*

It was discovered that government involvement through its policies, promotion, requirements and rules pertaining to building projects and IBS technology adoption, was perceived as having some influence in determining the competitive directions of the construction industry, as well as on IBS decision-making. This government involvement was relevant primarily in a relative sense, since these outside forces affected all building projects in the industry. The key was the ability of individual projects to deal with them when deciding on IBS technology adoption. For example:

> *"…it is not only the government to play its role in IBS use. We have to look at the present and future situation and they must be able to study the social and demographic situation or preferences…" (SH/DA/6)*

In order to consider some of the aspects or ways in which the government influenced IBS technology adoption and IBS decision-making, the participants perceived that it was important to examine the effect of government promotional activities on IBS technology adoption. As the most important aspect of government-related factors, IBS promotion by the government was perceived as highly important to create attention, awareness, knowledge, interests and action in the industry. The following quote reflects the general consensus of most participants:

> *"…we know that the government has been promoting IBS and make sure that government projects use IBS in their projects…" (SH/DR/15)*

> *"The incentives and promotion offered by CIDB and through our government policies look promising but they should be expanded to reach the whole nations…" (SH/CE/13)*

In essence, the participants perceived that the government has been aiming to inspire the construction society's mind, change their attitude and encourage them to adopt IBS technology in building projects. However, it was extremely important to determine and evaluate the effectiveness of IBS promotional activities by the government when deciding on IBS technology adoption, as the interpretation of these promotions may be too general or too uncertain to be taken seriously. As determined by these participants:

> *"…government encouragement should not be the major consideration if other factors are not well analysed or considered." (SH/DA/19)*

> *"With the government's concerted effort to encourage both investors and the public to embrace IBS technology, the government had allocated a lot of money…" (SH/DR/21)*

Therefore, the participants acknowledged that IBS policy developed by the government was the less relevant factor in IBS decision-making. They noted that, although many IBS policy issues have been resolved, and while most of the programmes have been achieved, the industry's response to IBS technology was less encouraging, except in public projects. Assuming therefore, that a project intended to develop an effective IBS building project, there was a need first to identify IBS technology policy which was likely to have the greatest impact upon the project, when deciding on IBS technology adoption. Note these comments:

> *"…therefore the role of government in establishing the policy for IBS implementation should also incorporate thus to produce a significant impact on the IBS issues." (SH/CE/13)*

> *"I refer to previous IBS projects to obtain ways to improve the implementation of IBS in terms of the current policy and guideline available to implement the usage of IBS in our projects." (B/DR/38)*

As the next relevant government factor, the aspects of government requirements pertaining to IBS technology adoption were essential in IBS decision-making. In this situation, the participants perceived that there must be suitable fit between the key requirements of IBS technology set by the government, and the particular competencies of a building project, because IBS decision-making had to be timed to coincide with the government's requirements. Examples of this include:

> *"The most important thing whether or not to consider IBS is about statutory requirements that IBS building designs have to comply with such as planning and building control, fire, safety and standards." (SH/CR/8)*

> *"Buildings that meet the requirements of our national standards whether in terms of testing or design or construction practices typically can increase asset value…" (SH/DR/11)*

Additionally rules and regulations concerning IBS technology had to be carefully considered in IBS decision-making if changes in the government's requirements outstripped the project's capability to adapt to the new project circumstances, as described by these participants:

> *"…the use of IBS need the governance of a particular organisation which cost a lot of money in terms of standardization of sizes, improve the building regulations through research…" (SH/CL/49)*

> *"The government has to make more progress in terms of standardisation because the lack of uniformity in building projects has serious impact on design…" (SH/CT/12)*

In addition, there had been the increasing regulation of building standards but this situation was perceived by the construction-profession stakeholders as less influencing on IBS decision-making because the anticipation of building-rules compliance was already a part of the requirements of project development. For example:

> *"…and CIDB came up with the IBS design guide which contain the modular coordination concepts, design rules, drawings and preferred dimensions for architectural finishes material…" (SH/CL/49)*

> *"…the authorities are pursuing power and access in some project ruling". (SH/DR/21)*

iv) Sustainability Features

The factor of sustainability features was perceived by the construction-profession stakeholders as another relevant factor in IBS decision-making, from the contextual perspective. As these participants commented:

> *"…people are talking about sustainability and green construction which are understood to be more than only insulation and waste reduction in construction industry." (SH/CL/50)*

> *"They even assign the project commitment to sustainable development, project performance and life-cycle analysis…" (SH/CL/49)*

They acknowledged that sustainability aspects were related to the process of creating, building, maintaining and delivering building users' value by giving emphasis to strong IBS technology positioning, and differentiation related to physical environment. This sustainability element was perceived as a less important consideration because it would take a long time to gain hold in society despite the changing perspectives towards environmental concerns, as demonstrated by a couple of the participants:

> *"Moreover, the use of IBS can greatly reduce the usage of conventional timber and therefore the environment will be preserved…" (SH/CL/49)*

> *"The technology enables automation process to perform sequences of tasks onsite by interaction with its environment through a more systematic way." (SH/DR/21)*

Recognising this, the participants also realised that there was also concern about the environment-protection aspects in the decision-making of IBS technology adoption. They acknowledged these aspects based on the different types of building users and also the construction entities who were more concern on environmental protection and more willing to adopt IBS technology in building projects. The following are examples:

> *"Thus, there are several ways to consider IBS for the betterment of our environment and standard of living..." (SH/CE/13)*

> *"If we are talking about green environment, I have to consider if IBS can tackle and handle this problem…" (SH/CT/12)*

Moreover, the participants acknowledged that there was a certain level of response on IBS technology adoption which could contribute to a better environment in terms of quality, hygiene and sustainability, with more effective construction-waste management, less noise and a safer environment created by IBS technology adoption. They realised that this situation could have led to more efficient work methods at the construction site. Therefore, the aspect of efficiency was perceived as another relevant aspect of sustainability factors in IBS decision-making, in terms of the industry's preferences to complete building projects in a shorter time frame. Note the following observations:

> *"…the government had allocated a lot of money and budget to intensify IBS awareness activities and to encourage the practice of more efficient construction practices…" (SH/DR/21)*

> *"…the potential to promote green construction by implementing controlled production environment, minimisation of construction waste, extensive usage of energy efficient building material…" (SH/CE/13)*

As IBS technology adoption involved prefabricated components and offsite manufacturing activities in a more controlled environment, this had created an efficient working environment with less hazards and congestions. Moreover, the participants also acknowledged that IBS could reduce a building project's dependences upon more unskilled or imported labour, thereby improving the efficiency of the vulnerable construction sector. Thus, these improvements have also influenced IBS decision-making due to the technology concept, as noted by one participant:

> *"....it can also reach general public who would be willing to accept a technology and concept of industrial facility with a more efficient process." (SH/MR/26)*

As the third influencing factor on IBS decision-making, the aspect of living trends was perceived as an essential consideration, based on the change in social and demographic environments. The implications for IBS decision-making of changes such as these had already proved significant in a variety of ways, in terms of lifestyle, and have been reflected in demand for smarter building, and greater emphasis on convenience building methods. Moreover, the attention to environmental concerns, efficiency and living trends was perceived as underlying sustainability achievements, contributed by IBS technology adoption. As one participant commented:

> *"…to change owner's perceptions based on our lifestyle or culture and incentives…" (SH/DA/6)*

Lastly, the aspect of waste management was perceived as the least relevant factor influencing IBS decision-making but a participant remarked:

> *"…IBS for the betterment of our environment and standard of living and one of them is the focus on the reduction of materials and construction waste at site…" (SH/CE/13)*

Although IBS technology adoption could minimise waste at the site, due to the factory-controlled prefabrication environment, adoption was not easy due to a short-term preoccupation with the project specifications rather than a longer-term consideration of environmental issues.

v) Stakeholders Participation

Lastly, the participants perceived that stakeholders' participation was the least relevant contextual element in the decision-making of IBS technology adoption. They perceived that each of the primary stakeholders in the construction industry would tend to concentrate on different parts of a building project, in terms of the specific identification of financial return, project margin, accomplishment of project milestone, market share and IBS technology quality and reliability, to address their particular area of interest pertaining to IBS technology adoption in building projects. As one participant noted:

> *"What is important is for the project stakeholders is an agreement and to promote a sense of common purpose and direction in IBS use…" (SH/DR/15)*

Additionally, the participants also realised that information based on stakeholders' opinions was important for developing a meaningful assessment of the IBS decision-making factor, as it could also be used to estimate the future potential of IBS technology adoption. Therefore, the consideration of these inputs concerning stakeholders' opinions was an influencing aspect on IBS decision-making. A participant acknowledged that:

> *"…we consider stakeholders opinions in the areas that involve issues concerning costs…" (SH/QS/10)*

Moreover, in IBS decision-making, the consideration of partnership development was perceived as relevant as it would become increasingly necessary as a means of exploring, and entering into IBS markets or projects, partly because partnering could offer the advantage of access to greater shared knowledge, understanding and experience of IBS technology adoption, and also because of the sharing of risks and costs based on this kind of strategic alliance. As revealed by a participant:

> *"…it becomes critical that both contractor and government work in partnership to achieve the outcomes sought." (SH/CL/51)*

A number of participants noted that if decision-makers could consider IBS technology adoption based on the stakeholders' opinions and partnering as satisfying, these would be used to examine potential sources of IBS problems and to develop appropriate action programs for IBS projects.

c) Behavioural Factors

Decision-making, including decisions on IBS technology adoption is the human element in the determination of a course of action in the construction industry. Hence, as perceived by the construction-profession stakeholders, IBS decision-making was also influenced by the behavioural factors of making choices and judgments. Note this observation:

> *"People are human too and are exposed to much kind of attitudes and even some of them decide to help them to achieve their own goals too…" (SH/CR/8).*

Although the behavioural theme was perceived as the least relevant factor in IBS decision-making, compared with structural and contextual themes, the results of this study, from an inter-project perspective, have revealed that behavioural factors were relevant in relation to the role of decision-makers in the adoption of IBS technology and to the understanding of this significant sphere of human activities, as indicated by a participant:

> *"…IBS can overcome this in the long term with more efficient construction process control which still requires human skills and experts to establish a stable application of IBS." (SH/DR/15)*

Moreover, it was discovered that there were some considerations to view decision-making as an art, linking decision subjectivity and IBS technology adoption. However, in IBS decision-making, as perceived by the construction-profession stakeholders, decision-making was a totally objective action based on a scientific approach, while at the other extreme behavioural aspects such as perception, experience, attitude and other subjective elements took over the decision.

i) Experience

As the most relevant factor of behavioural perspectives in IBS decision-making, experience was perceived by the construction-profession stakeholders as important because IBS decision-making involved the type of judgments that are driven from a wide variety of experience. It was acknowledged that in considering the decision-makers' experience in IBS and non-IBS projects, they must learn to rely on evidence from the reality of building projects. For example:

> *"With many businesses considerations, people can actually take benefits that literally if they can really experience them …" (SH/CR/8)*

Moreover, the participants perceived that building-project experience and the rule-of-thumb in building projects were not of the same importance, but knowledge of basic IBS technology adoption, with the experience of relevant projects, could allow decision-makers to decide on IBS technology adoption even in the absence of project- or IBS technology-specific guidelines. Therefore, it was noted that the influence of experience on IBS decision-making must be based on the emphasis placed on the practicality of project matters. The following are examples:

> *"…that previous experience especially in the industry is very helpful especially when estimated costs are exceeded as each unexpected condition is addressed." (SH/MR/27)*

> *"…all lessons learnt should be shared among interested parties in order to inform future project planning in the light of experience with the project." (SH/CL/49)*

Specifically, the construction-profession stakeholders placed their concern more on the experience of project failures rather than any success experience, in the decision-making of IBS technology adoption. The experience of project failure was perceived as an important consideration as it could provide an equally useful insight into the causes of project failures. For this reason, it was best to examine failure experiences in terms of IBS projects or non-IBS projects that could not meet the expectations of the projects' clients and the requirements and specifications of the projects. As indicated by a participant:

> *"From those problems and may be failures, we should improve all aspects in the future's projects..." (SH/CR/8)*

According to the participants, when project failure did occur, there was an understandable tendency among the construction-profession stakeholders, and those associated with them, to distance themselves from similar projects as it was not easy to learn, improve and develop from failure experience. Often the causes of project failures were identified only in broad terms such as technical failures, cost overrun, over- or under-estimations, time extensions and operational and management problems, with the result that the organisation or the project did not learn much from the experience. As two participants commented:

> *"…the failure of technology transfer also results in the low reception of IBS in the Malaysian market…" (SH/DA/4)*

> *"May be for those who have faced with IBS project failure have different perspectives like anxiety and frustration that are growing…" (SH/CE/17)*

Therefore, in IBS decision-making the construction-profession stakeholders also emphasised the concern for examining failure experiences in considerable detail and the results then being fed back into the future decision-making of IBS technology adoption. Although the construction-profession stakeholders perceived that the aspect of failure experience has impacted IBS decision-making, they also perceived that the success experience of IBS and non-IBS projects associated with development in the area of building technology innovation was influencing IBS decision-making as well. These participants revealed that:

> *"When a claim is made against one of the project failure, it is difficult for the public to know whether a corrective measure has been taken or simply that a mistake has occurred…" (SH/CR/23)*
>
> *"But from our experience too, the downsides are just as evident: clients' fear of the IBS image buildings and memories of past IBS failures, and the fact that cost and time savings..." (SH/CT/16)*

Additionally, attention was given by the participants, to the reasons for the success of a specific project or to more general causes of success across a spectrum of building sectors in which IBS decision-making took place. The participants perceived that, based on these success experiences, the decision-maker could then provide a series of guidelines for project success that were of potential value in IBS decision-making. For example:

> *"As mentioned earlier, people want to see a lot success stories. I believe this is important to change people's mind." (SH/DA/4)*

Therefore, despite the rapid pace of business and economy, it was recognised that the success experience of building project was increasingly important. This situation was essential for decision-makers in building projects to develop their focus and insights on a need for human related factors rather than managerial and technical aspects. These focus and insights were particularly crucial when deciding on IBS technology adoption, such as the presence of an outstanding leadership in the successful project, high levels of cooperation and teamwork productivity. As acknowledged by a participant:

> *"Meaning that, we have to look at other IBS projects that are performing well in the industry." (SH/CL/51)*

By contrast, the use of practical experience, either of success or failure, as a basis for IBS decision-making was perceived as identical, with no formal explanatory basis, thereby rendering it a faulty guide to the prediction of future building projects and a totally inadequate basis for control.

ii) Bounded Rationality

The recognition of limited capability in human thinking, despite the ability to think strategically, plays such an unpredictable role in decision-making. As perceived by the construction-profession stakeholders, in certain circumstances, IBS decisions were not made entirely on the basis of managerial and economic rationality; this reasoning situation was known as bounded rationality. As one participant highlighted:

> *"Although owners and contractors may have different perceptions on project management for construction, they have a common interest in creating an environment leading to successful projects…" (SH/CT/12)*

As the next relevant factor which has influenced IBS decision-making, the bounded-rationality aspect was perceived as an essential consideration because it seemed overly pessimistic to assume that the decision-makers could apply and perform rational managerial and economic analysis to a substantial element in IBS decision-making, as evidenced by the following:

> *"Our operation is basically re-implementing our very own custom production. So, production decisions have to be based on the manufacturing requirement…" (SH/MR/26)*

> *"We are only into IBS in several aspects but not the total systems because it depends on the project requirements and suitability too…" (SH/CE/24)*

The construction-profession stakeholders also perceived that if alternative courses of action pertaining to IBS technology adoption could be analysed, organised and presented in rational and neutral terms, the choice still could be made but it would be biased in accordance with a personal set of bias, values, attitude and justifications. Note this critical observation:

> *"When we deal with IBS, the limitations in some or all of the basic elements required for the successful completion of a mega project include engineering design professionals to provide sufficient manpower to complete the design within a reasonable time limit. Not only that, we have to deal with construction supervisors with capacity and experience to direct large projects." (SH/CE/17)*

Equally, it was unrealistic to decide purely on the basis of common sense, thus, there was a need to consider bounded rationality aspects such as learning, justification, cognition and choice. As perceived by the construction-profession stakeholders, the aspect of learning was the most relevant factor in IBS decision-making. In building-project development, the participants realised that project members tend to make mistakes by focusing upon what they have done in the past rather than what they are most likely to improve in a future project. Examples of this include:

> *"…construction activities, learning from experience is very important. If one has to work out on an IBS project, we have to analyse the performance of previous projects…" (SH/CR/8)*

> *"It doesn't mean that when an IBS project failed, it is the end of it. That is a learning experience to improve IBS in the next project…" (SH/CT/12)*

It was acknowledged that quite obviously, future behaviour or personal conduct is often influenced by what has been done previously. The participants added that, because of this, for the purpose of IBS decision-making, it was vital to put a great deal of effort into learning, not just about previous experiences in building projects, but also into developing a detailed understanding of clients'- and project members' perceptions and expectations, and the extent to which these could be met. As one participant commented:

> *"…we shall increase efficiency and productivity through continuous learning and training to keep pace with time and survive in competitive market or else we will be left behind." (A/DA/7)*

Consequently, as perceived as a relevant aspect of bounded rationality factors in IBS decision-making, learning aspect could lead to an appropriate justification of each decision made with regard to IBS technology adoption. Specifically, it was essential to have knowledge of how particular courses of actions in building project could lead to particular project outcomes, and thus requiring analytical justification for improving IBS decision-making performance. Note these comments:

> *"What has been lacking until recently is a stable market for IBS, giving connection to justify further major investment." (SH/CR/9)*

> *"…there is this strange situation as I have noticed where some designers trying to justify their decisions without referring to us as the design just looks good." (SH/CL/50)*

Therefore, in IBS decision-making, adequate and reliable information for making important choices was essential, as perceived by the participants. A number of participants highlighted that working on building-project technology like IBS with limited time for problem-solving and decision-making, could lead decision-makers to appreciate the more efficient use of information in order to accelerate decision-making, through a cognitive process. As the next relevant aspect of bounded rationality factors, cognition, or the information-processing capabilities of decision-makers based on their knowledge and understanding, was perceived by the participants as necessary and to be considered in IBS decision-making. Examples of this include:

> *"We have to think what sort of interactions that can help to the transfer and share know-how knowledge and experience which are more likely to result in competitive advantage." (SH/DR/11)*

> *"So based on this, we have the ability to implement positive change resulting from our deep understanding of project management from our experience in numerous projects." (SH/CT/12)*

In a highly complex situation like the adoption of IBS technology in building projects, with the uncertainties of a dynamic environment, it was perceived that cognitive efforts were essential in order to see clearly the relationship among the elements of an issue on IBS technology adoption, or to decompose a more complex issue on this technology into a simpler issue, for a more efficient way of information gathering and processing, thus leading to effective IBS decision-making. As strongly advocated by a participant:

> *"What we need to do first is to come out with an understanding of the mechanisms through which the availability information about project progress, problems, budget and schedule in order to decide on any operational issues…" (SH/CR/8)*

Consequently, based on the cognition process with various information inputs, several alternatives were generated and a final choice had to be made. As the least influencing aspect of IBS decision-making, the participants perceived that the aspect of choice was crucial for choosing among alternatives when they were described by many attributes, or even when the decision-maker had to choose a course of action which would attain many project objectives. This is evidenced by the following excerpts:

> *"…definitely IBS is an alternate approach that can save time. It is an alternative approach of construction that is used together conservative building method…" (SH/DR/15)*

> *"Extending or altering existing building could provide alternative and possibly cheaper solutions. May be IBS can be applied at this stage. I don't think IBS has always to be for new projects…" (SH/DA/19)*

iii) People Awareness

The next factor which impacted on IBS decision-making consists of the aspects of people awareness which are based on the elements of culture, personality, support and values. The basic principle underlying the factor of people awareness was the ability of people to recognise any matters, issues, objects, problems and solutions in the same, or different, ways. Therefore, the aspects of people awareness were acknowledged by the participants as relevant because in IBS decision-making, it was important to know that people in the construction industry have a certain level of awareness of IBS technology and its related developments in the industry. Note these comments:

> *"...Thus, to develop the maturity of project owners appropriate structures must be created and the awareness of the role must be increased too..." (SH/CL/50)*
>
> *"…project owners must be aware of the impacts of these regulations on the costs…" (SH/MR/27)*

As perceived by the participants, people awareness was based on their principles or upholding values. In IBS decision-making, the participants highlighted that it was necessary to determine the value system of construction players and their awareness of IBS technology adoption in the construction industry. Therefore, by understanding the way people responded to IBS technology and its related developments based on their values and concerns, IBS decision-making could also be tailored according to people's response and values. Note these comments:

> *"Our consulting services are coordinated with all parties so everyone can share in the value. It is also the same if we want to value IBS from sustainability perspective." (SH/CT/12)*
>
> *"This initial first plan of action is based on incorrect perceptions on a whole series of values like economic, social, political, technical, cultural …" (SH/DA/6)*

The next influence on IBS decision-making based on awareness factors was that of the aspects of support towards IBS technology adoption. The participants perceived that it was the expectations and support of the project members that exerted an influence on IBS decision-making, although individuals may well have had a variety of personal aspirations. As indicated by a participant:

> *"If it is already a culture in our country, with the support and people have good view on IBS, definitely it is not that difficult to be implemented here..." (SH/DA/4)*

The next important influence on IBS decision-making was the perception of the aspect of culture. Therefore, it was discovered that in IBS decision-making, the consideration of the commonly held core beliefs and practice or culture of building projects was perceived by the participants as essential because, through culture, the way in which people in society and the construction industry behaved towards, and responded to, IBS technology adoption, could be determined. As acknowledged by a participant:

> *"...architectural design is actually all about representing the cultural and traditions of people in a way based on our society's belief and confidence in its unique characteristics." (SH/DA/6)*

The final influence on IBS decision-making as perceived by the participants was about personality aspects. However, the fact was that personality measures turned out to be less accurate predictors of IBS decision-making. These participants stated:

> *"There are some definitive positive traits which we should possess when doing our tasks. By having these traits, we can do better in project implementations." (SH/CE/13)*

> *"...but we have to create a kind of management with influence because a project manager should have a personality or other characteristics to convince others." (SH/PM/18)*

Although personality aspect was perceived as the least relevant factor in IBS decision-making, a more detailed understanding of personality aspects could be relevant in influencing a choice of building technology or IBS types.

iv) Attitude

The last relevant factor of behavioural context in the decision-making of IBS technology adoption, was attitude. The participants perceived that in IBS technology adoption, it was essential to have some understanding of how different project members viewed IBS technology adoption, in order to determine their orientation pertaining to this matter. In certain circumstances at least, the aspects of attitude could help in the process of understanding the IBS decision-making process, by identifying attitudinal barriers to IBS technology adoption, and vice-versa. Note this comment:

> *"People are human too and are exposed to much kind of attitudes and even some of them decide to help them to achieve their own goals too, I mean their career growth." (SH/CR/8)*

The element of attitude was demonstrated based on the project members' or the society's standpoint towards IBS technology based on their positive and negative outlook. The participants perceived that attitude elements must be understood, so that IBS promotional efforts could be tailored more firmly and clearly to the pattern of specific attitude. As one participant acknowledged:

> "*In all projects, I always emphasise on the way we would rate the trust the client has for us as compared to those new architects… I am very much a kind of open with it all…" (SH/DA/19)*

The construction-profession stakeholders also perceived that the positive attitude of project- and society members was the most influencing factor upon the decision-making of IBS technology adoption as reflected by their positive outlooks. The following are examples:

> *"What we can do is to make up the initiative which can be on operational basis…" (SH/DR/11)*

> *"…they develop a team environment where members have the confidence to operate on their own initiative but within clearly defined boundaries in IBS…" (SH/DR/15)*

The participants also acknowledged that by processing a wide range of interests in IBS technology adoption, this kind of positive attitude could lead construction entities to promote IBS technology ideas and adoption to others in the construction industry. It was recognised that by possessing positive attitudes towards IBS technology adoption, construction entities would be more receptive towards the decision-making of IBS technology adoption. As one participant concisely commented:

> *"It seems that we want to be more on a reactive side. Why not be proactive, find the client before any of us especially the clients makes the final decision on IBS and we also give the clients the information and certainty they need in order to be able to make the IBS decision." (SH/CR/8)*

Moreover, those with positive attitudes were perceived as relatively more subjective in evaluating and considering IBS technology adoption, hence they could provide encouragement and guidance for IBS decision-making. Obviously, differences in values and attitudes towards IBS technology adoption would almost certainly be reflected in the behaviour of construction entities. For example:

> *"…but as a manager you must respond to this resistance with patience, confidence and positive support if we really want to adopt IBS." (SH/CL/50)*

From another perspective, the negative attitude aspect was seen as the least relevant factor in IBS decision-making. Moreover, the elements of uncertainty and curiosity were also affecting people's attitudes in a negative manner. Note these comments:

> *"…some contractors even expressed that they are strongly reluctant in using IBS as they resist changing from their conventional system." (SH/QS/10)*

> *"There are some definitive positive traits which we should possess when doing our tasks. By having these traits, we can do better in project implementations." (SH/CE/13)*

The participants acknowledged that people developed negative attitudes towards the failure of IBS, uncertain performance, costs issues and IBS complaints, and thus reported experiencing less encouragement and motivation towards IBS technology adoption.

5.3.3 Summary of Analysis on The Group of Construction-Profession Stakeholders

The core factors examined are those identified as having a possible impact on IBS decision-making. They are then sub-categorised according to the priority aspects of these influencing factors. The construction-profession stakeholders perceived that the most important factor in IBS decision-making was the structural themes, followed by the contextual and behavioural themes. Having identified themes within the factors of IBS decision-making, it was important to recognise the priorities or hierarchy of these factors, based on their relevant categories, as perceived by the construction-profession stakeholders. The results of the analysis of the perception of construction-profession stakeholders towards the influencing factors of IBS decision-making based on three major themes are summarised in Table 5.2 below.

Table 5.2 Impact of Structural, Contextual and Behavioural Factors on IBS Decision-making in the Group of Construction-profession Stakeholders

CORE FACTORS/ THEMES: *(As perceived by the participants)*	**FACTORS AND REFERENCES:**		**PRIORITY ASPECTS AND REFERENCES**									
1.STRUCTURAL (4010 references)	Project Condition	1197	Development	341	Operation	300	Risk	278	Information	225		
	Procurement Setup	1117	Costs	420	Clients	267	Resources	136	Supply chain	112		
	Management Approach	1112	Process	393	Planning	281	Goals	103	Strategy	97	Leadership	74
	Communication Process	201	Formal	81	Informal	15						
	Decision-making Style	151	Group	80	Nature	34	Individual	32				
2.CONTEXTUAL (3397 references)	Economics Conditions	1252	Business	398	Demand	166	Opportunity	92	Uncertainty	69	Competition	66
	Technology Development	774	Productivity	230	Quality	175	Innovation	106	Creativity	36		
	Government Involvement	533	Promotion	152	Policy	103	Requirement	78	Rules	65		
	Sustainability Feature	373	Environment	143	Efficient	83	Trends	45	Waste	45		
	Stakeholders Participation	360	Opinion	140	Partnership	136						
3.BEHAVIOURAL (2899 references)	Experience	917	Failure experience	343	Success experience	316						
	Bounded Rationality	872	Learning	348	Justification	218	Cognition	138	Choice	121		
	Awareness	639	Values	209	Support	150	Culture	101	Personality	61		
	Attitude	403	Positive attitude	265	Negative attitude	51						

As presented in Table 5.2, the content analysis result shows that IBS decision-making in the construction industry is, to a certain extent, influenced by three core factors namely structural, contextual and behavioural. In terms of the perceptions of construction-profession stakeholders of the influencing factors of IBS decision-making, the findings indicated that structural factors were the most relevant, followed by contextual and behavioural factors. Project-condition aspects were perceived by the construction-profession stakeholders to have impacts on the decision-making of IBS technology adoption in the construction industry. The findings suggest that construction stakeholders perceived IBS decision-making to be about developing faster building projects. Next, they also acknowledged that the aspect of procurement setup was perceived as relevant to IBS decision-making, besides management approach aspects.

Another key finding on the impact of contextual factors in the current study, as perceived by the construction-profession stakeholders, was that the economic conditions and technology development aspects appeared to strongly influence IBS decision-making. Economic aspects are associated with business prospects for different types of construction method, including IBS technology. Besides the government involvement, some construction-profession stakeholders considered technology development aspects, particularly in productivity- and quality matters as important.

Furthermore, the majority of construction-profession stakeholders perceived that behavioural factors also influenced IBS decision-making in building projects. The impact of human-related factors on IBS decision-making among construction-profession stakeholders has also been confirmed by the study on the members of the supply chain. Since work- and project experience allowed the construction-profession stakeholders to gain IBS-related information, it seems likely that they recognised that the direct involvement in IBS projects could also provide knowledge and understanding required for IBS decision-making.

5.4 Intra-project Perspective: The Supply-Chain Members of IBS Projects

From the intra-project perspective, the focus is on how the supply-chain members of three IBS building projects in Malaysia perceived the influencing factors on the decision-making of IBS technology adoption. These three IBS building projects consists of chain members who are also the construction professionals. This section explores IBS decision-making from an intra-project perspective, with building projects that are mandated to adopt IBS technology.

5.4.1 Profile of Building Project Investigated

The building projects investigated were as follows: an office building project of a successful IBS project located in the centre of Kuala Lumpur, Malaysia (named as Project A), a non-performing IBS school building project on the outskirts of Kuala Lumpur, Malaysia (named as Project B) and an unsuccessful IBS commercial building project on the East Coast of Malaysia (named as Project C). The selection of IBS building projects was based on the document analysis of the determination and evaluation of project objectives, goals achievement and their success criteria as presented in Table 5.3.

Table 5.3 Evaluation of Project Objective and Outcomes

PROJECT OBJECTIVES, GOALS AND SUCCESS CRITERIA		**PROJECT A**	**PROJECT B**	**PROJECT C**
Project Objective		To build an office building with open plan space, comfortable for lab work, less environmental impacts.	To build school buildings with design and appearance constancy, on-time and less interruptions.	To build commercial buildings with aesthetic design, coordinated interfaces, less working labour.
Project Goals Achievement	Cost Effective	Yes	Yes	No
	Aesthetic	Yes	No	No
	Functional	Yes	Yes	Yes
	Timeliness	Yes	Yes	Yes
	Sustainable	Yes	Yes	No
Project Performance Criteria	Non Compliance, Report/ Complaints	Low	Moderate	High
	Workability/ Installation Tasks	Highly Efficient	Moderately Efficient	Less Efficient
	Durability/ Building Performance	Low Maintenance/ Long-term	Low Maintenance/ Short-term, Highly Long-term	High Maintenance/ Short-term
	Types of Common Defects	Minor Joints	Cracks	Cracks and Joints

In order to investigate the decision-making of IBS technology adoption, information on the background of each IBS building project was gathered, consisting of project facts such as project type, project members, owners and procurement type. A summary of these three building projects is presented in Table 5.4.

Table 5.4 Information of IBS Building Projects

BACKGROUND OF PROJECT TYPES:	**PROJECT A**	**PROJECT B**	**PROJECT C**
Project Type	Office Building	School Building	Commercial Building
Function of Building	Lab work Activities	Education Activities	Business Activities
Location	Central Coast of Malaysia	Central Coast of Malaysia	East Coast of Malaysia
Construction Period	March 2009-July 2011	February 2003-September 2003	June 2007-September 2009
Duration	29 Months	8 Months	28 Months
Owner	Federal Government	Federal Government	State Government
Architect	Public Works Department (PWD) Malaysia	Public Works Department (PWD) Malaysia	Private
Consulting Engineer	Private	Private	Private
Contractor/Manufacturer	Private	Private	Private
Type and Model of Procurement/Procurement Method	Tender/ Traditional	Tender/ Traditional	Tender/ Traditional

Further details on the background of Project A, Project B and Project C are presented as follows:

a) Project A

The office building (Project A), owned by the Federal Government of Malaysia, was completed in 2011. Project A is built with state-of-the-art IBS technologies and offers its occupants an open-plan layout and a conducive working environment to perform lab work activities. It was constructed with off-site steel-construction technology balanced with technical aspects of construction ease and planning efficiency based on the utilisation of modern building methods, in an urban location.

Project A had to face the challenges of urban constructions such as the need to minimise the construction work on local surroundings and the lack of site storage space due to its location in the capital city of Malaysia, Kuala Lumpur. Therefore, these construction challenges could be met by the adoption of IBS technology. This study was able to quantify IBS technology adoption performance through the reduction of labour using the use of steel frames and hollow-core slabs, when compared to traditional construction methods. Project A benefited from IBS technology adoption through a more efficient delivery period, cleaner working environment and reduced time for inspecting authorities.

b) Project B

The school building (Project B) was completed in 2005 and owned by the Federal Government of Malaysia. This case study explored a school building project which used various types of IBS technology adoption including pre-cast concrete beams, floor planks, wall panels and staircases. This is an education development project and thus received priority in government funding and construction materials. Its facilities include classrooms, meeting rooms and toilets. The findings support the view that IBS technology adoption results in faster construction than traditional on-site construction.

Timing was an important factor in the case of Project B as the building period or duration was based on, and determined by, the new school term. Project B, located in a sub-urban setting in Selangor, Malaysia had to be built to a tight schedule to be ready for the new school term. Faster construction time in Project B was only achievable by using prefabricated wall panels, precast concrete beams and floor planks, permitting a watertight building environment, thereby allowing other construction activities inside the building to be implemented earlier.

In Project B, the new buildings were based on the basic classroom design developed by the Public Works Department of Malaysia. Precast concrete beams were transported to the site where they were then lifted into the correct position. Therefore, highly skilled operational- or construction workers were not for concrete form work. Project B, with the adoption of IBS technology, was less dependent on weather conditions to achieve an accurate result.

c) Project C

The commercial building (Project C) was constructed using precast concrete beams, columns, wall panels and plank slabs. It was completed in 2009, and is owned by a state government, located outside Kuala Lumpur, Malaysia. Project C was delayed for a variety of reasons including IBS design changes and technical problems. Besides the unsatisfactory project performance, the joints of IBS components, especially wall panels had started to crack and several structures were at risk of cracking too.

Project scope, cost and building conditions were the major challenges during this project. In terms of the technical aspect, it appeared that the design of precast concrete beams in Project C was not adequately assessed, leading to inaccuracy of the beams' installation. There was a need to realise that the installation of IBS components must be performed by semi-skilled- and trained construction workers. There was also a lack of supervision by the main contractor and consulting engineer and substandard materials were used.

Before further or detailed exploration was performed in these case studies, on the decision-making of IBS technology adoption, an initial analysis was also conducted to understand the general nature of decision-making associated with IBS technology adoption performed at each building project stage, and the outcomes of Project A, Project B and Project C. Initial findings from the case studies are presented in Table 5.5.

Table 5.5 Background of IBS Project Context

BACKGROUND OF PROJECT CONTEXT		**LEVEL OF DECISION-MAKING ASSOCIATED WITH IBS TECHNOLOGY ADOPTION AND OUTCOMES**		
		PROJECT A	**PROJECT B**	**PROJECT C**
Project Stage	Feasibility	Moderate	Moderate	Moderate
	Design	High	Moderate	Moderate
	Planning	High	High	Moderate
	Construction	Moderate	Moderate	Moderate
	Operation	Low	Moderate	Low
Project Outcomes	Fast/ Timeliness	Yes, expectation met	Yes, expectation met	No, expectation not met
	Easy Installation	Yes, exceeded expectation	Yes, expectation met	Yes, expectation met
	Quality	Yes, expectation met	No, below expectation	No, far below expectation
	Cost Effective	Yes, target met	Yes, target met	Yes, target met

Table 5.5 provides an overview of the relevant information regarding the level of decision-making associated with IBS technology adoption for the three cases of building projects. As IBS decision-making is multifaceted, the case studies were considered from the view of project stages: feasibility, design, planning, construction and operation. Levels of decision-making associated with IBS technology adoption are determined from the information given by the participants, using their response on this matter. Thus, a project with a high level of decision-making associated with IBS technology adoption is one in which the total score of decision-making at each stage is more than 75%. Meanwhile, for a low and moderate level, the total scores are 0-35% and 36-75% respectively. The results on the level of involvement in IBS decision-making are presented in Appendix 12. However, it must be acknowledged that the overall study of IBS decision-making in this research is based on the decision-making nature.

5.4.2 Profile of Participants

The information under this section relates to the profile of participants in the intra-project-perspective group. Analysis is performed separately for the cases of Project A, Project B and Project C, for comparison purposes. In order to assist in further analysis of the influence of structural, contextual and behavioural factors on IBS decision-making, supporting data on the participants from the intra-project-perspective group is presented in Table 5.6, which consists of the participants' profiles in terms of background, and their nature of decision-making.

Table 5.6 Participants' Profiles of the Intra-project Perspective

PERSPECTIVE:	**INTRA-PROJECT PERSPECTIVE**					
Types of participants	Supply-Chain Members of IBS Projects					
	Project A		Project B		Project C	
Number of Participants	9 participants		9 participants		9 participants	
Type of Decision-making	Mostly Routine and Non-Routine		Mostly Routine and Non-Routine		Mostly Routine and Non-Routine	
Priority of Decision Category	Both Group & Individual	High	Both Group & Individual	High	Both Group & Individual	Medium
	Group Only	Medium	Group Only	Medium	Group Only	High
	Individual Only	Low	Individual Only	Low	Individual Only	Low

Working Experience of Project Member	More than 20 years	Contractor Client Developer	More than 20 years	Consultant	More than 20 years	Developer
	10 to 20 years	Architect Q. Surveyor Consultant Project Mgr. Manufacturer	10 to 20 years	Architect Q. Surveyor Contractor Client Developer Project Mgr.	10 to 20 years	Architect Q. Surveyor Contractor Consultant Client Project Mgr.
	Less than 20 years	Civil Eng.	Less than 20 years	Civil Engineer Manufacturer	Less than 20 years	Civil Eng. Manufacturer
Qualifications/ Academic Background	PhD	Manufacturer	PhD	-	PhD	-
	Masters	Contractor Clients	Masters	Architect Civil Eng. Client Manufacturer	Masters	Client
	Degree	Architect Q. Surveyor Civil Eng. Consultant Developer Project Mgr.	Degree	Q. Surveyor Contractor Consultant Developer Project Mgr.	Degree	Architect Q. Surveyor Contractor Civil Eng. Consultant Developer
	Diploma	-	Diploma	-	Diploma	-
	Others	-	Others	-	Others	-

Table 5.6 illustrates that the construction professionals participating in the semi-structured face-to-face interviews came from a wide range of backgrounds, in terms of their working experience and academic qualifications. An understanding of the characteristics of supply-chain members in these projects assists in focusing the analysis and putting the results into perspective. The next section presents results from the semi-structured face-to-face interviews and explores these construction professionals' views on factors related to IBS decision-making for Project A, Project B and Project C.

5.4.3 Content Analysis of Influencing Factors on IBS Decision-making

The content analysis for the intra-project-perspective interviews was performed to determine a pattern of responses amongst the participants, relating to IBS decision-making and its influencing factors. The emphasis and importance placed by each participant within the three cases of Project A, Project B and Project C for each factor were studied in terms of the amount of information gathered and the frequency of occurrences within the interview text documents. Each factor is enunciated using short, insightful and revealing excerpts from the interviews. It should be noted that not all quotations relating to the factors or their related aspects, are included. Rather, those excerpts which are pertinent and directly to the point are selected. Each quote is followed by the participant's codes of identification. Codes for the supply-chain-member participants of the IBS building projects as represented by Project A, Project B and Project C are presented in Appendix 13.

5.4.3.1 Case 1: Project A

In order to allow the comparison of factors that impact on IBS decision-making in Project A, based on the perception of Project A's members, those factors were categorised into three major core factors or themes and prioritised according to the perception of the participants, based on the frequency of occurrence or references in the content analysis. For each core factor, factor and priority aspect, the respective concerns of the participants about factors that impact on IBS decision-making are as follows, in descending order of levels and priority:

a) Structural Factors

As the theme of most concern in Project A, structural factors were contributing substantially to IBS decision-making. In this analysis, the influence of structural factors is greater than that of contextual and behavioural factors. Given their effect upon the decision-making of IBS technology adoption and their differential distribution among socio-economic scenarios, structural factors such as procurement setup, management approach, project condition, decision-making style and communication process have played an important role in influencing IBS decision-making in Project A. One participant stated:

> *"...and coordinate human and material resources throughout the life of a project by using some management techniques to achieve predetermined objectives of scope, cost, time, quality and satisfaction among all projects…" (A/PM/34)*

In order to describe the priority aspects of structural factors in Project A and to determine the extent to which these factors impact on IBS decision-making, further analysis will be based on the following sequence:

i) Procurement Setup

In enabling the requirements of the IBS project to be easily envisaged and coordinated by Project A's members, this factor was highly perceived as having the greatest impact on IBS decision-making, especially for procurement features like project costs and clients, which were considered to be important in the mechanisms and process of IBS project procurement. Note these comments:

> *"…reports to the client and also advice the client in details about the feasibility of the project…" (A/DA/7)*

> *"Cost is another thing that I consider another important factor for us…. procurement is important in terms of quality and cost, what more for IBS project." (A/CR/5)*

Procurement aspects in the outlook of structural factor in Project A was about the decision to adopt IBS technology based on the possible acquisition of a building project. This acquisition is particularly important for complicated building projects or building projects where their specifications were highly and strictly compelled. Collectively, the influence of resources and supply chain were less important than costs and clients consideration in the procurement setup or process of Project A. Two participants claimed:

> *"So, all in all, the top priority is to make sure systems are in place to enable all payments to be paid on due dates according to the terms of contract and in compliance with the policy…" (A/CL/53)*

> *"…that are producing huge IBS components, have to play a more effective role in developing an IBS supply chain." (A/QS/29)*

These statements served as an essential consideration in regard to the early stages or the early initiation of Project A because when deciding on IBS technology adoption, the majority of Project A's members perceived that cost determination, clients' requirements and resources allocation were the important elements of project procurement that made up the project implementation as a whole.

ii) Management Approach

It was perceived that in Project A, management approach, as a part of the structural perspective of Project A has also influenced IBS decision-making, after the procurement factors. This is evidenced by the following excerpt:

> *"…is now for us to simply decide on it but architects shall use innovation and management of new technologies like IBS to offer client a benefit of project advancement…" (A/DA/7)*

On a more specific analysis, among the managerial approaches found to have relevant impacts on the decision-making of IBS technology adoption was the aspect of planning mechanism. One participant claimed:

> *"…planning is important, also the group planning. At this stage, there are a lot of decisions…" (A/CR/5)*

Depending on the IBS requirements of Project A, the need for control in the project implementation and the obligation of IBS policy clarity have obviously required a lot of planning tasks. Besides planning mechanism, the aspects of management process and project strategy were perceived as relevant factors that impact on IBS decision-making. The members of Project A also perceived that by considering the efficiency and effectiveness of the management process of the building project when deciding on IBS technology adoption, it was a great way of ensuring that IBS building projects could be completed on time and to schedule. One participant revealed:

> *"…as the construction is cost a factual process designed to give a reliable estimation or prediction of its financial cost…" (A/QS/29)*

Project strategies have showed particularly strong influence on IBS decision-making as strategies could provide ways to analyse options for approaching and implementing IBS technology, as well as ways to relate IBS technology adoption to the competitive performance of Project A. One participant commented:

> *"…strategies that have been formulated under the category of strength-opportunity strategy that involve the encouragement of the government to promote more participation of the local workforce in the construction industry." (A/CL/53)*

Project goals were also perceived as an important consideration in IBS technology adoption as, in Project A, it had to achieve a series of clear goals. When the management of Project A set a more dynamic project goal, it created challenges among the project-team members to deliver the project successfully. These participants claimed:

> *"…so that we can align with the goal of the adoption…" (A/QS/29)*

> *"What is important here is that this completes the basic foundation characteristics like clear goals…" (A/PM/34)*

However, the aspect of leadership quality in Project A was perceived as having the least impact on the decision-making of IBS technology adoption. On interviewee stated:

> *"…the group of leaders themselves, are mentally committed as they know that this is the future of our next generation…" (A/CE/2)*

This indicates that the members of Project A appeared to value the idea that considering the management approach in an IBS-decision context was largely about not only dealing with project-related factors but also about looking after, and working with, people.

iii) Project Conditions

The third relevant factor under the structural theme which has impacted on IBS decision-making is the project conditions. This finding indicates that project aspects, especially project development and project operation, were particularly relevant in the decision-making of IBS technology adoption on Project A. The members of Project A perceived that the project development process was an influencing factor in IBS decision-making in order to provide directions and guidance in relation to the project's implementation and performance with IBS technology adoption, as demonstrated by these comments:

> *"Even some IBS investment can be influenced by the argument that project development opportunity as a sense of business…" (A/DA/7)*
>
> *"…it was quite difficult when we first developed projects using IBS in Putrajaya with 6000 building units…" (A/CT/31)*

Project operation was the second relevant factor impacting on IBS decision-making as, in an IBS building project like Project A, the issues of IBS component delivery and production were perceived by the project's members as critical, besides other logistics matters. In Project A, the aspect of project operation must be considered, as its mechanism was required to ensure project efficiency and to deliver a good project performance. One participant recommended:

> *"…due to the problems encountered in the design and also operation can be solved or at least minimised with proper management and a technical approach." (A/DA/7)*

Meanwhile, project information was perceived as the next relevant factor in Project A. The participants acknowledged that it is essential to discover or gather facts on IBS building projects and other industrial information. These facts and information were particularly related to IBS technology adoption in terms of their data and trends in making timely and main IBS decisions. Moreover, making timely decisions was vital to implement the project activities and IBS decisions successfully. These participants revealed that information is essential in this matter:

> *"…is how to be based on reliable information throughout the design process in order to make decisions efficiently and effectively…" (A/DA/7)*

> *"…information and payment and other related matters have to come together." (A/QS/29)*

Lastly, the aspect of project risk was the least relevant factor as an influencing element in IBS decision-making. Since Project A was a successful IBS project, it also aligned with positive outlook towards risk or specifically, calculated risks, as this was related to procedures that occurred throughout the operation of Project A. As one participant commented:

> *"The development of effective and efficient IBS project-specific risk management strategies requires the use of risk assessment…" (A/CL/53)*

This comment also makes clear the need for evaluating IBS technology adoption, with the participant describing risk assessment which may at times be regarded as essential but at other times be perceived as jeopardising IBS decision-making.

iv) Decision-making Style

In Project A, the fourth relevant factor that influences IBS decision-making from a structural perspective is the decision-making style. The obvious finding about the style of decision-making associated with IBS technology adoption and other decisions in Project A, as perceived by the project members, was that group decision-making was an important consideration compared to individual decision-making style. This was due to the requirement to coordinate activities in the project, as stated by one participant:

> *"…there are also related activities assigned to the same general area by administrative decisions and project or construction activities…" (A/PM/34)*

This was the reflection that group decision-making is a norm in the construction industry due to its project nature and group-based activities. While this idea of group decision-making in Project A was certainly a part of its project mechanism, by looking more deeply into what the project members have acknowledged, it is revealed that sometimes, although IBS decisions were initially described as group decisions, they were often actually made by an individual but with the group- or project members undertaking a review process. Some of them provided comments:

> *"Even, it is not my solely decisions in any projects. All have to be based on our consensus…" (A/CR/5)*

> *"We have to get a consensus to come out with IBS solutions…" (A/CT/31)*

In certain circumstances, the group members of Project A could also provide inputs to an individual who then made the final decision on IBS technology adoption.

v) Communication Process

The least relevant factor that influences IBS decision-making in Project A was the communication process. Some members of project A perceived that there was a strong recognition that communication aspects were vital to not only link the client and the industry, but there was also a need to comply to the IBS technology-adoption requirements of government agencies or authorities prior to the project implementation. For example, a participant highlighted:

> *"Now we have many communication tools, so communication process becomes easier in our project execution…" (A/DA/7)*

One very relevant point about the management of Project A was that, when it came to IBS decision-making, it was based on formal communication. One participant stated:

> *"…when we have to negotiate with all kinds of people, from site workers to directors, professionally and fairly, so you'll need to express yourself well, both when speaking and in writing…" (A/QS/29)*

Although informal communication was perceived as the least influencing factor in Project A, it has its role in IBS building projects, as revealed by one participant:

> *"…our supervisors or project managers and others contact each other via hand phones if there are any problems at sites…" (A/CR/5)*

Overarching the interaction between all members in Project A, there was the constant need for concise and clear communication with the concern of controlling IBS decision-making in the complex project.

b) Contextual Factors

The second most influencing theme on the decision-making of IBS technology adoption in Project A was related to contextual factors. Contextual themes in this case were based on factors such as economic condition, government involvement, technology development, and sustainability features and stakeholders' participation. In this research, contextual factors are based on a macro perspective of building projects which would be viewed and evaluated from a wider perspective. One participant noted:

> *"In this case, often the future of a building's use and purpose relative to market conditions are not clearly identifiable. For us, we include all of those because upon the initial review of the market analysis our clients may perceive that there is no place for the building's design…" (A/DA/7)*

The participants of Project A perceived that in order to ensure the effectiveness of IBS decision-making, they had to consider the influence of these external dynamics that could affect their project performance, and one participant stated:

> *"In the peak or boom, the confidence level in businesses is high, speculation occurs and the projects are likely to flourish as well as things are going very well…" (A/CR/5)*

Such contextual dynamics were the influences of contextual factors on IBS decisions which could make differences in the way Project A was executed. This also included any unexpected issues or uncertainties that could affect the performance of Project A if contextual factors were not well anticipated and adequately considered or managed.

i) Economic Conditions

All members of Project A believed that the economic aspects of the construction industry were typically seen as the major consideration in the decision-making of IBS technology adoption. Therefore, economic conditions were highly perceived as most relevant and influencing contextual factors, due to their abilities to exert any sort of influence on the implementation or performance of building projects. As a consequence, Project A's members were typically put into the position of responding to the setting of the economy and one participant pointed out:

> *"...not only has to consider the economic factor, but also risk and safety, as well as environmental factors." (A/DA/7)*

The members of Project A also perceived business dynamics as having their impacts on IBS decision-making, depending on the ability to view the economic perspective in a rather different way, since Project A's members were able to consider IBS technology adoption as an investment, as one participant highlighted:

> *"…definitely there will be some kind of investment in addition to the cost…" (A/CE/2)*

Additionally, the feature of market demand was perceived as the second relevant aspect, followed by the industry opportunity of market growth. Two participants noted:

> *"…we want to create demand whereby we only create it locally…" (A/PM/34)*
>
> *"…precast are in very high demand for adaptive use…" (A/DA/7)*

In Project A, the majority of participants perceived that in order to fully capitalise on the demand for IBS technology adoption in building projects, there was a need to understand how this opportunity is likely to affect IBS decision-making and thus the performances of building projects themselves, as one participants remarked:

> *"… typically other projects will follow giving priority to further IBS investment opportunities for the construction sector…" (A/DA/7)*

Although the aspects of competition and uncertainty were perceived as the least relevant factors, they were not considered, and looked at, in isolation when deciding on IBS technology adoption in Project A. Two participants verified the specific aspects of competition and uncertainty, respectively:

> *"…my company is also looking at the competition from other companies in this industry…" (A/CT/31)*
>
> *"Another thing related to IBS is about uncertainty, as it relates to project performance, cost, quality and duration, comes from a lack of knowledge about the future…" (A/CL/53)*

These aspects were viewed against the background of business dynamics and total economic development, besides other major changes in the economic context.

ii) Government Involvement

Concern with the government involvement was perceived by the members of Project A as the second relevant factor which influenced the decision-making of IBS technology adoption. Moreover, IBS technology adoption in building projects was perceived as closely and highly related to the government's vision in the construction industry. Besides this, much guidance on IBS technology adoption has been developed by a series of government agencies, as one participant stated:

> *"… the government can also think about that, in a way and I think CIDB is in a very good position or JKR (PWD) maybe…" (A/CE/2)*

The members of Project A highlighted the influence of promotional activities performed by the government, on IBS technology adoption and its decisions, and thus perceived it as the most relevant in IBS decision-making. Therefore, the government's promotional efforts on IBS technology adoption and its decision-making were very much interlinked, as evidenced by the following:

> *"Even there are incentives provided by the government, especially through the CIDB, I think it is very effective in promoting IBS…" (A/CR/5)*

> *"Moreover our government is now starting to encourage the sustainability of construction industry..." (A/CL/53)*

Moreover, as perceived by the participants, there was a more robust government policy on IBS technology adoption, which also influencing IBS decision-making. The members of Project A reaffirmed the importance of key government roles in IBS policy, as the adoption of building technology like IBS could provide the potential for altering or achieving the competitive status of building projects and nations. One participant indicates that:

> *"Recently the government is encouraging the usage of timber in IBS besides steel to compete…" (A/PM/34)*

Hence, as perceived by Project A's members, it would be wise to consider IBS policy in IBS decision-making, in terms of whether top-down technology commitments could accelerate and enhance project performance. One participant commented:

> *"…our government can formulate the exact policy and introduce better incentives…" (A/CL/53)*

Although the aspects of government requirements and rules pertaining to building technology adoption were perceived as less influencing in IBS technology decisions, they still have their own roles to play. Two participants claimed:

> *"Another thing is rules for locating building elements within the reference system…" (A/CL/53)*

> *"…have to get your head around building law and regulations, as well as health and safety matters, tax and insurance and contract law …" (A/QS/29)*

Although such legislations tend to be industry-specific, in IBS technology adoption it was perceived as important based on the specific requirements of Project A to ensure the efficient development and high performance of this project.

iii) Technology Development

Technology development aspects are the third relevant impacts of contextual factor on IBS decision-making in Project A. The members of Project A perceived that IBS technology adoption was likely to be affected by technological changes in two major areas namely: project design and site operations. One participant stated:

> *"…it is now for us to simply decide on it but architects shall use innovation and management of new technologies like IBS to offer client a benefit …" (A/DA/7)*

Out of four major technology factors in this case study, Project A's members perceived that the productivity aspect contributed by IBS technology adoption in a building project was the most influencing factor on IBS decision-making. Although the cost of operative labour is lower when using conventional construction methods, it was not only the labour cost which was perceived as very relevant to Project A's IBS decision-making, but also the productivity offered by IBS technology adoption. In terms of the project's output and performance obtained from IBS technology adoption, two elements of IBS technology productivity which must be carefully considered in IBS decision-making are labour and project progress. A leaner or smaller labour force and faster project progress (due to the IBS implementation) could lead to improved or greater project performance. One participant pointed out:

> *"This will involve the commissioning of option appraisals, analysis of outcomes and choice of the best option to ensure best value for money is obtained…" (A/CL/53)*

Consequently, the quality aspect, perceived as the next relevant technology factor which influenced IBS decision-making, was another essential consideration related to the compliance with the client's specifications. Moreover, it was essential that the specifications should be quality assured to satisfy the required industry standards of IBS technology adoption. One participant noted:

> *"…this is also supported with quality assessment, it is very encouraging…" (A/CR/5)*

It was therefore important to consider the innovation aspect of IBS technology in building projects, perceived as the third relevant factor in IBS decision-making. Some of Project A's members perceived that by exploiting and adopting IBS technology, it was certainly a way of committing to innovation and of securing a competitive edge. One participant explicitly clarified:

> *"…construction people have to consider IBS by looking at the old style of building image conservation in the mission for modernization." (A/DA/7)*

However, the aspect of creativity was perceived as the least relevant factor in IBS decision-making. One participant verified:

> *"We can gain more opportunities to understand the project, develop creative solutions and propose ways to reduce costs…" (A/DA/7)*

It was noticed that IBS technology adoption was not due to creativity elements, since the members of Project A strongly believed that the contribution of IBS technology adoption was not only to improve the project's productivity and quality but also positively improved its overall performance.

iv) Sustainability Feature

The fourth factor of contextual theme, as perceived by the participants of Project A was related to sustainability. They believed that the agenda of IBS technology adoption in terms of project-, or government-, or industry perspectives was not strongly based on the whole concept of sustainability which is related to the meeting of the socio-economic- and environmental needs of future generations. However, two participants noticed that:

> *"…our government is now starting to encourage the sustainability of construction industry…" (A/CL/53)*

> *"…IBS manufacturers always consider offering a competitive price in order for them to be sustainable in the construction industry…" (A/PM/34)*

However, the participants of Project A perceived that in IBS decision-making, the environmental aspect was an important consideration due to a belief that IBS technology could be part of long-term environmental management or protection. IBS technology was perceived as important in the upholding of a better project identity and providing for sustainability. This is evidenced by the following excerpts:

> *"…we can't afford to lose all these good environments that we have right now…" (A/CE/2)*

> *"Recently, built environment has also going to embark on sustainability and green technology in building…" (A/DA/7)*

Sustainability factors were not only related to environmental protection in the decision-making of IBS technology adoption in Project A but were also based on the efficiency level of project workers. Therefore, work efficiency in the building project was perceived as the second relevant sustainability factor. For example:

> *"Actually IBS is fast; get everything done at the production site, not at building construction site. IBS is very systematic, not only when you want to make a house…" (A/MR/30)*

The participants of Project A believed that in IBS decision-making the overall performance of a building project had to take account of work-efficiency gains which may be obtained from the target achievement of timely schedule, budgeted costs and required quality. As one remarked:

> *"However, in some cases where adopting IBS is proven to be economical compared to conventional construction…" (A/PM/34)*

Waste management and living-trend aspects were perceived as the third and fourth relevant aspects of IBS decision-making, respectively. Waste management in this context refers to the reduction of waste in the construction process by adopting IBS technology. As one participant highlighted:

> *"So, by using IBS in the construction projects, wastes can be reduced greatly …" (A/QS/29)*

Meanwhile living trend refers to the improvement of society's lifestyle based on the transformation of expectations created from IBS technology adoption. For example:

> *"…implementation of IBS in public building project that are sustainable and practical for the long run and can really reform our construction industry…" (A/DA/7)*

Therefore, despite those sustainability aspects in IBS technology adoption, the participants of Project A were less concerned with the influence of waste management- and society-trend aspects, when deciding on this technology.

v) Stakeholders Participation

The least relevant influence of contextual perspective, as perceived by the participants in Project A, was the stakeholder participation. In IBS decision-making, they perceived that it was still essential to identify and consider the wider stakeholder group in terms of their interests, influences and responsibilities, in a more transparent way to achieve the goals of building projects, as demonstrated by these comments:

> *"As all stakeholders can play their role in adopting IBS…" (A/DR/32)*

> *"…so it is entirely in the owner's interest to obtain these independent opinions for the reassurance they can provide…" (A/CL/53)*

Therefore, the participants believed that the consideration of stakeholders' opinions in IBS decision-making was important in terms of their engagement with the wider construction community, rather than just considering their interests in the construction industry, as noted by these participants:

> *"So, of course their opinions are useful in IBS adoption…" (A/PM/34)*
> *"It is not always easy to influence each other but we can make some suggestions by giving our opinions…" (A/DA/7)*

Accordingly, the evaluation of stakeholders' opinions as a consideration in IBS decision-making was perceived as a better approach in a building project. For example:

> *"…input from a client adviser will be required at inception or feasibility, prior to the appointment of a project manager…" (A/CL/53)*

Besides the participants' consideration of the stakeholders' opinion in IBS decision-making, some of Project A's members perceived that the aspects of partnering were also an essential consideration in IBS decision-making, but they were less significant compared to the influence of stakeholders' opinions, as demonstrated by these comments:

> *"…we developed something from nothing with a good cooperation from our consultants, quantity surveyors, contractors and clients…" (A/CT/31)*
>
> *"We also work closely with architects, financiers, engineers, contractors, suppliers, project owners, accountants, insurance underwriters, solicitors and with all levels of government authorities…" (A/QS/29)*

Specifically, the participants of Project A suggested that the development of a partnership formation in IBS technology adoption could be helpful, based on collaborative movements and co-operation, by gaining and sharing of better knowledge and understanding of IBS technology.

c) Behavioural Factors

The behaviour theme was perceived by the participants of Project A as the least relevant factor in the decision-making of IBS technology adoption. In this case study, the behavioural theme offers a different perspective in IBS decision-making as it is more concerned with the human-related factors of a building project. In Project A, from the viewpoint of the behavioural theme, the mix of bounded rationality, experience, attitude and perception aspects which influenced IBS decision-making were relevant.

In Project A, because of the influence that behavioural factors exerted upon IBS decision-making, the participants perceived that there was a need to turn to an evaluation of the series of non-technical- and non-managerial- or human factors in a building project. One participant revealed:

> *"They claim that there are insufficient IBS guidelines and unclear standards for IBS. Moreover, as we know, I think resistance to change is the biggest issue…" (A/CR/5).*

In the previous sections on the results of Project A, the radius of IBS decision-making has focused upon the influence of contextual and structural perspective. Whereas, in real practice, IBS decision-making covers a far wider range of situations and problems that are related to the decision-maker personally.

As IBS decision-making at the strategic level, in particular, involved the element of critical judgment, it was noticed that the participants of Project A were considering the dimensions of the behavioural matters together with the degree and nature of behavioural influence that it was possible to exert. The focus of attention within this section therefore shifts to the examination of decision-makers, to the behavioural factors that have influenced Project A's members in the process of arriving at an IBS decision, and to the ways in which behavioural factors could act as a constraint on the implementation of the IBS decisions.

i) Bounded Rationality

Bounded rationality was perceived as the most influencing factor on the decision-making of IBS technology adoption in Project A. Although IBS decisions could be made using all inputs in a building project or from the industry, it was perceived that the members of Project A had limitations in their decision-making ability. Therefore, Project A's members knew what was the best for the economic and business interests of their projects and acted accordingly in the decision-making of IBS technology adoption. One participant commented:

> *"When comes to IBS, it is not easy for us to simply decide on it but architects shall use innovation and management of new technologies like IBS to offer client a benefit of project advancement…" (A/DA/7)*

In particular, the members of Project A perceived that IBS decisions must be made in the light of filtered information and selective options, therefore, the final IBS decision was based on the project specifications and clients' requirements rather than the outcome of the rational decision-making process. One participant noted:

> *"You cannot expect all employees to know and understand the IBS concept. Even, sometimes we need specialised installer to do the joining works…" (A/CR/5)*

Meaning that in Project A, IBS decision-making was based upon a careful consideration of the possible project consequences, despite inadequate IBS knowledge or project information. Although the participants of Project A would prefer to maximise most project benefits from IBS technology adoption, it was not feasible to do so due to the limited capacity of the human mind or the decision-makers. Therefore learning was perceived as the most relevant aspect of the bounded rationality factor, by the participants of Project A. One participant verified:

> *"IBS logistic team has to include skilled-workers, while the project manager has to synchronise the workers training programs and timing..." (A/DR/32)*

Through the project operations, it could require the members of Project A to explore IBS technology and discover the suitability of this technology in building projects, as one remarked:

> *"May be they are good in terms of productivity, but in terms of the overall project performance, all must be improved…" (A/CE/2)*

Through project development, Project A's members perceived that they would able to identify IBS features that could not meet the evolving project demand of IBS technology adoption. One participant clarified:

> *"In fact when safety elements are required besides other major specifications, IBS is often left exposed and not even highlighted…" (A/DA/7)*

Thus, it was important to justify IBS technology and its operating activities in IBS decision-making, as many aspects that affected IBS technology adoption also required diverse areas for justification. Indeed, the aspect of justification was perceived as the second most important aspect of bounded rationality factors. One participant explained:

> *"Where such decisions affect project costs, standards, programme or content, we have to ensure adequate justification is provided, and approval obtained from us, or investment decision maker…" (A/CL/53)*

When deciding on IBS technology adoption, it was discovered that choosing between available IBS types was critical in Project A. Therefore the aspect of choice was perceived as the third relevant aspect of bounded rationality factors. Project A's participants noticed that a more subtle concern was whether IBS decision-makers would have enough confidence to make major choices with less IBS information and analysis to support their IBS decisions. Two participants verified:

> *"…here is the choice is between a manual or automated system for design and simulation…" (A/DA/7)*

> *"The matter of fact is that there are always choices of different IBS systems that can be considered in any construction…" (A/PM/34)*

Consequently, the role of mental process or cognition was also relevant in the IBS decision-making of project A, since the outcome of IBS decisions was based on a group consensus as a result of taking in perceptual information from the contextual and structural conditions, with analysis on the meaning of that information. Note these comments:

> *"So, our knowledge and experience also made us more careful in selecting materials and components of the right type and quality…" (A/CR/5)*

> *"… we use our knowledge of construction methods and costs to advise the owner on the most economical way of achieving his requirements…" (A/QS/29)*

Because the aspect of cognition was perceived as the least relevant factor in IBS decision-making, by the participants of Project A, they were more concerned about knowledge and understanding of IBS technology when deciding on its adoption, than on their way of thinking.

ii) Experience

Another factor which demonstrated its influences on IBS decision-making in Project A was made up of the decision-makers' set of past experiences including the success- and failure experience concerning project developments in the construction industry, specifically with IBS technology adoption in building projects. As a further progress of IBS decision-making, the participants of Project A acknowledged the emergence of what was referred to as, project and technology experience, deriving from the portfolio of IBS- and non-IBS-technology project developments. One participant noted:

> *"…experience is very important not only for construction activities but also for material selection…" (A/CR/5)*

The participants of Project A perceived this condition was based on the idea that major or critical events in a building project experienced by a project member would become a reference in IBS decision-making. The major and increasingly popular basis of IBS decision-making as perceived by Project A's participants was derived from the success experience of IBS projects. One participant pointed out:

> *"…you can do it starts from some projects, from big to medium size, make them a success first, equip them with all the necessary technologies, the tool and also the expertise, right…" (A/CE/2)*

The success-experience aspect which was perceived as the most relevant factor in IBS decision-making, consists of several elements such as i) there were numerous IBS-mandated or directed projects and as a result, it was easier to predict and refer experiences gained in these projects as the basis of IBS decision-making, ii) there were other IBS projects in which project members could attempt to fit in, adapt and improve based on the development or success of IBS technology adoption, iii) inner directedness where project members adapt and improve IBS technology adoption in a current or an ongoing building project. One participant identified:

> *"…they have to share more success stories for contractors and consultants to believe and trust IBS..." (A/CR/5)*

The participants of Project A perceived that although it was a relatively simplistic consideration of success experience in IBS decision-making, decision-makers were subsequently subjected to a degree of judgment due to the diversity of IBS projects. The following comments reflected this situation.

> *"... If we look at the success of some IBS projects, this situation has increased the popularity of IBS …" (A/DA/7)*

As an addition to the impact of successful experience in building projects and IBS technology development on IBS decision-making, a number of participants also considered the aspect of failure experience. One participant claimed:

> *"…the risk of failure and the impact of IBS use on project costs and the failure of the industry to address these issues in project contracts…" (A/DA/7)*

Therefore, the justification that underpinned the influence of failure experience on IBS decision-making was that a decision-maker had passed through a series of project-development stages, each of which assessed and evaluated, and therefore influenced, the attitude, motivation and learning of that decision-maker, through their perception of failure experiences. One participant acknowledged:

> *"…we know the technology, even a lot of them are imported from overseas but the concern is the failure of technology transfer in Malaysia …" (A/CR/5)*

However, Project A's members had various success- and failure experiences and therefore moved from a project-driven or survivors stage towards a directed project or achievers stage in IBS projects, which impacted on IBS decision-making.

iii) Attitude

The next relevant aspect of behavioural factors as perceived by the participants of Project A, was the feature of attitude, which has influenced the decision-making of IBS technology adoption, as one remarked:

> *"Their attitudes have been changing and are becoming important in the support of IBS use…" (A/DA/7)*

As previously analysed, once a participant in Project A had responded to their project-based experience, they went through a process of learning on IBS technology adoption. If the experience with IBS technology was generally positive, the likelihood of adoption was obviously increased. If, however, the experience was largely negative, the negative attitude or belief could be developed, or emerged both from project experiences and IBS technology development. One participant commented:

> *"The usage of IBS in our construction industry has shown some positive reactions among the industrial players...*" (*A/CL/53)*

In Project A, specifically, the participants highly believed that the positive attitude of project members towards IBS technology adoption had influenced IBS decision-making. Besides this, in Project A, a number of attitudinal features in IBS decision-making was perceived as important. One participant specifically pointed out:

> "*What is important here is the combination of people's attitudes and mentalities…" (*A/DR/32)

For instance, people's attitudes differ significantly according to the extent they were involved in IBS projects. This attitude was due to the level of confident or trust towards IBS technology adoption based on experience in various IBS and non-IBS projects. These basic attitudes have, in turn, influenced or shaped behaviour particularly in IBS decision-making. One participant clarified:

> *"Whereas, construction community is also thinking of positive psychological benefit, I mean not only solely about financial returns…" (A/DA/7)*

Next, against this situation, a number of participants in Project A also believed that those who typically experienced dissatisfaction or frustrations in IBS technology adoption could develop a negative attitude. Note these comments:

> *"…but they don't see about their future investment in IBS. Meaning that, there are many negative perceptions on IBS from the people…" (A/CT/31)*
> *"…there is a strong indication that many in the industry are reluctant to switch to the IBS method of construction..." (A/CR/5)*

Further, if these negative attitudes among decision-makers appear, this would make them reluctant to adopt IBS technology as their confidence in the technology had reduced.

iv) People Awareness

Beside other results of the influencing factors on IBS decision-making, it was also important to consider the impact of people-awareness aspects. As perceived by the members of Project A, people's awareness of IBS technology adoption is also related to their values, support, culture, and personality. The participants of Project A have identified a range of people-awareness issues which impacted upon IBS decision-making. One participant strongly advocated:

> *"What I can say is that some people are mindful that IBS is not supposed to be a system which can provide cost reduction compared with traditional in-situ construction…" (A/CR/5)*

The process of interpreting information concerning the external situation in IBS decision-making was greatly influenced by the response of others. The following quotes reflect the general consensus of most participants on this matter:

> *"Usually, IBS is also based on the perception of people especially about cost and quality…" (A/MR/30)*

> *"Meaning that, there are many negative responses on IBS from the people…" (A/CT/31)*

The first aspect of people awareness in IBS technology adoption related to their values. The nature of personal values was intrinsic in the decision-making of IBS technology adoption. The aspect of values could be extended to the support of IBS technology adoption as it was noticed in Project A that, to a certain extent, project members were expected to support IBS technology adoption based on gradual project change, as reflected in the changing of their views towards IBS projects and to what extent IBS technology adoption should uphold the projects goals. Two participants commented:

> *"It is very unlikely that we can achieve both scientific strength and superior skills at the same time if other things in the construction industry are not supporting each other towards IBS…" (A/CR/5)*

Additionally, the culture in the project and society itself proved to be an influence on IBS decision-making in Project A, based on a culture of shared beliefs about how project activities were, and should be done, which gave Project A its particular identity. Two participants noted:

> *"…what constitutes a risk averse culture as we know that some projects to certain extend have this kind of culture…" (A/CL/53)*
>
> *"…moving on to IBS, no matter there are a lot of benefits, there will be a number of problems too because these contractors have to switch from their norms to another new thing ..." (A/DR/32)*

Just as IBS building projects have their own distinctive culture, individuals as decision-makers also have distinctive personalities. A number of participants in Project A perceived that the aspect of personality was the least relevant factor impacting on IBS decision-making. IBS decision-making in Project A was mainly based on group decision-making and the personality of a decision-maker played an insignificant role in this situation.

d) Summary of Analysis on Project A

In Project A, the influencing factors on IBS decision-making are related to a number of core factors namely structural, contextual and behavioural, but their priority aspects are more associated with the IBS technology adoption in building projects within various phases of project implementation. Structural theme was one of the core factors which was highly perceived by the respondents as the major theme that impacted on IBS decision-making, followed by the contextual and behavioural themes. The results of the analysis are presented in Table 5.7 below.

Table 5.7 Impact of Structural, Contextual and Behavioural Factors on IBS Decision-making in Project A

CORE FACTORS/ THEMES: *(As perceived by the participants)*	**FACTORS AND REFERENCES:**		**PRIORITY ASPECTS AND REFERENCES**									
1. STRUCTURAL (863 references)	Procurement Setup	209	Costs	96	Clients	59	Resources	24	Supply chain	6		
	Management Approach	189	Planning	59	Process	56	Strategy	23	Goals	22	Leadership	8

	Project Condition	163	Development	54	Operation	45	Information	28	Risk	26		
	Decision-making Style	64	Group	32	Nature	19	Individual	13				
	Communication Process	26	Formal	14	Informal	3						
2.CONTEXTUAL (720 references)	Economic Conditions	249	Business	70	Demand	28	Opportunity	26	Competition	13	Uncertainty	12
	Government Involvement	159	Promotion	37	Policy	22	Requirement	18	Rules	12		
	Technology Development	135	Productivity	33	Quality	31	Innovation	17	Creativity	9		
	Sustainability Feature	108	Environment	49	Efficient	26	Waste	11	Trends	8		
	Stakeholders Participation	43	Opinion	32	Partnership	6						
3.BEHAVIOURAL (623 references)	Bounded Rationality	187	Learning	86	Justification	34	Choice	27	Cognition	26		
	Experience	165	Success experience	81	Failure experience	60						
	Attitude	135	Positive attitude	74	Negative attitude	29						
	People Awareness	119	Values	32	Support	21	Culture	20	Personality	11		

The content analysis results in Table 5.7 show the overall standing of IBS decision-making factors based on leveraging the specific factors of the themes and their priority aspects obtained from the nine supply-chain members of Project A. Results from the study of Project A revealed that the impacts of structural factors on IBS decision-making, as perceived by the supply-chain members of Project A from an intra-project perspective, were very relevant. Taking this condition into account, the findings indicated that Project A's members had stronger perceptions of the influence of procurement setup and management approach aspects than of other project-related factors. There is an indication, therefore, of most participants agreeing that IBS decision-making is highly dependent on the project procurement setup. Members of Project A perceived that project-condition aspects played a less important role on their decision to adopt IBS technology compared to procurement aspects because they were interested in further focusing their acquaintance on project-delivery issues, in order to ensure the efficiency of project operations.

Whilst structural factors appeared to influence IBS decision-making in Project A, contextual factors were perceived to be generally relevant and these factors were specifically related to the aspects of economic conditions and government involvement. As the project members of Project A were mostly involved in IBS technology adoptions, the issue of technology development did not materialise as very relevant in Project A, possibly because many were already aware that IBS technology development could expand IBS project opportunities in the construction industry in the future. In this study, the participants of Project A indicated that they had to really consider economic conditions. This finding therefore appeared to reflect upon the nature of the construction industry that emphasises the economic influences in deciding on IBS technology adoption. This finding on contextual factors was also consistent with the results obtained in the structural factors with the relevancy of procurement setup in IBS decision-making.

The findings obtained from the behavioural factors provided some evidence that human-related factors appear to influence IBS decision-making in the construction industry. Based on the perception of Project A members, it is identified that IBS decision-making was highly associated with bounded rationality aspects. These factors were learning, justification, choice and cognition aspects. The semi-structured face-to-face interviews revealed, that the limitation of decision-making abilities related to those aspects, was perceived to play an important role in people's decisions to select a construction method in a building project, whereas their IBS decision-making seemed to be influenced by their experience in IBS technology and other related building projects, particularly the success experience.

5.4.3.2 Case 2: Project B

As a non-performing IBS project, the decision-making of IBS technology adoption in Project B was depicted as typical of other construction projects. In Project B, nine participants, as the supply-chain members of an IBS project, were selected to explore their perception of various factors that impact on IBS decision-making. The analysis of IBS decision-making based on the perceptions of Project B's participants will be made according to the hierarchy of IBS themes, factors and aspects as follows:

a) Structural Factors

The results of Project B have demonstrated that as perceived by the participants, the decision-making of IBS technology adoption in Project B was initiated by activities and operations responsive to structural factors that were forces reflecting orientation towards project aspects. Note the following observations:

> *"The local authorities are generally unwilling to make changes in local building regulations as they need a lot of time, works and cost to establish the*

> *legislative, structural planning and economic conditions for industrial development…" (B/DR/38)*

> *"I often spend as much or more time on planning, management and other economic or social problems as on the traditional engineering design and analysis problems…" (B/PM/41)*

Based on this situation, it is noted that the decision-making of IBS technology adoption in Project A came about as a result of the influence of organisational- and project-related elements. Further analysis will be presented as follows:

i) Project Condition

The most important structural factor perceived by Project B's participants as very relevant to IBS decision-making, was the project condition. In project B in particular, it was discovered that project aspects were related to the goal of providing the best value for the client. The participants believed that every operation of the IBS project was different and had at least a unique specification-, time- and budget constraint. As these participants highlighted:

> *"…particularly for a large and complex project. These problems must be resolved quickly…" (B/CR/40)*

> *"…on a major project significantly affecting the budget, reputation or operation…" (B/CL/52)*

Therefore, project factors were perceived as a main factor impacting IBS decision-making based on the perception of Project A's participants. It was a particular challenge to Project B as they also perceived that project operation was relevant in IBS decision-making. For example:

> *"...project team members, set the goals and budget and are committed to the building's operation…" (B/CT/39)*
> *"…operation and maintenance are a part of the project life cycle..." (B/PM/41)*

The participants highlighted that it was vital to understand the operation of an IBS project in terms of activity flow, task coordination and procedures, to ensure not only the establishment of project capabilities, but also the much more difficult task of sustaining project operations when adopting IBS technology. Therefore, faced with the need for change, Project B's participants suggested the consideration of project development was necessary in IBS decision-making, as portrayed by one participant:

> *"Even both the design and construction of a project must satisfy the conditions unusual to a specific site…" (B/PM/41)*

In the light of project condition aspects, the participants perceived that there was a pressure on Project B to specifically concentrate on the project development process. This pressure was to ensure IBS technology adoption in Project B could match the changing project conditions. One participant acknowledged:

> *"…we also have our standard operating procedure in project development including decision-making…" (B/CT/39)*

Therefore, perceived as another relevant project factor impacting IBS decision-making in Project B, project information was also essential to evaluate the alternatives of project activities, technology and resources. As these participants acknowledged:

> *"Discussion should not only aim to provide information, but further to eliminate doubts ..." (B/PM/41)*

> *"…the information necessary to control and manage these risks…" (B/CL/52)*

Although building project development was recognised as a high-risk activity, Project B's members perceived that the risks aspect was a less relevant factor that could impact IBS decision-making. As one participant commented:

> *"Nevertheless, we must integrate risk assessment with IBS decision-making and they are commonly used for project coordination…" (B/DR/38)*

Even, given a good and consistent project condition, there were various changes that were recognised in Project B. These included the risks associated with the possibilities of changes in Project B, due to unforeseen circumstances.

ii) Management Approach

Management approach was perceived as the next relevant aspect which impacted IBS decision-making in Project B. The implications of this could be seen to be far-reaching, including the way in which management approach should be looked at from a project perspective rather than from the organisational perspective only. As one participant highlighted:

> *"…because factors like knowledge, perception, experience, entrepreneurial skill, scientific training and management training play an important role too." (B/DA/36)*

Therefore, the aspect of management approach was perceived by Project B's members to be the most influencing in IBS decision-making as management approach was concerned with establishing the ways in which the early inception works could transform the project to its present position, with complete implementation and performance, as evidenced by the following:

> *"…we have to study it as a project before any implementation starting from the design up to fabrication and installation…" (B/CE/35)*

The participants also believed that by gaining an understanding of how the project arrived at its present performance, the members of Project B could further develop some insights to help them in deciding on IBS technology adoption. As acknowledged by one participant:

> *"Throughout the design and planning process, we have to be based on standardised project performance guide…" (B/CT/39)*

Consequently, the planning aspect of the project was perceived as a relevant management factor that impacted IBS decision-making. A number of Project B's members noted that, to be effective in terms of the way an IBS project organises its activities careful attention was given to the coordination of planning activities, including operational planning and strategic planning. Those elements of planning, in consequence also influenced IBS decision-making in Project B. One profound observation captured this idea:

> *"We are just planning and coordinating all activities to achieve their goals…" (B/PM/41)*

> *"…we need to have knowledge of the contractor's requirements such as which planning and building regulation..." (B/DA/36)*

The aspect of leadership which was perceived as less relevant in Project B had also impacted IBS decision-making. This is because the participants of Project B perceived that when the IBS project had less support from the top management, it was also difficult to acquire the resources that were needed and the project performance was not successfully achieved. As these participants stated:

> *"…then maintains the visible and sustained senior management commitment to its delivery…" (B/CL/52)*

> *"Decisions by the top management of the owner will also influence the project to acquire new building technology..." (B/CR/40)*

Thus, also perceived as less relevant, the aspect of project strategy was still a necessary consideration in IBS decision-making. A number of participants in Project B believed that the implementation activities of IBS projects was related to the specific IBS strategies in the projects and this has proven to be the most difficult in IBS technology adoption but paradoxically received less attention. For example:

> *"…the industry in term of capacity and capability, strategy, process and mechanism in implementing IBS…" (B/QS/37)*

> *"…adopting a new technology like IBS is also crucial for new knowledge strategy and future market investment..." (B/CL/52)*

Although it was perceived as a less relevant aspect in IBS decision-making, as perceived by a number of Project B's participants, project goals was essential as they were concerned with the direction in which the IBS project was heading. As acknowledged by one participant:

> *"…building owners establish measurable project goals, assess progress toward meeting those goals..." (B/CT/39)*

Although the participants in Project B found that the management process had impacted IBS decision-making, the way in which they approached the aspects of the management process were very different.

iii) Procurement Setup

As perceived by the members of Project B, the aspect of procurement setup was another influencing factor in IBS decision-making. Having identified the various project- and management factors which have impacted on IBS decision-making, the participants of Project B also believed that they were in the position to examine the procurement process of IBS projects as stated in the following statements:

> *"IBS procurement is quite straight forward as we have to follow the policy of competitive tendering for government procurement…" (B/CL/52)*

> *"IBS procurement is very much influencing on its decision…" (B/CR/40)*

The participants of Project B also believed that identifying and considering the cost aspect was a relatively straightforward exercise, and placed it as the most relevant procurement aspect. The rationale of cost consideration was due to costs changes based on the level of project complexity, besides the anticipation of high project performance. Therefore, cost aspect was relevant in the procurement procedures of IBS projects. Project B's participants also emphasised that cost consideration could provide a significant input to the IBS decision. For example:

> *"…rising material costs and fuel price certainly make a case for the added cost of IBS…" (B/DA/36)*

> *"IBS risks are very much related to cost issues…" (B/CT/39)*

The next relevant perceived aspect, project clients, was seen by Project B's participants as another important consideration in IBS decision-making due to the fundamental need to understand the client's requirements and to satisfy them, as evidenced by the following examples:

> *"Their duties require specific skills-designing, engineering, managing, supervising and communicating with clients and contractors…" (B/DA/36)*

> *"This is not simply about the effort put into those companies who become clients..." (B/CT/39)*

Moreover, it was important to consider the project resources in the IBS decision-making of Project B because the procurement procedures of IBS projects must pay attention to the availability and constraints of resources in the project. One participant noted that:

> *"…construction planning is a process of identifying activities and resources required…" (B/PM/41)*

Additionally, the influence of the IBS supply chain, perceived as the least relevant in IBS decision-making, could be considered in order to fit the specific needs of the project, to achieve construction efficiency and to satisfy particular IBS quality criteria or performance. One participant recognised:

> *"… endless supply of building ready-made components by multiple vendors and suppliers…" (B/DR/38)*

The majority of Project B's members commented that it was difficult to quantify the aspects of procurement setup in IBS projects but attention and consideration must be given to the important and essential aspects in the delivery of IBS projects.

iv) Communication Process

It was recognised that a degree of interaction was involved in arriving at a project decision, like IBS technology adoption in Project B. The participants of Project B perceived that the aspect of communication process has to be tailored to fit the needs of each of the project members in providing information, feedback and messages related to the project development. As these participants highlighted:

> *"I can put the interaction as the major focus in any decisions…" (B/CR/40)*

> *"…we must be able to communicate our unique vision well…" (B/DA/36)*

Therefore, the aspect of communication process was perceived by Project B as also relevant in IBS decision-making. Specifically, between formal and informal communication, the participants of Project B believed that formal communication was highly relevant, because communication could be made in the most effective way compared to the informal communication of the project when deciding on IBS technology adoption. As mentioned by these participants:

> *"...most of the communications have to be formal, especially in all sorts of project related decisions..." (B/PM/41)*

> *"I have to put our communications formal, when we deal with them…" (B/CT/39)*

According to the participants of Project B, formal communication was important based on the degree of control that was required, in terms of how the message was delivered and interpreted, for the objective of efficient project implementation. For example:

> *"I suppose that both formal and informal communications are important…" (B/DR/38)*

> *"…yes, and our personal communications are fair enough as well as the messages are communicated…" (B/CT/39)*

However, informal communication was used and adopted in the project due to its ability to deliver personal messages in a more effective way.

v) Decision-making Style

Perceived as the least relevant aspect of the structural factors, the decision-making style in a project was seen by Project B's participants as less important in terms of its influence when deciding on IBS technology adoption. However, one participant noted that:

> *"...at the same time I have to realise how the project has to spend money with my decision style…" (B/CL/52)*

In project B, group decision-making was widely used and it was perceived as a standard practice based on the participation of wider-project members in the generation of strategic options related to IBS decision-making, which should go beyond the normal courses of action in building projects. These participants commented that:

> *"…the group consensus. Each one has its needs for the system..." (B/MR/3)*

> *"We have the committee here that decides whether or not the proposed investment in a project should be made…" (B/CL/52)*

Nevertheless, there was still a certain degree of influence about individual decision-making and the role of decision nature when urgent decision-making regarding IBS technology adoption was required, as noted by one participant:

> *"I have to make up on some quick decisions…." (B/CL/52)*

The results on decision-making style have made clear that although it was not highly relevant in the IBS decision-making of Project B, its functions and contributions were beneficial and supportive in building-project implementation.

b) Contextual Factors

In analysing the aspect of contextual theme, perceived by the participants of Project B as the second influencing factor after structural theme, its dynamics or changes were seen to ultimately exert a relatively strong influence on IBS decision-making. According to them, there were several reasons for this, the two most significant of which were, a strong relationship between the construction industry and economic growth, and the absolute size of population as the boundary condition determining potential building demand. Note these related observations:

> *"…there are numerous aspects to consider. First IBS should be based on the overall size of the industry, number of firms involve in the project and IBS contribution to the economy. Put aside the profit…" (B/CL/52)*

As perceived by the participants of Project B, a detailed understanding and consideration of the composition and trends of the contextual factors was therefore important in the decision-making of IBS technology adoption. The following analysis on contextual factors as perceived by Project B's participants will be based on the relevancy of these factors.

i) Economic Conditions

Against the background of contextual theme, it is clear that economic factors, their analysis and forecasting were perceived by the participants of Project B as capable of making a major contribution towards the decision-making of IBS technology adoption. As perceived as the most relevant factor in the IBS decision-making of Project B, the consideration of economic condition particularly on business dynamics was the starting point of any effective project strategy. It was articulated in Project B that effective project strategies were based on a detailed understanding of the project's capacity, besides considerations on a full knowledge and appreciation of business dynamics. Therefore economic forces and changes were likely to have impact on IBS decision-making. One participants stated:

> *"…construction is cost a factual process designed to give a reliable estimation or prediction of its financial cost..." (B/QS/29)*

Consequently, market demand was perceived as the second relevant aspect of economic factors that impacted on IBS decision-making in Project B. In particular, the aspects of market demand in terms of market characteristics, demand level and supply capacity must be understood in IBS decision-making, as stated in the following statements:

> *"While housing demand is increasing gradually, housing supply is following the trend at the same time..." (B/DR/38)*

> *"…initiation of such projects is also affected by the situation of the economy, long range demand forecasting is the most important factor." (B/PM/41)*

There was another aspect of industry opportunity that emerged in the economic factors, as a relevant aspect which has impacted on IBS decision-making. As perceived by the participants of Project B, the industry perspective of competition was also acknowledged as the starting point to satisfy clients' requirements based on the effort to recognise how actual and potential clients viewed IBS technology being offered, based on these responses:

> *"We have to plan a larger project scheme in order to keep the costs and price of houses competitive for economic viability…" (B/DR/38)*
>
> *"…the contract price will be higher even if competitive bidding is used in reaching a contractual agreement…" (B/PM/41)*

Additionally, the aspect of uncertainty was perceived as another consideration, by the members of Project B in IBS decision-making. The aspect of uncertainty was important to ensure that project members could take control in IBS building projects despite various doubts about the future of IBS technology and the construction industry. A variety of comments were:

> *"…economic conditions of the past few years have created uncertainty with high inflation, interest rates, currency and so on." (B/QS/37)*
>
> *"Site conditions, particularly subsurface conditions which always present some degree of uncertainty..." (B/CR/40)*

The aspect of business opportunity was perceived as less relevant in IBS decision-making. However, detailed assessment of the feasibility of IBS technology adoption was needed if the building project was either to capitalise on the opportunity in the building industry or fulfil the project specifications. One participant noted:

> *"If all these have clearer direction, then I recon, the possibility of industry players to use IBS might be higher…" (B/DA/36)*

Overall, the members of Project B perceived that various economic conditions had several possible impacts on IBS decision-making, in different ways.

ii) Technology Development

As perceived as the second important aspect of contextual factors, technology development was perceived by the Project B's members as another important consideration in IBS decision-making. From the viewpoint of IBS technology adoption in Project B, technology factors were crucial to ensure the success or performance of an IBS project, as clarified by one participant:

> *"...building projects act as system integrators and catalyst for transforming new technologies like IBS into marketable products…" (B/DR/38)*

In particular, the quality aspect of IBS technology was perceived by Project B's participants as highly relevant in IBS decision-making because the implications of quality aspect could be seen, and were reflected in, the final products of building projects, particularly in terms of project performance. One participant explained:

> *"…construction projects have utilised IBS components especially to meet the requirement of time constraint and with high accuracy and quality…" (B/DR/38)*

This situation was also related to the achievement of technology productivity, as the second relevant aspect of technology factors which has several impacts on IBS decision-making. The participants of Project B perceived that careful technology monitoring, in terms of productivity and quality aspects, was vital in order to ensure that project- and industry requirements could be fulfilled along with enhanced project performance. Another participant claimed:

> *"IBS is indeed the biggest growth in construction productivity, however, will have to compete face to face with the traditional method..." (B/DA/36)*

However, the aspects of innovation and creativity regarding IBS technology were perceived as less relevant in the IBS decision-making of Project B, as one remarked:

> *"But still IBS requires continuous improvement of processes involving the entire workforce…" (B/PM/41)*

Moreover, the participants of Project B perceived that the decision-making of IBS technology adoption should lead to more market-oriented and industry-oriented approach, rather than a product-oriented approach, and to a generally greater awareness of the negative aspects of IBS technology adoption.

iii) Government Involvement

As perceived by the members of Project B, IBS technology adoption is related to the government policy, thus, IBS decision-making was also affected in a variety of ways through the government's involvement. The participants of Project B perceived that with regard to the government involvement, even at the early stage of IBS decision-making, Project B had to recognise and analyse the ways of government involvement that could affect building project developments with IBS technology adoption, in a positive and negative manner. One participant pointed out:

> *"No doubt that the presence of government projects generates the development of IBS in Malaysia…"* (B/CT/39)

As perceived as the most important aspect of government involvement, Project B's participants perceived that the government's efforts in promoting IBS technology adoption have to be improved in order to be more effective and to reach a wider scope of construction entities. Therefore, the aspect of government promotion has its impacts on IBS decision-making. One participant claimed:

> *"…this is still lacking in promoting IBS to the consultants…"* (B/PM/41)

Moreover, the members of Project B also believed that the promotion aspects of IBS have extended beyond IBS policy itself, with concerns about the mechanisms of communication system throughout the construction industry, embracing the community as a whole, funding bodies, construction stakeholders, the media and the IBS supply chains, as clarified by two participants:

> *"The incentives and promotion offered by statutory authorities and government policies are desirable through planning approval process…"* (B/DR/38)

> *"Actually our government is doing pretty well in promoting IBS..."* (B/PM/41)

In terms of rules and requirements pertaining to IBS technology adoption, they were perceived as relevant to IBS decision-making in Project B. The participants acknowledged that it was important for decision-makers to be aware, not only ofthe current legislative framework in the construction industry, but also of the ways in which it is likely to develop, as the enforcement of construction rules might possibly influence IBS technology adoption. Moreover, it was also vital to have clear rules and regulations on IBS technology adoption. Note these statements:

> *"I think it's interesting to note that the industry requires standard rule in IBS technology for implementation…" (B/CT/39)*

> *"...when we bring to the Fire Department, they said that they cannot approve them based on the requirements of bylaws…" (B/MR/3)*

At a broader level, IBS policy established by the government was perceived as the least influencing factor on IBS decision-making. However, one participant noted:

> *"There is a chance to re-evaluate the demand and impact for prefabrication or IBS post war is significant due to changes… of institutional environment been promoted the prefabrication or IBS to be taken up especially as policy option…" (B/DR/38)*

Regardless of the development of IBS policy in the construction industry, a number of Project B's members highlighted that there have to be certain mechanisms to handle the way in which IBS projects deal with IBS policy.

iv) Stakeholders Participation

Undoubtedly, one of the major developments in recent years is the understanding of the ways in which the stakeholders of the construction industry have influenced IBS decision-making. This issue was also acknowledged by the participants of Project B. A number of participants in Project B acknowledged the role of stakeholders in influencing IBS decision-making, based on their interests, intensity, power and relationship. Note these observations:

> *"…solutions are not without difficulty and should be adopted only on the merit of the stakeholders…" (B/PM/41)*

> *"…when we have to also consider the fast consolidation among stakeholders these days actually to improve human interaction…" (B/DA/36)*

Consequently, it was acknowledged by the members of Project B that partnering in IBS technology adoption could lead to higher interaction, which each alliance used to gain information and build the support. As acknowledged by one participant:

> *"Another thing, adopting a new technology like IBS in a collaboration or partnership is also crucial for new knowledge strategy …" (B/CL/52)*

Moreover, stakeholders' opinion was perceived by Project B as a supporting aspect in IBS decision-making as they have very different expectations and these need to be addressed. Thus, stakeholders' views and outlook need to be evaluated so that any potentials and shortcomings in IBS technology adoption could be inputs for IBS decision-making. As one participant observed:

> *"...their opinions are actually part of the industry contribution too…" (B/QS/37)*

In conclusion, the participants of Project B recognised that partnership development in IBS technology adoption was an important aspect and perceived as relevant in IBS decision-making.

v) Sustainability Feature

The least relevant aspect of the contextual factor is that of the sustainability feature. The participants of Project B perceived that the consideration of sustainability aspects did not actually influence IBS decision-making, but IBS technology adoption should be seen as a path towards greater sustainability in that the development of new IBS projects or concepts could have positive effects on the well-being of human nature, as evidenced by the following:

> *"The most economical, safest and sustainable elements are structures of wood, steel and glass…" (B/DA/36)*

Specifically, the participants of Project B acknowledged that the aspect of efficiency brought by IBS technology adoption was the most relevant sustainability factor in IBS decision-making. In terms of project improvement, it could be achieved in various ways, but with IBS technology adoption involving the application of industry standards, this has enabled changes in building project operations in a timely and efficient manner. For example:

> *"…each specialty has made important advances in developing new techniques and tools for efficient implementation of building projects." (B/CR/40)*

Hence, the aspect of environment protection was considered as important by the majority of Project B's participants, due to an increased awareness of environmental management, improvements in diversity issues and other environmental impacts, as perceived as another relevant aspect in the sustainability feature. As one participant highlighted:

> *"…there are so many things that we can save like labour, materials and become environmental friendly…" (B/MR/3)*

It should be noted that from the environmental aspect, the element of waste management was another influence on IBS decision-making, as perceived as another relevant sustainability factor. The waste aspect was perceived by the participants in Project B as a basis which has influenced decision-makers to become more sensitive to the changing needs and requirements of the environment. As these participants remarked:

> *"Moreover, during construction, reductions in waste on site can be achieved." (B/QS/37)*

> *"We can benefit from the improvement in quality and reduction of waste everywhere." (B/PM/41)*

Lastly, a number of participants in Project B also perceived IBS technology adoption as a trend. This aspect was acknowledged as relevant to IBS decision-making. As one participant highlighted:

> *"…support the move of sustainability… what I notice the trend is where people are talking about environmental and sustainability in buildings." (B/QS/37)*

Finally, although attention in recent years has switched to lifestyle trend as an attracting element in adopting a new technology, from the sustainability outlook it was perceived that IBS technology adoption could not represent as an attractive part of the building market or construction industry.

c) Behavioural Factors

The least relevant factors that influence IBS decision-making were based on a series of behavioural factors including attitude, bounded rationality, experience and people's awareness, as perceived by the participants of Project B. It was acknowledged that the decision-making of IBS technology adoption was also influenced by human-related factors which could be explored from the perspective of behavioural aspects. As highlighted by one participant:

> *"Some behaviour concepts are helpful in overcoming communication difficulties that block cooperation and coordination..." (B/CR/40)*

Specifically, the participants noticed that the human aspects of IBS decision-making should be given attention. Therefore, in order to fully understand IBS decision-making and to understand the process involved, it was necessary to have an understanding of the decision-maker as a person. One participant captured this idea:

> *"…when we have to also consider the fast consolidation among stakeholders these days actually improve human interaction issues because humans create the problems that other humans fix." (B/DA/36)*

The challenge of changing- or different behaviour among decision-makers involved with IBS technology adoption, in reaching an effective solution or decision, was highlighted by the participants of Project B based on different background, identity, exposures and project experience. For example:

> *"…the method is really fast and easy, but it turns simple tasks become difficult due to the lack of exposure." (B/CE/35)*

Further analysis of the influence of behavioural factors on IBS decision-makers, as perceived by the participants of Project B, will be explained according to the relevancy of those aspects.

i) Experience

The aspects of experience were perceived by the participants of Project B as the most relevant behavioural factor in the decision-making of IBS technology adoption. In the case of organisational-, project- and industry experience, differences were exhibited in the involvement of Project B's members pertaining to IBS technology adoptions. For example:

> *"…having 20 years' experience of the conventional system, and we want to come in with new technology…. researchers to study on this technology by giving them some exposure and experience using IBS products..." (B/CE/35)*

Despite these complexities, it was vital that the decision-makers of IBS technology adoption, as perceived by the participants in Project B, could understand the dynamics of IBS technology, project development and industry knowledge through their experience in these areas, since the costs and competitive implications of overlooking those related issues were likely to be significant. As noted by one participant:

> *"All their knowledge and experience must be considered in our decision-making." (B/QS/37).*

It was acknowledged that the participants of Project B perceived the success experience of IBS projects as the most influencing factor on IBS decision-making. Based on this success experience, stimuli in the form of the project exposure, IBS technology development and the interaction with the decision-makers' characteristics could generate a basis of reference in IBS decision-making. Generally, the success experience of IBS or non-IBS projects could influence IBS decision-making in a positive mode. For example:

> *"...the success and failure of construction projects must also be dealt with effectively ..." (B/PM/41)*

Despite this situation, the consideration of the failure experience was also necessary in IBS decision-making in order to make further evaluation, improvement and development on IBS technology adoption, as perceived by one participant:

> *"...to make sure that we reduce the risk of failure, but also from a quality of project standpoint..." (B/CT/39)*

ii) Bounded Rationality

As perceived by the participants of Project B, the decision-making of IBS technology was dependent upon the information available pertaining to IBS technology adoption in building projects. In most IBS decisions, it was difficult to determine what project information was relevant and its value for reaching a rational decision, as evidenced by the following:

> *"Usually we tend to use values and judgment but the important stage is when your decision-making skill whether rational or intuitive, is put to test." (B/DA/36)*

Therefore, the factor of bounded rationality was an important consideration in IBS decision-making due to certain limitations and boundaries in the capacity of information and the capabilities of human thinking. As acknowledged by one participant:

> *"Honestly, there is going to be a limit to what people can do with IBS decision because there are so many infrastructures that goes into building a project." (B/DR/38)*

Besides this, the participants also highlighted the importance of the learning aspect as perceived as the most relevant aspect in bounded rationality factors, which involved more than simply taking in information, when deciding on IBS technology adoption. It was acknowledged in Project B that effective learning about IBS technology and the construction industry was about a continuous process that pervaded IBS decision-making. As these participants remarked:

> *"…that was really to do with kind of learning experience in a way and maybe improving from time to time and learning all those sorts of things. It is the same with IBS." (B/DA/36)*

> *"Regularly, different project members have different cultures or modes of operation. From here, I learn a lot and they become my new learning experience too." (B/CR/40)*

Perceived as another relevant factor, the aspect of justification was seen as an essential consideration in IBS decision-making in Project B, due to the ability of decision-makers to combine information from multiple sources in making justifications pertaining to IBS technology adoption. The participants of Project B perceived that some IBS decisions involved interaction among the project members in that one member was dependent upon other members for information to make better and more accurate justifications before they could proceed with the decisions.

> *"Given that construction stakeholders are a part of this industry; their opinions are actually a part of the industry contribution too. Just like what I said, whether they are influencing or not, we have the justifications for our decisions." (B/QS/37)*

> *"I understand the aspiration of both the project owner and the member and the project. I think everybody has their own justifications throughout the project." (B/CT/39)*

Consequently, in Project B, the learning process and the justification of IBS- related information could be utilised by decision-makers to assist them in making the final choice of IBS-related matters. The aspect of choice was also perceived as a relevant aspect of the bounded rationality factor, as it included what choice to make in a variety of situations or alternatives pertaining to IBS technology adoption. As these participants stated:

> *"In order to identify the best alternative, it is necessary for us to evaluate all available alternatives in any property development." (B/DR/38)*

> *"Various possibilities may be considered in the conceptual planning stage and the technological and economic feasibility of each alternative will be assessed …" (B/CR/40)*

There was a situation where the processing of information through thinking or cognition would affect IBS decision-making. Although cognition was perceived as the least relevant aspect in IBS decision-making, information processing was required to determine IBS related inputs based on project records or IBS data that have been analysed to identify the relevancy and values which underlie an IBS decision.

iii) Attitude

The next relevant behavioural factor in IBS decision-making, as perceived by the participants of Project B, was attitude. Although the attitude of decision-makers had less influence on IBS decision-making, a number of participants anticipated that general attitude towards IBS technology adoption had evolved rapidly, and therefore was seen as being a part of behavioural factors that focused on commitment, interest, beliefs and responsibility. As indicated by one participant:

> *"There are measures to take the mind-set problem, attitude problem, perception of people…" (B/MR/3)*

Specifically, the aspect of positive attitude was the most relevant to have influenced IBS decision-making, as perceived by Project B's members. In terms of positive attitudes, there was a need to understand the commitment that was made as a result of the decision-makers' belief in the worthiness of the course of action pertaining to IBS technology adoption. Note this critical observation:

> *"I have to get going and move on to improve from one project to another, from one project member to another, so that IBS can be improved." (B/QS/37)*

Therefore, in Project B, it was discovered that their attitudes were the reflection of their self-justification, justification to others and the norms of project practices pertaining to IBS technology adoption. As these participants commented:

> *"The architect has overall responsibility for the quality of the works…" (B/QS/37)*

> *"…if everything goes well, IBS can also empower workers to be responsible for satisfying customer needs…" (B/PM/41)*

Although, the negative attitude of decision-makers was perceived as a less relevant factor in IBS decision-making, a number of participants in Project B implied that negative attitude was treated as a learning experience, to evaluate the beliefs of decision-makers as inputs to revise IBS technology adoption for the final IBS decisions. As demonstrated by the statements of two the participants:

> *"Although IBS is okay but when people see and experience some drawbacks, they have such a negative remarks on IBS." (B/CE/35)*

> *"...if they are asked to perform on IBS components, they feel a bit reluctant as they might be facing some problems in construction…" (B/CE/35)*

iv) Awareness

The least relevant behavioural factor as perceived by the participants of Project B, was the aspect of awareness. It was acknowledged that the participants of Project B had provided a series of insights into the awareness process of IBS decision-making, particularly towards support, values, personality and culture on IBS technology adoption. Therefore, in Project B, it was important to explore the way in which decision-makers perceived a given situation or aspect in the decision-making of IBS technology adoption that could influence IBS decision-making, as evidenced by the following:

> *"First, is the developer itself, the contractor himself, the engineer himself….measures to be aware and take the mind-set problem, attitude problem, perception of people…" (B/DA/36)*

> *"…we have to really consider other's opinions and awareness…" (B/CE/35)*

The participants also believed that the accumulated support for IBS and from other project members had convinced the decision-makers to adopt IBS technology. As perceived as the most relevant aspect of the awareness factor, the participants of Project B noticed that people's awareness on IBS technology adoption was a reflection of their support. As these participants highlighted:

> *"...it shows that IBS needs a good support from the industry..." (B/QS/37)*

> *"Yes, we can give our support for IBS if the project really requires IBS to be used in a project…" (B/CR/40)*

These kind of supports have provided a kind of check-and-balances system in the decision-making of IBS. Next, the second relevant behavioural element in IBS decision-making, is value. The participants of Project B believed that decision-makers were also preoccupied with their personal values in terms of appreciating, concerning and emphasising on IBS technology, as evidenced by the following:

> *"Usually we tend to use values and judgment but the important stage is when your decision-making skill whether rational or intuitive…" (B/DA/36)*
>
> *"This is an important decision for us. It would also be of value to professionals..." (B/QS/37)*

Moreover, besides values, differences in the personality of decision-makers in terms of their characteristics could also influence their independence of judgment in IBS decision-making. As the less relevant aspect in IBS decision-making, the character of those who were involved in IBS decision-making has to be considered, as one participant noted:

> *"There also people character who are not confident with these products..." (B/CE/35)*

Lastly, the awareness of culture influences on IBS decision-making, as acknowledged by Project B's participants, was the least important factor when adhering to cultural preferences in IBS decision-making, as it would not guarantee a successful building innovation effort. As remarked by these participants:

> *"The fragmented nature of the construction industry also can result in a negative thinking culture and this can be a major challenge..." (B/QS/37)*
>
> *"…different project members have different cultures or modes of operation." (B/CR/40)*

d) Summary of Analysis on Project B

In Project B, factors examined are those identified as having a possible impact on the decision-making of IBS technology adoption in building projects, and are sub-categorised according to the priority aspects of each structural, contextual and behavioural factor. The results of the analysis are summarised in Table 5.8 below. From the results obtained in Table 5.8, the most significant core factor, as highly perceived by the participants, is structural; second is contextual and third is behavioural.

Table 5.8 Impact of Structural, Contextual and Behavioural Factors on IBS Decision-making in Project B

CORE FACTORS/ THEMES: *(As perceived by the participants)*	**FACTORS AND REFERENCES:**		**PRIORITY ASPECTS AND REFERENCES**									
1.STRUCTURAL (1086 references)	Project Condition	372	Operation	111	Development	73	Information	42	Risk	36		
	Management Approach	330	Process	117	Planning	85	Leadership	28	Strategy	27	Goals	26
	Procurement Setup	299	Costs	125	Clients	66	Resources	53	Supply chain	16		
	Communication Process	54	Formal	16	Informal	4						
	Decision-making Style	51	Group	35	Individual	9	Nature	6				
2.CONTEXTUAL (897 references)	Economic Conditions	343	Business	96	Demand	53	Competition	25	Uncertainty	24	Opportunity	15
	Technology Development	179	Quality	56	Productivity	42	Innovation	25	Creativity	12		
	Government Involvement	146	Promotion	31	Rules	25	Requirement	24	Policy	23		
	Stakeholders Participation	110	Partnership	56	Opinion	44						
	Sustainability Feature	98	Efficient	31	Environment	30	Waste	15	Trends	10		
3.BEHAVIOURAL (633 references)	Experience	225	Success experience	91	Failure experience	77						
	Bounded Rationality	220	Learning	88	Justification	49	Choice	44	Cognition	31		
	Attitude	92	Positive attitude	54	Negative attitude	24						
	Awareness	81	Support	21	Values	20	Personality	12	Culture	8		

The content analysis results illustrate that in terms of structural factors, Project B's members perceived structural factors to have influenced their decision to adopt IBS technology but their decision appeared to be predominantly influenced by two major aspects, namely project condition and management approach. The project members perceived that their considerations on both aspects would allow them to progress and balance project-management tasks in IBS building projects. Project B's members, however, indicated that procurement setup appeared to impact less on IBS decision-making. This finding reflects the project nature and background, which emphasised the importance of project-related factors compared to procurement aspects.

The perceptions of contextual factors among Project B's members were also considered to have impacts on IBS decision-making in the construction industry, after the impacts of structural factors. Another contextual factor impacting Project B's IBS decision-making in the construction industry was economic condition aspects. The findings indicated that technology development- and government-involvement aspects impacted on the way Project B's members perceived IBS decision-making in their projects. They perceived that the aspects of technology development were relevant in IBS decision-making. Project B's members indicated that in their projects, the productivity of IBS technology adoption is the basic technology requirement for their project developments. Additionally, government-involvement aspects, especially governmental promotion and policy, were essential considerations in IBS decision-making and this fact appears to be recognised by Project B's members.

Behavioural factors also appeared to influence IBS decision-making, as perceived by the members of Project B. The study found that among the four human aspects in the behavioural factors, the aspects of experience were explicitly relevant to IBS decision-making. This result demonstrated the relevancy and influence of the success experience, in IBS technology adoption and building projects in the construction industry, to the IBS decision-making in Project B. Consequently, the study suggested that the aspects of bounded rationality appeared to have fewer relevancies with Project B decisions to adopt IBS technology in building projects.

5.4.3.3 Case 3: Project C

The overall result concerning the influencing factors on IBS decision-making in Project C is the same as for Project A and B, in terms of the overall theme positions of IBS decision-making factors. Although the themes of Project C are of the same pattern as that of Project A and B, the specific factors of IBS decision-making were perceived differently by the participants of Project C. Therefore, it is important to conduct a detailed analysis of Project C's perspective, as an unsuccessful project, on the factors that influence IBS decision-making. Faced with what was proving to be viewed as steady, but generally unimpressive performance, in terms of its IBS adoption, Project C's participants still had a positive outlook on the decision-making of IBS technology adoption.

a) Structural Factors

As the most relevant theme in IBS decision-making, the participants of Project C highlighted a number of concerns which they suggested should be the focus of attention in the structural theme, namely: a largely reactive managerial philosophy and the project's strong management orientation but a lack of project representation at board level, in terms of the operational process, technical skills and constructability of IBS technology adoption. One participant stated:

> *"The construction process and project management emphasizes the organized revision of management by identifying members' functions in a project…" (C/CT/45)*

The analysis of structural factors has proven that the participants of Project C perceived the influence of structural factors on IBS decision-making as relevant, by giving prominence to the managerial and project aspects. Despite the generally disappointing performance in Project C, it was noticed that the participants were positive and believed in the long-term growth potential of the IBS markets and opportunities offered by IBS technology adoption. This is evidenced by the following statement:

> *"…and the supplier or manufacturers have to play their roles in enhancing their working system, management and administration to enable the modernisation in the industry…" (C/QS/43)*

Further analyses on the influence of structural factors on the decision-making of IBS technology adoption in Project C are as follows:

i) Management Approach

The participants of Project C perceived that the aspects of management approach were the most relevant factor that influenced IBS decision-making as they also pointed to the high level of management concentration in the process of IBS decision-making. The participants believed that in almost every instance, successful adoption of IBS technology required the strong support of the project's powerful management team, who could also provide essential resources, mediate intergroup or project issues and were positioned to protect the IBS developmental effort with outside sources of assistance. Note these comments:

> *"We do this with the help of information technology in designing and in project management, especially by means of software packages..." (C/DA/42)*

> *"That is why professional construction management or integrated design or construction is often preferred by private owners." (C/CE/47)*

Realising that Project C had a less-structured planning process, the participants acknowledged the need to focus on management aspects in IBS decision-making.

Hence, the aspect of management process was perceived as an important consideration in the decision-making of IBS technology adoption, in order to be proactive in IBS technology adoption and for this technology to be supported by a strong management team. As one participant commented:

> *"Generally decisions that I make on a routine basis are more related to the construction process of a project..." (C/DR/44)*

In a related matter, the participants of Project C perceived that the aspect of planning was the next relevant factor of management aspect which also influenced IBS decision-making. A number of participants acknowledged that effective planning was perceived as relevant to the outcome of project decisions.

> *"Construction planning for IBS is more difficult in some ways since the building process is dynamic…" (C/DR/44)*

> *"...relevant costs of these alternatives could be assessed during construction planning to determine the lowest cost alternative." (C/CT/45)*

Moreover, a number of participants in Project C acknowledged that detailed plans on IBS projects must be specifically made to fit any project circumstances, so that they could be readily adjustable for applications in other IBS projects with situational improvements. Consequently, the aspect of strategy was perceived in Project C as another relevant factor which has influenced IBS decision-making. A number of Project C's participants noted that if the consideration of the planning aspect was necessary in IBS decision-making, based on the development of project activities, strategies were also essential for the implementation of those activities due to the importance of strategy in a project context which dealt with resources allocation, competition and growth. Examples of this include:

> *"… investment strategy and financial standing, both factors are really influencing our decisions..." (C/DR/44)*

> *"First and foremost is the project strategy for building use, justification, plan, economic analysis…" (C/CT/45)*

Additionally, the participants of Project C perceived that the element of goals was the fourth important influence on IBS decision-making. This situation was based on the existence of project goals to express its aspiration and commitment, besides clarifying priorities. A few participants stated that:

> *"Although there are some developments and growths, the goals of IBS must be of the same..." (C/PM/48)*

> *"…to achieve this important goal…. by determining what we really want to achieve and measurement of performance…" (C/CT/45)*

Against the background of these management factors, the participants of Project C perceived leadership aspects as the least relevant factor which influenced IBS decision-making. One participant commented:

> *"…this is why good leadership skills are a beneficial trait for building contractors to have…" (C/CE/47)*

A number of Project C participants acknowledged that the leadership aspect was not enough to effect large project changes, particularly pertaining to IBS technology adoption, as IBS decision-making must be bolstered by effective leadership through attention to detail on project roles, responsibilities, structures and rewards.

ii) Project Condition

The next relevant factor from structural perspectives which influenced IBS decision-making, as perceived by the participants of Project C, was project condition. It was acknowledged that an IBS project's mix of activities would be constantly changing and each change has managerial, resource and profit consequences. Therefore as acknowledged by the participants, IBS performance could be higher when IBS decision-making was seen as having more regard for the project condition, including the operational- and technical content of what went into the project, in order to achieve the expected project performance level, as evidenced by the following:

> *"…that we have to deal with in the course of a project performance…" (C/PM/48)*

> *"…major developments in construction industry reflect the IBS acceptance to various degrees from the building process perspective, the decision process…" (C/CT/45)*

Consequently, project operation was perceived as having a number of influences on IBS decision-making in Project C based on the fact that project operations, in terms of the technical details of the project work, were seen as dominant in IBS technology adoption. As these participants highlighted:

> *"It depends whether the project is a kind of owner-builder operation in which all work will be handled in house…" (C/DR/44)*

> *"IBS project may involve complex new technology for operation in aggressive environments..." (C/CR/46)*

Thus, in IBS decision-making, it was vital to be concerned with internal project operations and activities, as perceived by the participants of Project C. They suggested sufficient control within the project was important to gain the assistance and continued support from the top management, not only for ensuring efficient project operation, but also for the purpose of project development. As stated by one participant:

> *"…development of an IBS construction plan is very much equivalent to the development of modern facility designs with stringent control…" (C/DR/44)*

As the next relevant project aspect, the elements of project development were perceived as influencing IBS decision-making in Project C because project-development aspects were concerned with efforts to obtain critical resources and coordinate other project divisions. As these participants noted:

> *"…involves developing project alternatives at a conceptual level, analysing project risks and economic impact, developing a financial plan, making a decision…" (C/CT/45)*

> *"Even for residential buildings, IBS is always been associated with high-rise. In both cases, there must be some inefficiencies in terms of architectural and designs elements..." (C/MR/33)*

Consequently, it was recognised in Project C that decision-makers should be able to make informed IBS decisions concerning its technical content, for any project developments. But these considerations could never be completely separate, as dependency on related information was perceived by the participants as having implications for IBS project operation, development and performance. Thus, as the next relevant aspect in project factors, project information was acknowledged by Project C's participants as important. In Project C, project information was considered as an essential input to determine a wide variety of IBS decisions, as demonstrated by these comments:

> *"…our consultants do is usually involves the steps of gathering relevant information, searching for solutions, evaluating the alternatives and proposing a more cost effective alternative." (C/CR/46)*

> *"…detail information even before the transportation is being made, time saving can be achieved as the IBS components can be installed immediately upon the arrival on site." (C/CE/47)*

However, a number of participants in Project C noted that each type of information may perform a different function or way in influencing IBS decisions. Moreover, fast-track projects, like IBS projects, have required sufficient information which was valid and reliable to deal with technical-, management- and market risks. As observed by these participants:

> *"…we will make the final decisions provided that we have all that information in hand..." (C/CL/54)*
>
> *"...general information about the construction site is usually available at the planning stage of a project…" (C/DR/44)*

Although project risk was perceived as the least relevant aspect of project factors which influenced IBS decision-making, there was a requirement for decision-makers to manage risk in an accelerated IBS project, as sensitivity to risk should be a part of IBS technology adoption itself. As noted by a participant:

> *"…some owners are generally more open to IBS and to share risks with designers and contractors." (C/CR/46)*

iii) Procurement Setup

Although procurement factors are seen as essential for project survival, it is important that the pitfalls are recognised and the progress or process is monitored vigorously. The participants of Project C perceived that procurement setup was another important consideration in the decision-making of IBS technology adoption. This condition was based on the fact that procurement setup was employed as a foundation in IBS project circumstances to obtain a building project. As demonstrated by these comments:

> *"IBS procurement is actually requires an integration of organizations…" (C/DR/44)*
>
> *"In the procurement of goods and services especially in a construction of IBS project implementation, we have to ensure the some important matters are carried out effectively…" (C/CL/54)*

The participants of Project C acknowledged that in IBS decision-making, the procurement process may be justified based on several aspects, and cost was perceived as the most important consideration due to the cost of IBS components being slightly higher duet to the controlled production procedures in the factory. Moreover, an IBS project has to consider the cost elements in such a way as to maximise its profit with growth, market share, and turnover, size and survival. For example:

> *"This will allow us to obtain supplies, hire workers and finish the construction in a cost-efficient…" (C/CE/47)*

> *"…is to use pre-fabricated components whenever their cost, including transportation, is less than the cost of assembly on site..." (C/CT/45)*

As cost information was required in IBS project procurement, the clients' aspect was another influencing factor on IBS decision-making, as perceived by Project C's participants. IBS project procurement in this case was based on the clients' requirements and their underlying principles. Moreover, once the decision to proceed with the IBS project had been undertaken, detailed cost information, the design progress and the project-variation situation were required by the client as the construction period approached. This procurement process, which began with the recognition of project costs, could be started off by internal incentive, as demonstrated by these comments:

> *"The common factors are that the implementation of IBS is costly, lack of skilled labour…" (C/DA/42)*

> *"...we need IBS cost analyses that can offer users tangible benefits such as enhancements in productivity…" (C/QS/43)*

The decision to adopt IBS technology in Project C required more vigilant resources allocation and the consideration of resource aspects was perceived as another relevant factor in IBS decision-making, due to the requirement of new material, new equipment and skilled workers for IBS installation works. As these participants stated:

> *"…we only select which IBS type to be proposed for a project based on all available resources…" (C/DR/44)*

> *"IBS projects with exceptional demands for resources such as labour supply, material and infrastructure…" (C/CR/46)*

Lastly, the aspect of IBS supply chain was perceived by Project C's members as the least important consideration in IBS decision-making because from the determination of costs, clients and resources aspects, this would lead to the development of product or IBS specification and subsequently towards a search for IBS suppliers. As noted by a participant:

> *"With detail information even before the transportation is being made, time saving can be achieved as the IBS components can be installed immediately upon the arrival on site." (C/CE/47)*

iv) Communication Process

The aspect of communication was considered as the next relevant factor which influenced IBS decision-making, as perceived by the participants of Project C. In this matter, the participants noted that in deciding on how best to adopt IBS technology, they had to come to terms with a variety of issues, including the question of how the communication process, or practice, in a project could be integrated with other elements of the project management, in order to achieve the synergy between communication and IBS decision-making. These participants stated:

> *"…we have our project management structure and communication routes to introduce and summarise essential project information…" (C/CL/54)*

> *"When we communicate, it depends on the matter…" (C/CE/47)*

The participants acknowledged that through formal communication, it was easier to handle the sorts of IBS issues to which the decision-maker had to pay attention when developing the guiding principle for IBS decision-making. Moreover, in IBS decision-making, most of the important matters of project information should be communicated in a more formal way to create more impact. Note these comments:

> *"...these actions are highly interactive so we have a kind of formal communication…" (C/DR/44)*

> *"…we need information when we receive and review detailed reports on the project from the design team…" (C/CL/54)*

Although informal communication was perceived as less influencing on IBS decision, a number of participants in Project C acknowledged informal communication as complementing formal communication in conjunction with the IBS decision-making process. As noted by a participant:

> *"Working to improve our communication with other team members will increase trust, decrease problems and rework..." (C/CE/47)*

v) Decision-making Style

In IBS decision-making, the participants of Project C perceived that decision aspects, such as decision-making style, were the least relevant factor in IBS decision-making based on the structural perspectives. They acknowledged that IBS decision-making involved a decision authority which was a kind of charter between the project clients and the rest of the project members. Examples of this include:

> *"Most of the decisions are made by contractors. Contractors will see our quotations, and then the contractors will decide…" (C/CE/47)*

> *"Consensus is also needed as the best way to make decisions and it is required in a project…" (C/PM/48)*

In Project C, it was perceived that IBS decision-making was considered as a group activity and only rarely did a single individual within the project have sole responsibility for making all the decisions involved in the process of IBS technology adoption. Instead, a number of people from different areas, and often with different statuses, were involved either directly or indirectly. As the most influencing aspect on IBS decision-making in Project C, group decision-making was seen to vary considerably in handling issues and solving problems, leading to IBS decision-making. For example:

> *"So it is extremely important to take your team into your decision-making process…" (C/DA/42)*

> *"…project decisions, usually they have to be on a group basis or consensus…" (C/CE/47)*

The aspect of decision nature was discovered as the least relevant aspect in IBS decision-making. In Project C, decision nature aspect were perceived as only assisting the final decisions of building projects. As noted by a participant:

> *"…we will make the final decisions provided that we have all that important information in hand…" (C/CL/54)*

b) Contextual Factors

If there was a single issue or theme which linked all types and sizes of building project, it was that of the faster pace of contextual change and the consequently greater degree of uncertainties, as perceived by the participants of Project C. One participant highlighted:

> *"Because of the uncertainty of the objectives and the uncertainty of external events, early studies can also influence our decisions…" (C/CR/46)*

The second relevant theme as an influencing element on IBS decision-making, contextual factors, involved diversities in such a way that they could affect IBS decision-making. Therefore, the participants of Project C acknowledged that it was important to understand and consider the extent to which the contextual factors had affected decision-making related to IBS technology adoption, and to consider the ways in which contextual pressures such as economics, government, stakeholders, technology and sustainability movements were related to IBS decision-making in Project C. One participant commented:

> *"…planning and controlling potential IBS risks, the required skills and how this process fits with scope, cost and schedule requirements in the overall context of the project life cycle." (C/PM/48)*

According to the participants, a possible threat that had been highlighted by several project members of Project C, was that of making an analysis on all possible contextual influences in only a fragmented way rather than with a more integrated approach. The following analysis of Project C's results will focus on the various elements of the contextual theme, with a view to illustrating the nature of their interaction and subsequently, their effects on the decision-making of IBS technology adoption.

i) Economic Conditions

Although IBS technology adoption in building projects involved technological breakthroughs which could provide the innovative project with a major competitive advantage, it also had impacts on IBS decision-making. Given the impact of economic factors, the participants of Project C perceived that it was obviously essential wherever possible, for decision-makers to identify the nature of important economic influences, when they might occur and their likely impacts on IBS decision-making. As these participants stated:

> *"The developers have to plan a larger project scheme in order to reduce the costs of houses for economic viability…" (C/CE/47)*

> *"…that there is slightly concern on the economic aspect of IBS where the supply-demand in short term and long term…" (C/CL/54)*

Given the importance of economic conditions in the IBS decision-making of Project C, it was vital to perform project portfolio assessment and integration with business issues. As the most relevant factor in IBS decision-making perceived by Project C's participants, business aspects were seen as the means to boost IBS technology adoption. As these participants highlighted:

> *"...that can create deliverables, in the form of return on investment for the client…" (C/CT/45)*

> *"The fragmented construction industry include over several professions and business…" (C/CL/54)*

Instead, a number of participants in Project C acknowledged that the consideration of business dynamics has brought the matters of profitable growth and technology leadership into IBS decision-making. In Project C, it was realised that there was a commitment to consider business dynamics based on the consideration of demand aspects in the construction industry. As one remarked:

> *"When comes to investment decision-making process, it is normally driven by demand and supply, and it is long process of development." (C/DR/44)*

As the next relevant economic factor in IBS decision-making the aspect of industry opportunity was acknowledged by the participants of Project C as a prospect to explore the untapped market of IBS building projects, such as housing projects. However, the participants acknowledged that as the least relevant aspect of the economic conditions factor, the consideration of business or project opportunities in IBS decision-making would depend on the project's capabilities to exploit those opportunities in the construction industry. As one participant highlighted:

> *"…it will be an excellent opportunity to demonstrate our innovative modular foundations to the key decision makers in the industry…" (C/MR/33)*

Consequently, the participants of Project C also perceived that the aspect of industry uncertainty as another relevant aspect of economic factors. The industry uncertainty must be recognised in IBS decision-making because a rapidly changing business context was commonly subjected to considerable uncertainty. A variety of comments were:

> *"Construction planning for IBS is more difficult in some ways since the building process is dynamic as the site and the physical facility change over time as construction proceeds…"* (C/DR/44)

> *"A project has a manager who is involved in coordinating a process of interrelated functions, which are random and predetermined but are dynamic as the process evolves." (C/CT/45)*

Lastly, although it was perceived as the least relevant aspect in IBS decision-making, an understanding and consideration of competitive trends or industry competition was of particular importance in the construction industry where competition was always perceived as very stiff. As commented by one participant:

> *"…the most important criteria to ensure that the marketability and the competitive edge over the other players is the quality of the finishes…" (C/CL/54)*

ii) Technology Development

As the next relevant factor of the contextual theme, the aspects of technology development were perceived by Project C's participants as the other economy dynamics that affected the decision-making of IBS technology adoption. In this case, IBS technology breakthroughs were anticipated as undermining conventional building methods, bringing in new technical competencies, challenging current work methods and even redefining the structure of the construction industry. For example:

> *"…others' experience is important in terms of the knowledge sharing of technology development in the IBS..." (C/CL/54)*

> *"We also have to consider other things like lack of client motivation, financial constraints, tight project timeframe, low labour capability and developments in IBS technology…" (C/QS/43)*

From this perspective, the participants of Project C also perceived the aspect of productivity as the most relevant technology factor which influenced IBS decision-making. A number of Project C members acknowledged that in certain building projects, IBS technology adoption was crucial for high productivity. Moreover, in IBS technology adoption, productivity analysis could help in establishing the pattern of resource allocation by relating project inputs, especially costs, to project output in terms of profit. As one participant highlighted:

> *"…they should improve the estimate, taking into account not only present effects, but also future outcomes of IBS projects…" (C/DR/44)*

The next relevant factor of the technology aspect in IBS decision-making, as perceived by Project C, was quality matters. Although quality control or the quality requirement was acknowledged as necessary in IBS projects, the fact was that extra cost was incurred because the quality of the IBS installation works was not sufficiently stable. Note the following:

> *"If we use IBS, projects can enjoy benefits like reduction of unskilled workers, reduced wastage, increase in quality, safer working environment…" (C/DA/42)*

> *"...the curing process and the quality of the surfaces can be controlled under a strict environment and standards…" (C/CL/54)*

The true value from IBS technology adoption became apparent to achieve a high level of IBS project performance. As the next relevant aspect of the technology factor, innovation matters were considered as influencing IBS decisions to ensure cost-effective innovations in IBS projects. As acknowledged by one participant:

> *"...IBS research and development efforts which are required to increase innovation…" (C/DR/44)*

Therefore, the features of IBS technology development in IBS decision-making were stimulated mostly by cost-reduction- and operational objectives. Deriving from innovation aspects, the participants of Project C perceived that the creativity aspect was the least influencing or relevant factor on/in IBS decision-making as it was uncertain that IBS technology adoption could introduce creativity elements that could also improve project performance.

iii) Government Involvement

The participants of Project C perceived that the next relevant factor of the contextual theme was the influence of government involvement on the decision-making of IBS technology adoption, as the government has, and represents control in the construction industry. Due to the direct involvement of the government in IBS technology adoption, Project C's participants acknowledged that government efforts to promote IBS were perceived as the most relevant factor in IBS decision-making. As one participant noted:

> *"…the main concerns for these parties are just profit and the resistance to change due to unclear incentives given by the government…" (C/CL/54)*

A number of participants in Project C noted that the credibility of government promotional activities, through its campaigns, has influenced IBS decision-making through its incentives to persuade the industry to switch from conventional building methods towards IBS technology adoption. Perceived by the participants in Project C as the next relevant aspect of government involvement, rules pertaining to IBS technology adoption could influence IBS decision-making either positively or negatively, by the relevancy of the regulations. However, irrespective of whether the rule is positive or negative, a number of participants in Project C discovered that they had to identify the significance and impact of rules and regulations pertaining to IBS technology.

> *"...the incentives that guaranteed to be given to developers by the government should be clearly stated in the law of Malaysia…" (C/DA/42)*

> *"The government should look into allowing the local authority to inspect the work in the manufacturing process up to the construction stage…" (C/DA/42)*

Moreover the aspect of government rules was regarded by the participants in Project C as relevant to the IBS policy itself. In this case, IBS policy was perceived as an influencing factor on IBS decision-making, provided that it was compatible with the project's own policy. These statements captured this idea:

> *"It is not only the government directives are important but there are also other important factors affecting IBS implementation in Malaysia like standardisation, innovation…" (C/CR/46)*

> *"We should make this as an important awareness and include this in IBS guidelines too…" (C/MR/33)*

However, the participants of Project C perceived that decision-makers had to understand how IBS policy was related to the requirements of certain government projects. For example:

> *"...we have to make sure that the factory has an ISO certification apart of other project requirements…" (C/MR/33)*

> *"Just like other building projects, site information including applicable regulatory reporting and permits requirements are also important…" (C/CT/45)*

Thus, although government requirement was perceived as the least relevant factor in IBS decision-making, the consideration of this aspect was likely to enhance the performance of IBS projects in the industry.

iv) Sustainability Feature

The sustainability feature covers all efforts aimed at improving the aspects of environment, in terms of its contribution towards the nature and well-being of people and their physical environment. The participants of Project C perceived that sustainability factor was another relevant factor of contextual perspective related to IBS decision-making. They noted that the sustainability features have included all aspects of work efficiency in project activities, environment protection, living trends and waste management. These participants noted:

> *"If there is no fit among project activities, there is no project success and little sustainability…It is more about efficient construction process." (C/CT/45)*

> *"…change the behaviour in the construction industry towards sustainable construction…for the improvement of the environmental practices." (C/QS/43)*

A number of participants in Project C perceived the aspect of environmental protection as the most relevant sustainability factor in IBS decision-making. The thinking behind this was that, by adopting IBS technology in building projects, decision-makers should determine and clarify that the result would have a beneficial impact on the physical environment of the project. One participant noted that:

> *"…it must be subjected to thorough analysis to make sure that it can sustain the environment." (C/CR/46)*

Although there was an obvious reason behind the idea of considering and integrating the elements of environment in IBS decision-making, as noted in Project C, a number of participants acknowledged the reality was, that in many IBS projects too little effort was placed upon environmental protection. Moreover, the participants acknowledged that IBS technology adoption was based on the concept of technical efficiency, to maximise project output and the idea of economic efficiency, while minimising the project costs, for the long-term support and sustainability of the industry, as demonstrated by these comments:

> *"…not only primary functionality but also productivity, serviceability and even recyclability…" (C/CE/47)*

> *"…understanding of the technological complexities often associated with innovative designs in order to provide safe and sound projects…" (C/CR/46)*

Besides this, the participants of Project C perceived that the next relevant factor in IBS decision-making was waste the management aspect. This concern derived from the increasing levels, and consequences, of pollution which could be handled by IBS technology adoption in building projects as it involved less construction waste at site. This is evidenced by the following excerpts:

> *"Cleaning up or controlling hazardous wastes can be extremely expensive…" (C/DR/44)*

> *"Let's take a look at wastes that can be recycled as materials have to be placed effectively and efficiently…" (C/MR/33)*

Although in Project C, it was perceived as the least relevant aspect in IBS decision-making, living trend seemed to involve social shifts and lifestyle changes from rural living to urban living brought about by buildings with IBS concepts. One participant acknowledged that:

> *"Since market demand for IBS buildings follows demographic trends and other socio-economic conditions…" (C/DR/44)*

v) Stakeholder Participation

Although it was perceived as the least relevant factor in IBS decision-making, from the contextual theme, the participants of Project C noted that there was a common agreement on the necessity to consider the interests of different construction stakeholders in the decision-making of IBS technology adoption. The participants felt that the construction stakeholders were most interested in the value creation of IBS technology adoption in building projects, in terms of financial return, IBS quality and reliability, defect rate, technology investment and project success from IBS innovation. As advocated by these participants:

> *"The source of our stakeholders to perform standardization is based on some difficulties in IBS designs and implementation process…" (C/CE/47)*

> *"Industry stakeholders are indifferent, perhaps due to resistance towards change, insufficient information and…" (C/DA/42)*

Consequently, a number of participants in Project C acknowledged that the aspect of partnership development was relevant in IBS decision-making. It was suggested that through a high level of interaction, a partnership could be established in the construction industry. As indicated by these participants:

> *"One of the most important aspects of construction activities is the necessity of communication in the design and construction partnership..." (C/CR/46)*

> *"Collaborative working such as partnering is also essential for construction to address the entire lifecycle…" (C/CE/47)*

Additionally, a number of participants in Project C also perceived the influence of stakeholder opinion as the least relevant aspect in IBS decision-making. As noted by a participant:

> *"…depends on who is the stakeholder. If they are in our project, we have to consider their views…" (C/DR/44)*

The opinion of stakeholders was recognised by Project C as influencing IBS decision-making in terms of the outlook on delivery, price reliability and reputation of IBS technology, besides technical services and supplier flexibility.

c) Behavioural Factors

The behavioural theme of IBS decision-making was perceived as the least relevant factor after structural and contextual themes. The need to understand and consider the foundation of IBS decision-making and the way in which IBS technology was adopted in Project C could be viewed from the behavioural perspective of IBS decision-makers. It was essential that as much effort as possible was placed into understanding how people or decision-makers reacted and interacted with external factors, and ultimately how they influenced the decision-making of IBS technology adoption. As one participant commented:

> *"It is good if the government facilitate dialogue between the public and private sector to voluntarily change the behaviour in the construction industry towards sustainable construction." (C/QS/43)*

In Project C, the participants perceived that behavioural factors have influenced IBS decision-making as they were the most fundamental of the social perspective that came into IBS decisions involving a substantial element of human judgment. The focus of attention within this analysis therefore attempts to understand how project members or construction professionals in Project C made IBS decisions and how they perceived those influencing factors were related to behavioural aspects, in the form of patterns of human conduct which were found to be typical of people in the construction industry.

i) Bounded Rationality

The first major category of influences upon IBS decision-making was made up of bounded rationality factors. The participants of Project C perceived that in coping with various issues concerning IBS technology adoption, and contextual- and structural factors, they were faced with the necessity of coping with complex decision problems. As realised by one participant:

> *"You may encounter problems where one wrong decision could have adverse long term effects and lead to severe mistakes and considerable failures..." (C/CR/46)*

Yet, the decision-making of IBS technology adoption was made with sharply limited abilities or bounded rationality that was good enough in the view of intended IBS- or project goals. It was acknowledged by the participants of Project C that as the first most relevant aspect of bounded rationality factors, learning elements have influences on IBS decisions as human judgments were formed as a result of a learning process in construction projects and throughout the development of IBS technology adoption. Examples of this include:

> *"… the more likely they will be to learn about IBS. Even, we are still at the learning stage…" (C/DA/42)*

> *"While the general information about the construction site is usually available at the planning stage of a project, it is important for the design professionals and construction manager as well as the contractor to visit the site. Each group will be benefited by first-hand knowledge acquired." (C/DR/44)*

It was discovered in Project C that as decision-makers, they have a set of preferences, performance and drawbacks concerning IBS technology adoption. Additionally, they also assessed and valued their learning process for IBS decision-making. To a certain extent, these processes determined and drove their justifications for IBS decision-making. It was acknowledged that in Project C, decision-makers were unable to decide in an absolutely objective way and they had a tendency to use subjective judgments to justify IBS decision-making. Examples of this include:

> *"...personally, the conception of IBS is by and large a matter of subjective decision since there is no established procedure for generating innovative…" (C/CR/46)*

> *"When comes to the quality control on the human and technical experience, they are very subjective and there are no classifications of standard..." (C/CL/54)*

Moreover, in Project C, a number of participants noted the element of choice, as a relevant aspect which has impacted IBS technology decisions based on the consideration of several choices in IBS technologies, or attributes of IBS decision alternatives which were likely to lead to desired project- and IBS outcomes. Note the following:

> *"The relevant costs of these alternatives could be assessed during construction planning to determine the lowest cost alternative…" (C/CT/45)*

> *"IBS decision means that each of the IBS type is evaluated and compared to the alternatives until the best solution is obtained…" (C/DR/44)*

Although it was perceived as the least relevant aspect in IBS decision-making, cognition or information processing had to be anticipated in IBS decision-making. In the construction industry, which is more complex, IBS decision-making involved field-dependent information being processed analytically with the combination of IBS-technology complexity and economic uncertainty.

ii) Experience

In Project C, IBS decision-making was certainly influenced to some degree by the experience of decision-makers concerning success- and failure experiences in IBS and non-IBS projects. As perceived by the participants of Project C, in terms of project success or failure, they could refer to their experiences to achieve success and avoid failure in IBS technology adoption. As noted by a participant:

> *"…to make evaluations on the basis of past experience." (C/CR/46)*

The participants of Project C highly recognised that the success experience of IBS and non-IBS projects was influencing IBS decision-making based on the rationale that successful project performance could lead to an increase in the overall standard of project achievement, as there were positive lessons learned from this success experience. As commented by a participant:

> *"If there is no fit among project activities, there is no project success and little sustainability…" (C/CT/45)*

Moreover, it was noticed in Project A that less effort could be made if the decision-makers were equipped with IBS success experience as they would utilise this experience as the benchmark and reference for IBS decision-making. Meanwhile, failure experience was perceived by the participants as a relevant factor in IBS decision-making. As a participant stated:

> *"…developers themselves have not been as successful in making the most fundamental form of IBS innovation..." (C/DR/44)*

The participants of Project C also acknowledged that failure experience concerning IBS and non-IBS projects was important in enabling the cause-and-effect analysis of such project performances, for future improvements in IBS decision-making. Therefore, past experience of failure seemed to have less influence on IBS decision-making compared with the success experience of building projects, as perceived by Project C's participants. For example:

> *"…so this practice has been more accepted but some of them don't really accept it although there are many projects that have been proven successfully…" (C/MR/33)*

iii) People Awareness

In order to embrace a behavioural perspective within a framework of IBS decision-making in a building project perspective, it was necessary to determine the detrimental effects of people's response towards IBS technology adoption. Therefore, in Project C, awareness was perceived as the next relevant aspect of behavioural factors which had influenced IBS decision-making. As one participant noted:

> *"...but people are aware that there are also other important factors affecting IBS implementation in Malaysia like standardisation…" (C/CR/46)*

As the construction industry has experienced a number of important changes due to IBS technology adoption, key issues from the point of view of decision-makers have changed accordingly, in terms of the support for IBS technology adoption. Thus, a number of participants in Project C acknowledged that the support of project members or construction professionals for IBS technology adoption was another relevant aspect in IBS decisions, as evidenced by the following:

> *"…to exploit production economies of scale and to support new IBS product development." (C/DR/44)*

It was clear that project C had faced critical decisions pertaining project investment decisions, particularly in IBS technology. As major investments were needed to modernise the construction process, project requirements and project-team members had to respond to changed and changing conditions to adopt IBS technology. As one participant highlighted:

> *"We also have to consider other things like lack of client motivation, financial constraints, and tight project timeframe..." (C/QS/43)*

Consequently, it was noticed that within Project C, there were individual values and group values, besides the project values themselves, which resulted in different perspectives on IBS technology adoption, deriving from the values that each decision-maker had, as reflected also by their philosophies. Two participants stated:

> *"…how are we going to tell people how implement IBS with values and knowledge using tools…" (C/MR/33)*

> *"…is that owner philosophy with regard to maintenance, operation and design, and how all these can be matched with project requirements for IBS design..." (C/CT/45)*

As the next relevant aspect of the awareness factor, culture in the society, which was related to the appreciation of new building technology such as IBS, had to be considered in IBS decision-making. Moreover, this situation was anticipated due to the awareness of cultural aspects concerning IBS technology adoption in the society. Two participants stated:

> *"…culture and competitive environment in construction may hinder successful partnering and strategic alliance…" (C/DA/42)*

> "*To effect change in the culture of the project delivery process is to use partnering agreements between supply chain organisations…"* (*C/CE/47)*

iv) Attitude

In order to identify the influence of those behavioural variables that impacted on IBS decision-making in Project C, it was essential to further investigate the aspects of attitude as this gave a useful scenario for understanding the particular individual- and personal perspectives of IBS decision-making. As the least relevant factor in IBS decision-making, the attitude of decision-makers was identified as a result of project orientations, preferences and requirements. Each of these aspects was of course bound up to a greater or lesser extent with the external- or project exposures of IBS technology adoption which influenced the attitudes of decision-makers, and the decisions of IBS technology adoption. Note these comments:

> *"Attitudes of clients have to be changed as well…" (C/CE/47)*

> *"It all depends on our attitude. A purposeful effort to broaden your experiences is the single most helpful effort…" (C/CT/45)*

The participants of Project C perceived that the influence of positive attitude on IBS decision-making was greater than the influence of negative attitude, among the members of Project C. Accordingly, a number of participants acknowledged that decision-makers with positive attitude had a broader outlook on IBS technology adoption. As noted by a participant:

> *"...we are always at the back of this technology, I am quite optimist that IBS will grow from time to time…" (C/MR/33)*

Thus, with positive attitude, greater confidence in justifying IBS decisions could be built up. In contrast, the participants of Project C perceived that decision-makers with negative attitudes towards IBS technology adoption had less involvement and exposure in this technology, as those with negative attitudes expressed reservations concerning the appropriateness of IBS technology adoption. For example:

> *"Yet, even as they are expressing themselves, they must make certain why they are doing so in a clear and concise manner, especially in decision-making…" (*C/MR/33)

Therefore, these different views between decision-makers with positive- and negative attitudes as perceived by a number of participants in Project C, and to a certain extent added to by different outlooks of IBS technology adoption and conventional building methods, were influencing the decision-making of IBS technology adoption.

d) Summary of Analysis on Project C

This section discovers that IBS decision-making, as perceived by the supply-chain members of Project C, is affected by three core factors. In particular, the participants of Project C perceived that the three most important factors in the decision-making of IBS technology adoption, based on their perceived importance, were structural-, followed by contextual- and behavioural factors as presented hierarchically in Table 5.9 below:

Table 5.9 Impact of Structural, Contextual and Behavioural Factors on IBS Decision-making in Project C

CORE FACTORS/ THEMES: ***(As perceived by the participants)***	**FACTORS AND REFERENCES:**		**PRIORITY ASPECTS AND REFERENCES**									
1.STRUCTURAL (1036 references)	Management Approach	337	Process	128	Planning	94	Strategy	41	Goals	18	Leadership	16
	Project Condition	325	Operation	119	Development	86	Information	57	Risk	49		
	Procurement Setup	248	Costs	100	Clients	45	Resources	41	Supply chain	35		
	Communication Process	52	Formal	16	Informal	7						
	Decision-making Style	43	Group	31	Individual	7	Nature	2				
2.CONTEXTUAL (904 references)	Economics Conditions	283	Business	74	Demand	49	Opportunity	32	Uncertainty	11	Competition	8
	Technology Development	253	Productivity	74	Quality	67	Innovation	39	Creativity	18		
	Government Involvement	148	Promotion	43	Rules	30	Policy	23	Requirement	18		
	Sustainability Feature	104	Environment	42	Efficient	25	Waste	14	Trends	10		
	Stakeholders Participation	93	Partnership	49	Opinion	33						
3.BEHAVIOURAL (661 references)	Bounded Rationality	246	Learning	95	Justification	61	Choice	47	Cognition	38		
	Experience	177	Success experience	83	Failure experience	56						
	People Awareness	133	Support	41	Values	37	Culture	17	Personality	16		
	Attitude	89	Positive attitude	57	Negative attitude	14						

It was also interesting to find that structural factors in IBS building projects were perceived to have important impact on IBS decision-making including in Project C. Most of Project C's members regarded the aspects of management approach such as project planning and goals to have played an important role in their decision to adopt IBS technology in building projects. The case study also indicated that members of Project C had different perceptions of the way project operations facilitated IBS decision-making, as they suggested that the consideration of project operations allowed them to explore possible building-technology- or method choices and facilitated their

IBS decision-making. Whereas, the members of Project C felt that project management aspects allowed them to progress IBS decision-making.

After structural factors, the next relevant factor in IBS decision-making, as perceived by Project C's members, was contextual factors. In particular, economic aspects appeared to play a major role in their decision to adopt IBS technology in building projects. One likely explanation for this finding is that Project C's members realised that, although building demand in the construction industry was growing, project-development opportunities depend on a range of other economic factors. Consequently, technology development was perceived to be another relevant factor for achieving a match between IBS decision-making and project development. As a result, the project members were likely to perceive IBS decisions based on a variety of factors, and not just on building demand in the industry.

The case study further investigated the relevance of behavioural factors with IBS decision-making by focusing on the impact of human-related aspects during their project development process. According to the perceptions of Project C's members, several key findings highlighted the impact of these bounded rationality aspects on IBS decision-making and indicated that their learning process had an important influence on IBS decision-making. Next, the findings suggest that Project C's members perceived that their work experience in the construction industry, particularly with successful projects, played an important role in establishing their interests and their decision to adopt IBS technology in building projects.

5.5 Influencing Factors on IBS Decision-making

Malaysia's construction industry has been expanding to meet the needs of its dynamic and rapid economic growth. Although many IBS building projects have been completed, several major projects are found to be categorised as successful, non-performing and unsuccessful IBS projects. Therefore, the factors that affect IBS decision-making in Malaysia pertaining to various IBS project performances have yet to be explored in depth. In order to gain insight into the influencing factors of IBS technology adoption in building projects, the results of the interviews were analysed and summarised with a computerised approach using QRS NVivo, Version 10, as explained in section 5.1.

It was discovered that the three major factors that influence IBS decision-making are structural, contextual and behavioural factors; and the way these factors impact on IBS decision-making is in a hierarchical way. The results of qualitative research methods for data analysis are presented hierarchically as shown in Table 5.10.

Table 5.10 Impacts of Structural, Contextual and Behavioural Factors on IBS Decision-making

CORE FACTORS/ THEME:	**INFLUENCING FACTORS ON IBS DECISION-MAKING:**			
	INTER-PROJECT PERSPECTIVE	***INTRA-PROJECT PERSPECTIVE***		
	CONSTRUCTION-PROFESSION STAKEHOLDERS	**SUPPLY-CHAIN MEMBERS OF IBS PROJECTS:**		
		PROJECT A	**PROJECT B**	**PROJECT C**
STRUCTURAL	Project condition	Procurement setup	Project condition	Management approach
	Procurement setup	Management approach	Management approach	Project condition
	Management approach	Project condition	Procurement setup	Procurement setup
	Communication process	Decision-making style	Communication process	Communication process
	Decision-making style	Communication process	Decision-making style	Decision-making style
CONTEXTUAL	Economics condition	Economics condition	Economics condition	Economics condition
	Technology development	Government involvement	Technology development	Technology development
	Government involvement	Technology development	Government involvement	Government involvement
	Sustainability feature	Sustainability feature	Stakeholders participation	Sustainability feature
	Stakeholders participation	Stakeholders participation	Sustainability feature	Stakeholders participation
BEHAVIOURAL	Experience	Bounded rationality	Experience	Bounded rationality
	Bounded rationality	Experience	Bounded rationality	Experience
	Awareness	Attitude	Attitude	Awareness
	Attitude	Awareness	Awareness	Attitude

Table 5.10 shows the results of the data analysis which seeks to determine the way various factors impact on the decision-making of IBS technology adoption in the Malaysian construction industry, based on three case studies in this research, namely Project A, Project B and Project C as the supply-chain members of IBS projects in exploring inter-project perspective, and another group of the of the construction-profession stakeholders in exploring intra-project perspective.

In the analysis of the results, Table 5.10 presents the findings on structural, contextual and behavioural factors influencing IBS decision-making, as perceived by the supply-chain members of IBS projects and the construction-profession. The results as shown in the first column of Table 5.10, are presented using three major themes, representing structural, contextual and behaviour factors. Table 5.10 also presents the results according to the hierarchical order of the data analysis based on the perception of participants towards the influencing factors on IBS decision-making, based on the frequency of occurrence of the rate of reference sources.

The second column indicates the results for influencing factors on IBS decision-making, as perceived by the construction-profession stakeholders, from an inter-project perspective. The third, fourth and fifth columns represent the results concerning the impact of structural, contextual and behavioural factors on IBS decision-making, as perceived by the supply-chain members of Project A, Project B and Project C respectively, from an intra-project perspective.

In general, although quantitative findings usually demonstrate relationships, they could not provide an explanation of how various factors influence IBS decision-making. The current research, therefore, used qualitative data to gain a better understanding of how the factors emerging from the quantitative study impact on IBS decision-making. The three selected IBS projects and the group of construction stakeholders had exhibited different results pertaining to the influencing factors of IBS decision-making, which will be discussed based on each case study. Each case was derived from the perception of each project member or construction professional of the impact of structural, contextual and behavioural factors on the decision-making of IBS technology adoption. The core factors examined are those identified as having a probable impact on IBS decision-making, and categorised according to the structural- or project-related factors, contextual- or industry-related factors and behavioural- or human-related factors. The relevant aspects of these factors are then sub-categorised according to these core factors, namely structural, contextual and behavioural factors.

In summary, this section found that almost all participants accepted that the structural factors which are related to project-organisation aspects were necessary considerations for the decision-making of IBS technology adoption. Most participants realised that structural factors applied seriously in IBS decision-making because they strongly believed that project-related factors could improve the performance of building projects. The only differing views on these structural factors came from the group of construction-profession stakeholders, Project A, Project B and Project C who believed that their priority aspects in structural factors are according to the nature of their projects, such as project condition, procurement setup and management approach. However, the majority view was that structural factors are necessary for the decision-making of IBS technology adoption.

Consequently, most of the participants from the four groups agreed that contextual factors would have various effects on the decision-making of IBS technology adoption. They pointed out that IBS decision-making is a concept that must be adhered to the economic condition of the construction industry. Because of this conception, they participants believe in IBS decision-making, they should consider economic factors carefully. They feel that the economic condition would have a substantial effect, as decision-makers will not dare to regulate any economic changes because they would think that the economic uncertainties would affect the performance of building projects.

In addition, a number of participants also remarked that the behavioural factors would be influential in IBS decision-making as they perceived that IBS decisions are made in a bounded rational condition. The participants also realised that IBS decision-making is influenced by their experiences. They believed that the aspects of attitude and awareness are important considerations in IBS decision-making. These aspects were particularly insightful, as the participants commented that on the importance of right and positive attitudes towards IBS technology adoption in building projects.

The analysis of results focused on developing IBS decision-making profiles for each project as well as profiles for each of the structural, contextual and behavioural influences, in explaining and understanding their influences on IBS decision-making. The analysis used an interactive process of reviewing data, categorising, clustering and prioritising influencing factors on IBS decision-making with their major aspects, and preparing preliminary briefs to summarise the information in a building project with the purpose of developing IBS decision-making criteria and models that will be discussed in Chapter 8.

5.6 Summary

This part has reported the findings of the qualitative study. This chapter set out to document the analysis of inter-project and intra-project perspectives on IBS decision-making and its influencing factors. The inter-project perspective involves the stakeholders of the construction industry, while the intra-project perspective involves the supply-chain members of IBS projects, with three case studies. In this chapter, the analysis of the interview data was framed around three identified major areas, namely structural, contextual and behavioural factors. These core factors or themes were further expanded to include relevant sub-categories or aspects, which were subsequently categorised according to their frequency of occurrence within the interview transcripts. The findings also identified the way these factors impacted on IBS decision-making in the construction industry. The findings were also presented in hierarchical order according to the relevancy of each factor. The findings indicated that, despite exploring the perception of construction professionals on IBS decision-making from multiple perspectives, construction professionals appeared to consider several factors when deciding on IBS technology adoption. Some factors were perceived to be either very relevant or less relevant to IBS decision-making. The results of the analyses from both perspectives will be integrated in the next chapter.

CHAPTER 6 – INTEGRATED DATA ANALYSIS AND RESULTS

6.1 Introduction

This chapter synthesises the analysis results from the semi-structured face-to-face interviews exploring the inter-project and intra-project perspectives presented in sub-sections based on the explanations in Chapter 5. Therefore, the focus of this chapter is on the synthesis of the results based on the integration of the two units of analysis; first the group of construction-profession stakeholders, for exploring the inter-project perspective and second, the group of supply-chain members in IBS projects for exploring the intra-project perspective.

The integrated analysis of the interview data is framed around three identified key areas pertaining to influencing factors on IBS decision-making, namely structural, contextual and behavioural factors. The first factor is mainly concerned with looking at IBS project-related aspects as a micro environment; the second factor is related to the context of IBS projects as a macro environment and the third aspect looks specifically at discovering the behavioural or human-related aspects that affect the decision-making of IBS technology adoption. These factors or areas are further expanded to include relevant aspects or sub-categories, which are subsequently determined according to their frequency of occurrence within the transcripts. It was also discovered that the way structural factors, contextual factors and behavioural factors impact on IBS decision-making is in a hierarchical manner and these factors are discussed according to the degree of influence of each factor in the following sections.

The chapter is presented in four sections and starts with section 6.2 which presents the cross construct analysis of the impact of influencing factors on IBS decision-making frame. Section three presents the results of influencing factors on IBS decision-making which consists of structural, contextual and behavioural factors. This chapter concludes with a discussion of the way structural, contextual and behavioural factors appear to impact on the decision-making of IBS technology adoption in the Malaysian construction industry (section 6.4).

6.2 Cross Construct Analysis of the Impact of Influencing Factors on IBS Decision-making Frame

In the construction industry, the analysis of the interviews yields several key points about how IBS decisions are perceived in building projects. This analysis is now interpreted and evaluated to explore the decision-making of IBS technology adoption, which is a representation of how IBS decisions are actually being made or will be made in building projects, according to the IBS decision-making frame. Two situations need to be noted in the interpretation and evaluation of IBS decision-making data. First, the inputs and outputs of the IBS decision-making process are built from all the statements of all participants and are based on their perceptions. Second, the concerns about various internal and external aspects of building projects are based on their perceptions of the decision-making of IBS technology adoption in building projects.

The data instrument and software utilised in the analysis of data for the interview of the research have been fully described previously in chapter 4 of the thesis. The focus of this section is primarily in the results or outcomes of the analysis in answering the research question. Despite a small number of participants, it is important to obtain primary data from the potential and users of IBS technology using a wide range of participant from surveyor through to project client organisations; to ascertain the influence of various factors on IBS decision-making. This is accomplished through a semi-structured and in-depth interviews; which enabled this research to achieve its objectives based on two justifications. First, the interviews are used to obtain invaluable information on the decision-making of IBS technology adoption from two major perspectives, namely inter- and intra-project perspectives. Secondly, to enable the influencing factors on IBS decision-making to be investigated and to gauge their relevancy to the research theme.

Moreover, the interviews conducted were semi-structured and one-to-one basis, to allow some probing and hence gather more in-depth information on IBS decision-making. In addition, the interviews provide the specific focus on certain areas and features, particularly the influencing factors on IBS decision-making. Hence, a larger number of participants might prove to be inconvenient, besides the inherent cost and time implications.

Patterns emerging from a thematic analysis of the interview transcripts evolving around the research topic were classified into two key areas; firstly, cross construct analysis of the impact of influencing factors on IBS decision-making frame (section 6.2) and secondly, results of influencing factors on IBS decision-making (section 6.3). These two classifications were then further examined through content analysis.

The results revealed that structural, contextual and behavioural aspects have influenced IBS decision-making. Despite this view, however, closer analyses have revealed that IBS decision-making is ultimately based on inputs from, and concerns about, the internal and external sphere or dynamics of building projects which later generated the project performances. The complete result of the input-output analysis on the decision-making of IBS technology adoption is attached in Appendix 14 and the summary of this result is presented in Table 6.1 below:

Table 6.1 Results of Cross Construct Analysis of the Impact of Influencing Factors on IBS Decision-making

DECISION FRAME:	**SOURCES:**	**REFERENCES:**	**ASPECTS AND FACTORS:**
CONCERN	54	6017	**19 aspects** 12 contextual factors 4 structural factors 3 behavioural factors
INPUT	54	4380	**11 aspects** 5 structural factors 4 contextual factors 2 behavioural factors
PROCESS	54	3797	**9 aspects** 5 structural factors 4 behavioural factors
OUTPUT	54	3337	**12 aspects** 7 contextual factors 4 structural factors 1 behavioural factor

As presented in Table 6.1, the style and process of IBS decision-making as perceived by the participants, were quite distinct. IBS decision-making was perceived in terms of whether it could create positive or negative outcomes or outputs in building projects. Successful performances were considered to be a shared interest which the decision-makers have in common. That was, if the decision succeeded based on decision inputs and concerns that had been well acknowledged and considered in IBS technology adoption, the whole building project was seen as succeeding, and vice versa.

Although the building-project team consists of interdependent members– usually technical members or professionals who have specialised IBS skills, knowledge and understanding of the development of building projects and the dynamics of the construction industry– they have great concern about these matters and they could also influence each other in the decision-making of IBS technology adoption. The prime characteristics of the IBS decision-making process were perceived as involving the combination of structural and behavioural aspects based on its hierarchical level.

Leaders of project teams, or clients, made the final decisions based on the recommendations of other project members. Therefore, an input-output approach of decision-making may be applicable in IBS projects. It was still important to observe that at the distinct decision level of IBS technology adoption, the human side of the decision-making was also still greatly involved. The interviews revealed that the most important considerations were concerned firstly with contextual factors, secondly with structural factors and lastly with behavioural factors. Specifically, aspects such as economics (contextual factor), attitude (behavioural factor) and management process (structural factor) were acknowledged by the participants as the three most important concerns in IBS decision-making.

6.2.1 Decision Concern

Based on a thorough investigation of the contextual factors, besides economic aspects, other aspects such as business dynamics, government involvement, environment protection, government policy and promotion factors were perceived as the five most important contextual factors influencing IBS decision-making. From the perspective of structural factors, there were three major concerns in IBS decision-making involving aspects such as management process, clients and risks. The results of the analysis are summarised in Table 6.2 below.

Table 6.2 Decision Concern in IBS Decision-making Frame

DECISION	SOURCE	REFERENCES	FACTORS:		
			STRUCTURAL	CONTEXTUAL	BEHAVIOURAL
CONCERN	54	6017	1. Management process 2. Clients 3. Risk 4. Decision Nature	1. Economics 2. Business 3. Government 4. Environment 5. Promotion 6. Policy 7. Rules 8. Uncertainty 9. Competition 10. Waste 11. Creativity 12. Trends	1. Attitude 2. Values 3. Support

Lastly, from the perspective of behavioural factors, the results indicated that the aspect of attitude, particularly positive and negative attitudes, was the most important concern in IBS decision-making; second was the perception towards values and last was the perception towards IBS support. Based on the perception of IBS decision-making by the participants, IBS decisions were viewed from the various types of concerns that could be figured out by the decision maker to make the decision.

6.2.2 Decision Inputs

Consequently, from the analyses, it appeared that inputs for IBS decision-making were perceived by the participants as the second most important consideration, as it was common practice for decision-makers to require that the decision-making of IBS technology adoption be based on the internal and external inputs of the building projects. The results highlighted that the structural factors of building projects were the most important inputs for IBS decision-making, with the focus on planning, costs, project information, resources and strategy. The results of the analysis are summarised in Table 6.3 below.

Table 6.3 Decision Inputs in IBS Decision-making Frame

DECISION	SOURCE	REFERENCES	FACTORS:		
			STRUCTURAL	CONTEXTUAL	BEHAVIOURAL
INPUT	54	4380	1. Planning 2. Costs 3. Project Information 4. Resources 5. Strategy	1. Technology 2. Stakeholders' Opinion 3. Demand 4. Technology Innovation	1. Success experience 2. Failure experience

The second important decision input, as perceived by the participants, was contextual factors which consisted of technology aspects, stakeholders' opinions, market demands and technology innovation. These aspects were viewed by the participants as essential in IBS decision-making because of the amount of information that they provided to make the decision, along with a consideration of two other behavioural factors, namely the success and failure experience in building-project development, particularly in IBS technology adoption.

However, in terms of the priority on these inputs in IBS decision-making, the success or failure experience in building-project development was perceived by the participants as the most important input for IBS decision-making. This is evidence that IBS decision-making had to be based on the success or failure experience of building projects. The success experience could create project reference, while the failure experience could lead to project improvements, particularly in IBS technology adoptions.

6.2.3 Decision Process

Taking into account the concerns and inputs of IBS decision-making, these aspects had led to the decision process of IBS technology adoption. Rather than making IBS decisions based on particular concerns and inputs, the results showed that the decision process of IBS technology adoption was another essential consideration as it should be possible to make the most practical IBS decisions by considering the influencing factors on IBS decision-making process. These aspects were not under the individual or group's control, where the decision-maker was not the person who had direct control of the decision-making process of IBS technology adoption. The results of the analysis are summarised in Table 6.4 below.

Table 6.4 Decision Process in IBS Decision-making Frame

DECISION	SOURCE	REFERENCES	FACTORS:		
			STRUCTURAL	CONTEXTUAL	BEHAVIOURAL
PROCESS	54	3797	1. Operation 2. Communication 3. Management 4. Group and individual decision 5. Leadership		1. Bounded Rationality- choice, cognition, justification and learning 2. Culture 3. Personality

The results pointed out that in the process of IBS decision-making, the most important factors which influenced IBS decisions were structural factors. In addition, several behavioural factors were considered, by the participants, to influence the decision-making process of IBS technology adoption. In order to achieve a balance within the decision-making process, it was necessary to have an understanding of relevant aspects throughout the process.

Rather than the IBS decision process just being based on decision inputs and concerns about external and internal aspects, the aspect of bounded rationality, which involves the elements of choice, cognition, justification and learning, was perceived as the most important aspect of behavioural factors in the process of IBS decision-making.

Therefore, along with the high level of reasoning required to generate and recommend a certain IBS decision, the participants acknowledged that it was also necessary to have a reciprocal connection between the process of IBS decision-making and bounded rationality because decision-makers had to act against a background of incomplete information, inexperience and limited resources and could only explore a limited number of options on IBS decisions and could not put together accurate value to the decision outcomes.

6.2.4 Decision Output

The final vital aspect of IBS decision-making in the construction industry, as perceived by the participants, was decision outputs. The participants revealed that in order to decide on IBS technology adoption in building projects, this decision should lead to expected outputs. The participants also stated that IBS decisions were based on the achievement of project performance, particularly in terms of project development, productivity and quality. They generally clarified that IBS decision-making required inputs and the decision-maker, as the authorised or highest-ranking person either inside or outside the building project, was accountable for the IBS decisions which were based on the recommendations or consultations of project members throughout the process of IBS decision-making, in order to come out with the desired outputs. The results of the analysis are summarised in Table 6.5 below.

Table 6.5 Decision Output in IBS Decision-making Frame

DECISION	SOURCE	REFERENCES	FACTORS:		
			STRUCTURAL	CONTEXTUAL	BEHAVIOURAL
OUTPUT	54	3337	1. Project development 2. Procurement 3. Goals 4. Supply chain	1. Productivity 2. Quality 3. Partnership 4. Opportunity 5. Efficiency 6. Requirement 7. Sustainability	1. Awareness

In essence, although there were influences on IBS decision-making as clustered by contextual, structural and behavioural factors, the participants regarded IBS decision-making as being effected in a very structured or well-prepared and hierarchical manner, as reflected by the input-output approach of IBS decision-making. In fact, many participants indicated that there was a current trend to shift the decisions to more senior project members, which was responding to some internal and external concerns with IBS decision inputs, process and outputs.

6.3 Results of Influencing Factors on IBS Decision-making

The examination of influencing factors on IBS decision-making was performed through content analysis. Specifically, the emphasis placed by each participant on major 'phrases 'or fundamental 'expressions' initially identified through the initial analysis was examined in terms of the frequency of occurrence in the interview text document. Further, the outstanding and important concepts were then ranked according to position and cross-referenced from the interview containing the relevant phrases. Therefore, significant points were able to be extracted and ranked in a hierarchical manner. Rankings of each sub-category are presented in star diagrams.

The results for factors that influence IBS decision-making that will be presented below are based on the analysis of the merged synthesis of inter-project and intra-project perspectives, encompassing three major factors namely structural, contextual and behavioural, under data integration. This is so as to provide a broader information base and better clarify each factor. By relating the issues discussed concerning each factor with the research question "*How do contextual, structural and behavioural influences impact on the decision-making of IBS technology adoption?*" its priority can be determined and listed , from the most to least important, according to the degree of influence of each factor.

6.3.1 Structural Factors

The major factors that influence the decision-making of IBS technology adoption in the construction industry are structural factors that are managerial and project-based. The fact that structural factors play an important role in IBS decision-making, to choose a particular building method or technology in the construction industry, supports the findings from the analysis of inter-project and intra-project perspectives that the consideration of project management factors are appropriate for IBS decision-making. As illustrated in Table 6.6, structural factors consist of management approach, project condition, procurement setup, communication process and decision style, with their respective priority aspects.

Table 6.6 Structural Factors Associated With IBS Decision-making

CORE FACTOR/ THEME: (As perceived by the participants)	**FACTORS:**	**Source:**	**Frequency of occurrence/ References:**	**PRIORITY ASPECTS:**	**Source:**	**Frequency of occurrence/ References:**
1. STRUCTURAL *(54 Sources, 6797 References)*	Management approach	54	1970	Process	54	694
				Planning	52	519
				Strategy	49	188
				Goals	47	169
				Leadership	38	127
	Project condition	54	1958	Operation	53	575
				Development	53	554
				Risk	51	389
				Information	50	352
	Procurement setup	54	1873	Costs	54	741
				Clients	52	437
				Resources	48	254
				Supply chain	45	169
	Communication process	49	333	Formal	44	127
				Informal	21	29
	Decision-making style	53	309	Group	49	178
				Individual	38	62
				Nature	32	61

In essence, the aspects of management process and project operation appear to have most profoundly affected IBS decision-making at the project level. However, the claim of cost aspects based on the procurement setup presented above cannot be validated without any financial data. Rather, there is an indication of clients' considerations in IBS decision-making.

This also reveals that the impacts of structural factors, in terms of management approach, project condition, procurement setup, communication process and decision style, on IBS decision-making depend on a number of interrelated factors such as management process, management planning, project operation, project development, procurement costs, clients, formal communication and group decisions, with the emphasis on how they are perceived by the participants. As a result, inter-related structural factors are essential in IBS decision-making as various structural aspects were considered in depth before an IBS decision could be made.

a) Management Approach

Two managerial issues, namely management process and planning aspects, in a project were the core managerial elements of the organisational elements in the decision-making of IBS technology adoption. Anticipation and consideration of these management approaches were also characterised by high technical- and project output from IBS technology adoption and efficient IBS technology management practices. In relation to those management factors, IBS technology decisions require a careful anticipation of management process and planning aspects despite the difficulty in defining and measuring each of these management factors.

Additionally, cross-management functions that involve planning activities and strategies should support the key performance goals, not undermine them. Therefore, in IBS decision-making, the results indicated that a building project should exercise more control of IBS decision-making, and its output and performance because management process, planning and strategy are more complex, and so more highly skilled leadership would be required. The star diagram, Figure 6.1 illustrates the priority aspects of management approach in IBS decision-making.

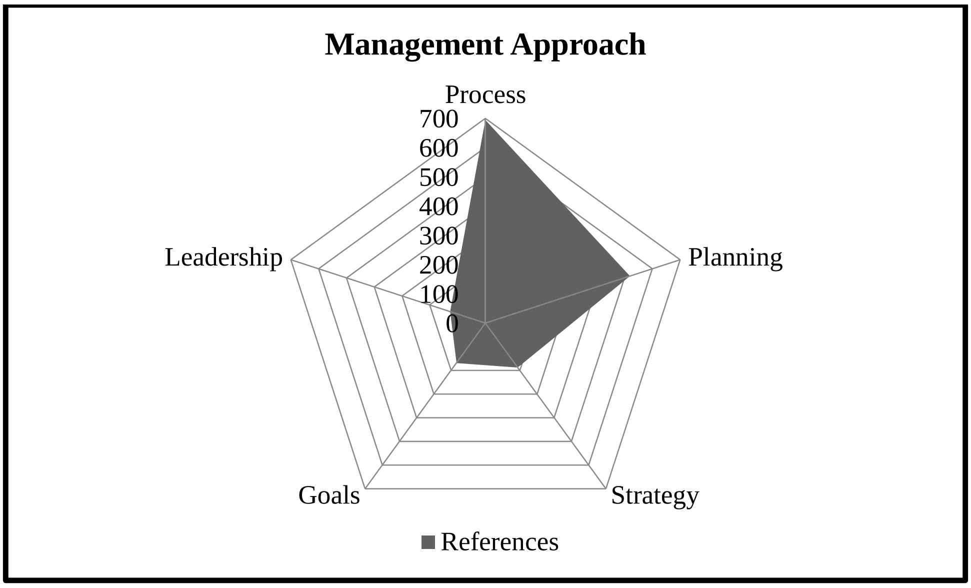

Figure 6.1 Priority Aspects of Management Approach

It was also important to consider management process based on effective organising-, coordinating- and control activities. Additionally, managerial matters are the facilitating elements through which IBS strategy or plans can be implemented, and therefore influence IBS decisions. The results indicated that organisational matters would have effects on the IBS decision-makers themselves, in presenting them with the opportunity to review IBS technology adoption matters and make IBS decisions; and creating a climate of IBS technology adoption in which project members could exercise their judgment on the broader organisational aspects of IBS technology adoption.

It can be concluded that management approach was certainly the most relevant factor, from a structural perspective, which impacted on IBS decision-making. Organisational mechanisms were important to ensure that IBS technology adoption did not get turned down for the wrong reasons. Although the mix of management aspects differs from project to project and regardless of the types of building projects, the results indicated that construction professionals had to focus on pre-existing management approaches when it came to the decision-making of IBS technology adoption.

Thus, the results highlighted that it was important to decide on IBS by having some basics to make sure IBS technology decisions were in alignment with the project requirements. As these foundations were acknowledged, they could guide decision-making by building common understanding among decision-makers. When a strong mission, clear philosophies and detailed policies were acknowledged, referred to and implemented respectively in IBS decision-making, they could ensure that technology adoption decisions are consistent in approach.

i) Management Process

The results highlighted that management processes could provide remarkable influence on IBS decision-making. Thus, the consideration of management process as a general approach in IBS decision-making was acknowledged as important and it could inter-relate key managerial processes, project goals and IBS technology goals into a multi-faceted framework, as a base for IBS decision-making.

Consequently, the results revealed that in IBS decision-making, the coordination of available resources was an important consideration to achieve desired outcomes in building-project performance. Coordinating is a concept of management process to manage and bring together project resources and activities in an organised manner so that a more effective IBS decision can be generated for a given building project.

The concept of project management was an important consideration as it could remove the barriers between project functions such as design, research and development, project operation and implementation, enabling all parties to be involved in IBS decision-making and resulting in high-quality decisions being made throughout the project lifecycle. It was necessary to consider the integration of project activities since it can break down functional boundaries by using cross-functional process in IBS decision-making.

Summing up, the influence of functional project divisions was evident in the building projects and these projects may have a procedurally oriented approach to coordination. Despite the use of procedures to make IBS decisions, which could become slow and cause project delays, these procedures have provided an opportunity to anticipate any obstacles to the progress of IBS technology adoption.

ii) Planning Mechanisms

The results highlighted that planning activities in building projects have attempted to control the features which could affect the outcomes of IBS decisions, so that project success is likely to be achieved. Additionally, planning was also essential to determine what to do before deciding on IBS technology adoption. Meaning that, project plans could be specifically made to fit circumstances in the project so that they could be ready for IBS technology adoption. The results also showed that planning was an important concern in IBS decision-making by allocating resources for IBS technology adoption in order to achieve project goals.

Additionally, the consideration of scheduling was another important element to monitor the progress and performance of the construction stages or project stages and to ensure that those who were involved in the project could perform their responsibilities. Scheduling the project activities could assist in making timely IBS decisions, paying particular attention to the critical activities and providing information about how IBS decisions were made.

Besides that, monitoring the planning process makes it easier to decide on IBS technology adoption. Even project progress could be specifically maintained by closely monitoring and controlling design activities. Apart from assessing project performance and progress, monitoring activities have provided a chance for identifying project issues or problems and developing appropriate solutions, through IBS technology adoption. The results revealed that monitoring tasks should consist of identified performance criteria as specified in building projects.

The results show that it was vital to refer to the long-term planning as it consisted of building-project milestones based on managerial-, strategic- and financial forecasts based on the overall work sequence and resources allocation. The influence of long-term planning on IBS decision-making was relevant as the role played by the master plan made it transparent to the project members, and ensured goals achievement based on targeted milestones at managerial-, operational- and functional levels.

In summing up, practice seemed to indicate that the elements of planning which involved monitoring and long-term plans influenced IBS decisions because these are formal mechanisms in the management of a building project. From a practical perspective each managerial planning had different roles which influenced IBS decision-making in a project and this is important for dealing with uncertainty, as well as for adequately supporting IBS decision-making.

iii) Project Strategy

Results indicate that project strategy also played a major role in IBS decision-making. Additionally, the board of directors assessed proposals for the entire project, including IBS technology that might be adopted for potential building projects. IBS decision-making was essentially developed jointly with the direct assessment of building-project proposals integrated into planning decisions through specific project policies and project development plans. As such, the results did not highlight specific project strategies, particularly on IBS technology but generally revealed that IBS strategies had impacted on IBS decision-making.

Although not much has yet been explored about specific implementations of project strategies on IBS technology in particular, the results pointed out that in relation to project strategy, this was an early consideration in IBS decision-making. Project strategies with regard to IBS decision-making and its guidelines were important in the building-project context. At the project level for instance, it was essential to focus and improve on pre-existing IBS technology, in already well-developed project areas.

Conforming this view, the results have indicated that project strategy was a reflection of a project's technology policy, from a functional and a project perspective. Therefore, the consideration of this aspect has allowed an assessment of the portfolio of IBS and non-IBS projects, both from the point of view of how well they could accomplish the project goals and objectives, and how well they allowed the development of competitive advantages to be sustained.

iv) Project Goals

The least influencing management factor on IBS decision-making was project goals. In the management of a building project, goals refer to activities that must be accomplished in terms of prioritising and timing. The results indicated that project goals was a main influence on IBS decision-making. Goals were perceived as having their roles to facilitate the implementation of project strategy and the new project developments.

IBS decision-making often proceeds in clear directions when goals are apparent. Clear project- and industry goals that are articulated by top management could influence IBS decision-making. However, it is also evident that sub-goals or specific project objectives must also be considered in IBS decision-making resulting in a close alignment of IBS decision-making with project needs. Additionally, management style must also leave enough flexibility for project members to develop commitment to their decisions, the timing of specific goals and the project-implementation approach. The project members must also translate their common purpose into specific project-performance goals such as complying with the tendering-, procurement- and design purposes.

Overall, the considerations and influences of project-related goals on IBS decision-making were influential because it was important for project members to uphold these goals by maintaining professional standards in the face of strong competition, for effective results to be achieved from IBS technology adoption. Moreover, project members were more optimistic in their overall perspective of IBS decision-making and were in fact interested in working on the adoption of IBS technology.

v) Leadership Qualities

Leadership qualities were discovered as the least influencing aspect of IBS decision-making. The results highlighted that the outcomes of IBS projects were dependent on carefully coordinated group efforts, requiring the project leadership to integrate many of the task specialists of IBS technology adoption in a dynamic construction environment with complex organisations and project interfaces. A strong emphasis on good leadership practice in the project, with clear accountability and focus on leadership skills and qualities, are necessary considerations in IBS decision-making.

Projects with clear leadership vision were important to transform the projects and must be initiated at the top and diffused throughout the project. IBS decision-making is also influenced by the clients' visions to achieve better project performance. This transformation has helped building projects to improve IBS technology adoption efforts. The results also pointed out the importance of visionary leadership along with project- and organisational terms, structures, systems, and process to translate and transform project visions of the future into project reality pertaining to IBS technology adoption.

The element of empowerment was also necessary in IBS decision-making. Empowerment through project leadership was another key factor of IBS technology adoption and its ability to gain additional value and competitive advantage in the construction industry. The results indicated that IBS decision-making involved getting inputs from all team members, through leadership and empowerment, then assigning the final IBS decisions to the team members who were accountable for the outcomes.

Overall, in IBS decision-making, it was discovered that the consideration of leadership qualities, particularly regarding empowerment, within a building project and from a structural management standpoint, could lead to a greater understanding of team or group processes in IBS technology adoption. The results have demonstrated that IBS decision-making also required various leadership aspects such as leadership qualities, their visions and empowering project members. This changing view of leadership has emphasised the need to synergise between management and leadership, since in IBS decision-making, leaders were seen to set directions and provide inputs for a building project to adopt IBS technology.

b) Project Condition

Project conditions were the second structural factor influencing IBS decision-making. The data shows that the conditions of building projects in the construction industry could determine their future. Increasingly, IBS technology adoption involved technically complex products and processes; therefore the results revealed that there was the need for cross-functional expertise or elements to improve project conditions and this was regarded as a powerful tool for IBS decision-making.

Furthermore, to implement IBS technology adoption, a decision-maker needed to call on the cooperation of many others in a building project and consider other project variables. It was important for decision-makers to understand the influence of project variables on the strategy, feasibility, design, operations, implementation and outcomes of IBS technology adoption. Therefore, those variables should be evaluated when deciding on IBS technology adoption, especially when assessing the option of building methods and technologies in order to achieve project goals. The star diagram, Figure 6.2 illustrates the priority aspects of project conditions in IBS decision-making.

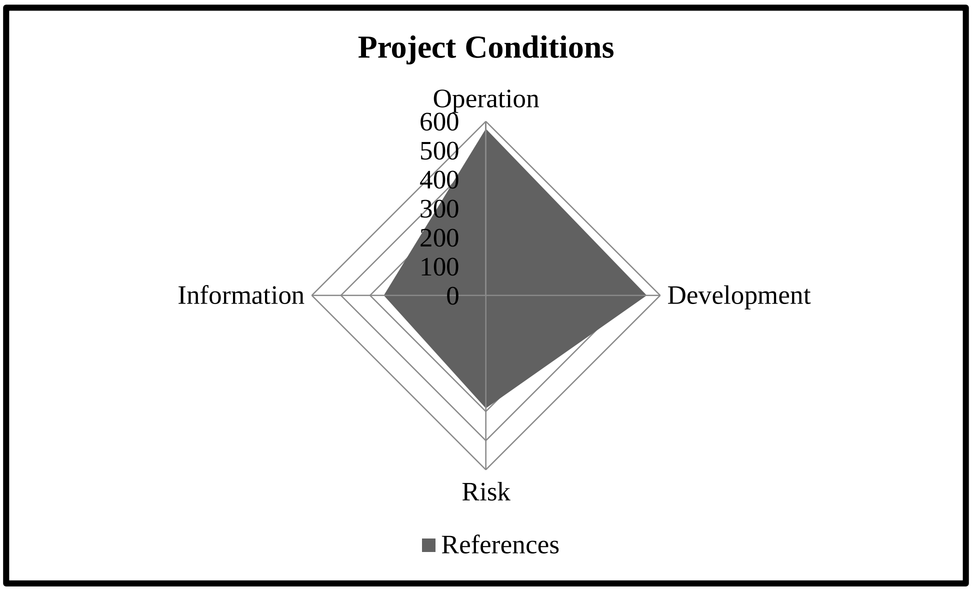

Figure 6.2 Priority Aspects of Project Conditions

Project operation appeared to be an important aspect in considering project condition with a great influence on IBS decision-making. The results also revealed the importance of gaining resources and recognition for the building project to ensure that the project's operations fit the overall plan of the project. There was a strong belief that improved results from project operations could also lead to increased profits or to better project performance.

The results indicated that the consideration of project types, for example public or private, could guide decision-makers to better evaluate these different types of project and their operational nature and include related project issues in IBS decision-making. It was evident that in IBS decision-making, it is vital to understand the increasing importance of different types of IBS technology for achieving project goals. In many cases, the identification of project types and their operational nature could lead to the more effective and efficient adoption of IBS technology.

In a nutshell, the relevance of project conditions was an essential consideration in IBS decision-making. Therefore, careful thought must be given to various project conditions particularly on how the building project is assessed, operated, developed and implemented. Detailed aspects of project conditions will be explained in the following sections.

i) Project Operation

The operations of building projects were implemented on a daily basis, up to a year. The results indicated that in IBS decision-making, project operations should be clarified in order to achieve projects goals. Moreover, the fundamental operating level of construction was the determination of project operations regardless of the size of the project.

The operational factors are highly impacted by the type of IBS technology used in building projects since it impacts the nature of site operations throughout the project stages. Moreover, these factors were perceived as representing relevant elements of the basis of IBS decisions, as they involved strong project supervision for the execution of well-focused project plans or strategies.

The results indicated that consideration of work procedures was important to enable project constructability and therefore the success of the building project. Their rationale was to make sure that all project operations were carried out efficiently and implemented based on the right work procedures, when adopting IBS technology. These procedures could also be linked to the work steps or initiation of construction activities according to the contract and resources allocations.

The results highlighted that the influence of project operations on IBS decision-making involved the way major construction works could be performed by the entities responsible for project execution. In essence, IBS decision-making was influenced by project-operations factors that included operational practicality, work procedures, project efficiency and project targets in the context of types and sizes of building projects.

ii) Project Development

The project development process in the construction industry requires the involvement of a large number of players including decision-makers, who comprise different project entities that need to work jointly to develop building projects. There was a clear indication that significant progress of construction works by adopting IBS technology for building project developments, was desirable and attainable. The results also highlighted the likely impact that a projects' progress may have on IBS decision-making.

Continuous project improvement was an area of focus in building projects that were to adopt IBS technology, as construction entities have the tendency to manage building projects on a project-by-project basis, with continuous improvement agendas being pursued. The results showed that achieving a sound balance between continuous improvement in projects adopting IBS technology, and diverting effort to bring on IBS technology, revealed that an understanding of the process by which IBS technology arrived and an appreciation of the barriers to its introduction were essential to ensure continuous project improvement.

Summing up, although building projects have in the past been seen to adopt IBS technology for a variety of reasons, the underlying strategic purpose should always be either, to help create and maintain a competitive advantage or to fulfil certain project specifications or clients requirements. Recognising this, the specific influence of project development on IBS decision-making could be stated in terms of, ensuring that IBS decision-making was coordinated with competitive moves, reducing the project's dependence upon labour and achieving greater long-term growth. This shows that in many building projects, the relative importance of the project-development aspect in IBS decision-making was also related to the project progress, overall improvement or performance, project effectiveness and project life cycle.

iii) Project Risk

In brief, this section discovers that construction risks in IBS decision-making are in terms of failure risk, financial risks and the risk associated with safety in building projects. The results indicated that the consideration of various risks in a building project was necessary. Therefore, IBS decision-making is concerned with identifying relevant project risks associated with IBS technology adoption, assessing their likelihood and impacts, and thus deciding how best to manage them. Taking calculated risks was revealed as a part of IBS decision-making. Moreover, the results indicated that IBS decision-making has been associated with huge financial and technology risks due to high investment in IBS projects.

The results highlighted the possibilities of negative impacts which influenced IBS decision-making. This was involving IBS designing solutions that are complex, difficult and costly to produce which may extend the project or contract duration. In many cases, consideration of the risk possibilities was a crucial part in IBS decision-making, since the implementation of new technology like IBS requires proficient risk projections.

Overall, the results indicated that there were varying degrees of project risks and their related features in IBS decision-making. Such risks may become not only a part of the risk management task, but also of operational-, functional- and strategic project management. The results also pointed out that it was difficult to deal with risk and changes in building project settings as they are constituted internally and cannot be easily quantified. Although the results have shown that the influence of project risks on IBS decision-making is relevant, for stable building projects, risks tend to be a normal occurrence that should not to be avoided but properly managed.

iv) Project Information

IBS decisions require timely and accurate information on the project-implementation plan and the project-development plan for better coordination and more certain IBS decision-making. IBS decision-making involves the consideration of setting project targets, in order to determine the project tasks that need to be carried out. The availability and accessibility of project information is an important tool in IBS decision-making. The results revealed that as a project was able to gather and process relevant information, particularly on IBS technology adoption, this may have contributed to more informed IBS decision-making.

IBS technology adoption must be supported in such a way that the availability of reliable information about the building project, from internal and external sources, could support IBS decision-making in a timely manner. However, the source of information on IBS technology adoption in building projects was seldom deployed according to the requirements of the project as a result of a shortage in information source. In order to decide on IBS technology adoption more efficiently, relevant information must be gathered or obtained from valid and reliable sources.

Further, the locations of building-project sites and of project-team members could be geographically different which required information sharing and transfer throughout the project-development process. As there was a scarcity of IBS project information in the construction industry, in terms of its specific IBS information system, the results also revealed that IBS decision-making should no longer be supported by technical and managerial information relying heavily on informal, paper-based documents which were inadequate, inconsistent, inaccurate and less systematic and could not lead to effective IBS decision-making. Moreover, accurate performance reporting and interpretation of IBS technology adoption should constitute a useful information input to the project-management function in general, and to IBS decision-making functions in particular.

In conclusion, the results revealed that project information, particularly on IBS technical adoption and other general project developments was influencing on IBS decision-making. IBS decision-making requires a variety of project information with an inherent compatibility between project input and output, making it accessible to construction entities for IBS decision-making. It was also discovered that as building projects transform resources, IBS decision-making also transformed information into various building-technology options. Therefore, decision-makers first must have complete project information in order to further understand, formulate and solve project problems confronting them.

c) Procurement Setup

Results revealed that project members appeared to recognise procurement aspects as another influencing factor in IBS decision-making. Major decisions such as IBS technology adoption were made during early project phases, even before the start of conceptual design, as the procurement setup is also determined by the IBS technology adoption of a building project. The features of procurement setup in the building project were evaluated because each of the procurement features has important implications for IBS decision-making based on the project risk allocation, project requirements and project activities.

It is evident that the procurement setup of IBS projects involved integrating the clients' objectives in the building project. The results show that the underlying principles of the project procurement pertaining to IBS decision-making involved the detail of IBS technology adoption in terms of its implementation in the project, based on the clients' requirements. The impact of a project procurement principle on IBS decision-making has indicated that construction professionals should make the assessment of project procurement to match with the priorities of the clients. The star diagram, Figure 6.3 illustrates the priority aspects of procurement setup in IBS decision-making.

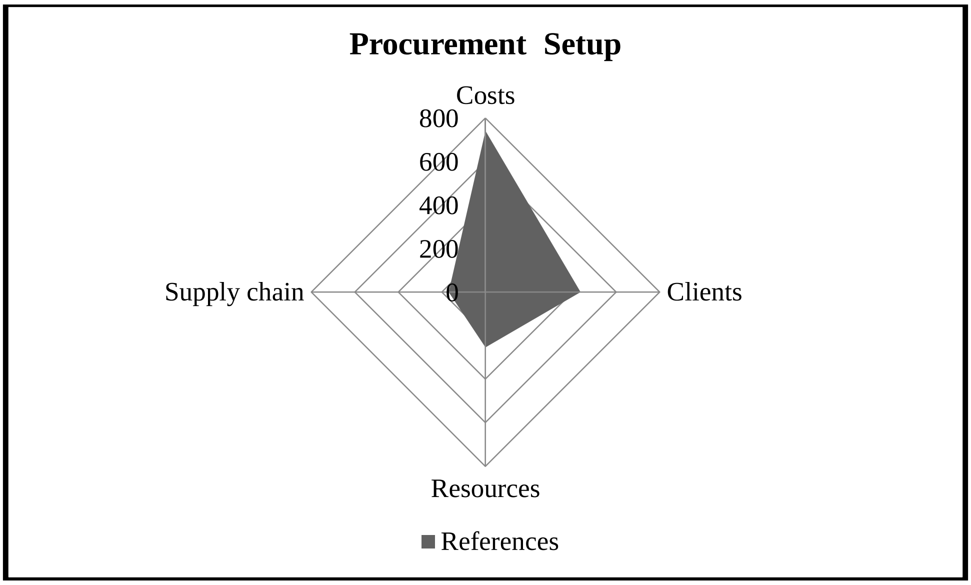

Figure 6.3 Priority Aspects of Procurement Setup

In IBS decision-making, it was necessary to consider the project's contractual terms, contract strategy, contract price, contract variations and the overall contracting process, as a part of its project procurement. It also appeared that although all these contractual matters could be linked with certain types of project procurement, there were further, or specific, considerations in the contract conditions when deciding on IBS technology adoption, such as the purchasing process, clarifying responsibilities, specific or special clauses, agency contract arrangements, sub-contracting and other specific contract provisions.

Overall, the results on procurement setup indicated that there was a close association between tendering, contracting, procurement mechanism and the project delivery itself, in deciding on IBS technology adoption in building projects. Decision-makers should deal with complex procurement challenges as the project procurement had to be opened out to a wide range of vendors and specialists, besides interacting with different parts of the project team. The findings also signified that in a project's procurement setup there were other considerations concerning the speed and complexity of building projects that must be clearly identified, considered and closely monitored in IBS decision-making.

Finally, procurement setup across development stages in building projects was fundamental to describe the underlying basis of IBS decision-making. The rationale for this consideration in IBS decisions was that procurement setup must be developed with regard to the structural characteristics of the construction project, using project-oriented perspective. The detailed findings of each procurement aspect will be discussed in the following sections.

i) Cost

It was discovered that, based on the project's procurement setup, cost aspect was the most influencing element. The results indicated that cost analysis in building-project procurement was necessary for the decision-making about building technology, like IBS technology adoption, which could secure costs based on project duration, design, resources allocation and delivery.

Although the project's clients have a huge role to play in the project procurement and project success, they also had to refer to cost information in all decisions, including IBS technology adoption, in order to drive out unnecessary cost. Thus, this evidence revealed that, from a project-management perspective, procurement tasks depended on the balance of three factors namely cost, quality and time against clients' requirements, while retaining the basic aim which was to complete or deliver the project at minimum cost, to the highest quality standard and in the shortest time possible, while also creating competitive tender prices.

In IBS decision-making, the estimation of a project cost was vital for assessing its financial viability for procurement purposes. In the procurement process of building projects, the site investigation aspect was also important to estimate the cost of site transformation work based on the site condition. Therefore, it was also easier to estimate construction activities based on a unit price or lump sum work price related to each construction work.

It was discovered that in IBS decision-making, capital costs must be taken into account in project procurement. Therefore, IBS decisions could imply the consideration of future costs and revenues associated with project procurement, including operating costs. Moreover, additional capital costs would be required to cover a higher stock level of IBS components and therefore it was worthwhile for the building project to earn a return on capital. It was reasonable to conclude that the cost of capital was an important element in the consideration of project procurement.

In conclusion, the most important consideration in building-project procurement, with regard to IBS decision-making, was the cost aspect. Particularly, it was important to consider the cost aspect as project procurement teams were exceedingly conscious of the problems of project survival and sought to predict, monitor and control costs and revenues far more diligently than in optimistic times. This evidence revealed that project costs should be monitored and tuned to the requirements of the project procurement, as profit was often seen as being the primary objective of building-project procurement.

ii) Project Clients

The results showed that in the context of procurement aspects pertaining to IBS decision-making, there was a strong influence from project clients on IBS decision-making. The requirements of the project's clients should not be overlooked as they were an important consideration of project procurement. The results discovered that many of the factors that specifically capture the nature of project procurement, namely clients' needs or requirements, orientation, categories and priorities were certainly considered as important in IBS decision-making. Thus, client concerns were considered as very relevant in terms of procurement influences on IBS decision-making, after cost aspects.

Accordingly, the orientations of a project client who was intending to decide on IBS technology adoption, were driven by the project procurement and also their strategic project plans, as the clients were orientated by the achievement of IBS technology adoption. By knowing and understanding clients' requirements, particularly in terms of their clear orientation in IBS decision-making, issues that were not really relevant could be avoided from being over-emphasised. Therefore, the results indicated that the clients' orientation could lead to the focus on more important issues in the procurement setup, such as cost and time financial viability when deciding on IBS technology adoption.

Consequently, client priorities such as project cost certainty, project speed or time and quality, role responsibility, control over design and the environment of consultants or contractors may be met in more than one of the procurement mechanism of contracting or tendering. In meeting clients' requirements, the priority of procurement criteria was important, to understand the implications of the different procurement criteria on IBS decision-making.

iii) Project Resources

In a project procurement process, as a part of its acquisition process, decision-makers must identify and evaluate the availability of resources for the purpose of IBS technology adoption. The results also highlighted the importance of considering all inputs that were required in the project-procurement phase when deciding on IBS technology adoption. One of the most important tasks in managing the procurement for a building project was to identify important and major resources that were required for the project and to assess their accessibility and availability.

It was evident that material resources could affect IBS decision-making from the procurement point of view. Apart from considering the costs of project procurement setup, IBS decision-making must also be fully resourced with the required inputs, funding, capacity, manpower and material. It is noted that these resources must be allocated to each procurement activity and their demand levels checked against the maximum limits set for each resource. Moreover, the ability of the building project to make a profit from IBS technology adoption was very much dependent on the ability to manage committed resources in the project procurement activity.

For the purpose of project procurement, it was not only vital to ensure the availability of human resources for IBS technology adoption, particularly technical experts in IBS technology itself, but also to include the manpower planning to ensure the most effective use of manpower for the implementation of any building project which adopted IBS technology. This condition, however, was a risky assumption to make since available, suitably skilled manpower may be limited in terms of its quantity and quality. It was therefore necessary to ascertain the availability, quality and quantity of the required IBS technical- and managerial expertise.

It was discovered that specific manpower plans could be used to determine the requirements of total manpower for the purpose of project procurement, which also function as a foundation for forecasting the demand conditions of IBS expertise. Therefore, in IBS decision-making, it was vital to take note concerning the impact of the human-resource requirement, as the skill profile of the work force of IBS projects must coincide with the construction activities to be carried out.

Overall, the results indicated that it was beneficial to consider the requirements and allocation of project resources for the procurement setup when deciding on IBS technology adoption. The essence of project procurement setup was an influencing factor in IBS decision-making because project capabilities were actually resulting from careful development and integration of the project’s resources, in such a way as to add value to them through the project development. One of the most useful insights in IBS decision-making was the influence of project competencies in managing all resources effectively as a function that must be performed prudently.

iv) Supply-Chain Roles

The results highlighted that in IBS decision-making, the concept of supply-chain management in project procurement was essential, both to improve IBS technology adoption and to provide information about logistic processes and costs for IBS decisions. Project procurement involved the calculative elements, control and planning features of IBS supply-chain management in terms of order management, logistics, transportation and on- or off-site management. The results revealed that since IBS technology adoption involved enormous and various building components, this situation required good product identification throughout the IBS components’ journey from the manufacturers to the construction site, based on an integrated supply-chain management system, to handle IBS supply and to control the flow.

Besides that, from the results, IBS stock- or supply control was an important consideration to identify the additional IBS supply needed to cope with fluctuations in demand and to determine those stocks that were held in anticipation of shortages or the price fluctuations of IBS components. Thus, the mechanisms of IBS-supply control or order management in building project procurement, have influenced IBS decision-making due to the duration of time taken to manage IBS orders, dispatching activities, delivery time and material handling. Specifically, these activities were also relevant to the allocation of costs associated with storage, insurance and safety, in ensuring sufficient storage and ordering capacity.

Furthermore, the logistics aspect was another important consideration in IBS decision-making, as a part of the project procurement setup. Logistics in IBS technology adoption involves physical distribution management as a of the whole construction process. As IBS components must be transported from the manufacturing plant or factory to the construction site, it was vital to consider the transportation of IBS components for easy distribution and installation. Therefore, it was evident that logistics management for IBS components was an influencing factor in IBS decision-making due to the importance of material- or components handling and operations related to the delivery of IBS components.

Summing up, the evidence shows that in order to deal with the complex and diverse nature of building projects, it was necessary to consider the perspectives of project procurement setup such as cost elements, supply chain, resources and clients' needs, nature and requirements in IBS decision-making. However, the influence of project procurement matters or setup on IBS decision-making was also dependent on the project size, type, nature, location, ownership and duration. Besides that, the influence of project procurement setup on IBS decision-making varied enormously, because some procurement mechanisms were purely based on price competition and project design. It can be concluded that while the cost aspect was perceived as an important area, it was not the only deciding factor in terms of how a construction project was organised and a procurement was effected.

d) Communication Process

Communication is another influencing factor on IBS decision-making, under the structural factors. It was discovered that project members must take into account the vital elements of project operations and developments in terms of communication practices, nature, process and the ways in which the elements of the communication styles were to be considered and integrated with IBS decision-making.

Moreover, the results highlighted that it was also important to recognise that almost certainly, various interactions would be involved in arriving at IBS decisions. Therefore, in considering the effects of communication aspects on IBS decision-making, decision-makers had to start by recognising the various outlooks of communication such as internal communication, external communication, communicating messages, feedback and contacts as they should not be looked at and managed in isolation. Instead, communication aspects should be seen as the component parts of the IBS decision-making process which in turn, is just one part of the project's management approach.

Underlying the elements and functions represented by the communication process of a building project was the influence of feedback on IBS decision-making. It was essential to ensure project team members obtained feedback on any project activities in terms of its shortcomings, performance, problems and constraints in terms of constructive response for corrective actions or inputs for IBS decision-making.

As IBS technology adoption was perceived to be characterised by high risk, and uncertain and high numbers of variation orders to the construction works while, at the same time keeping to the specified project duration, decision-makers would have to make sound and impromptu decisions. Therefore, the results revealed that effective communication in IBS decision-making must be meaningful, accurate, timely, coherent and relevant, through the integration of the communication process, feedback, contact and interaction from internal and external communication. It was also clear that developing open communication with a good relationship among project members was an on-going process that influenced IBS decision-making. Therefore, in IBS technology adoption, the ability to get information out into the field and vice-versa, through good internal communication, could support better IBS decision-making. Besides this, formal and informal communications were shown to be relevant determinants of IBS decision-making as illustrated in Figure 6.4.

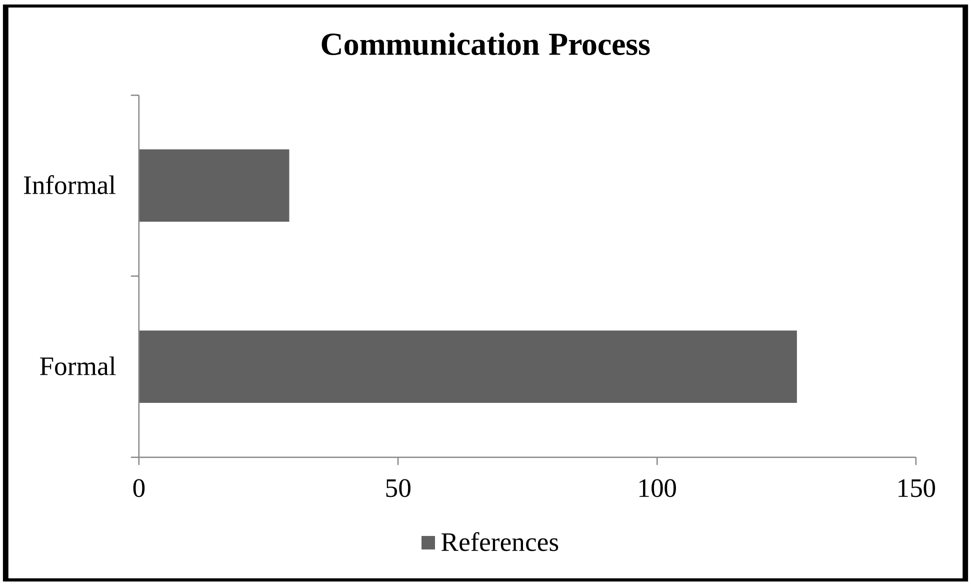

Figure 6.4 Priority Aspects of Communication Process

In many cases, the results showed that IBS decision-making was strongly associated with high levels of managerial- and technical communication by all project members with information sources in the project. Generally, the key to building-project communications was having a clearly defined communication channel with direct contacts between project members and other external members.

The results indicated that the internal communication aspect was an influencing factor on IBS decision-making, based on a wide variety of techniques for improving coordination and communication between building projects and their supporting staffs. Furthermore, it was important for project members to rely on more people both within their own technical- and managerial specialties, as well as on other specialties in the project.

i) Formal Communication

Generally, formal communication includes the systematic, orderly flow of ideas, sources of information, interactions and reporting relationships that could be easily identified and located in order to provide support to higher authority line and that facilitates control from the perspective of IBS decision-making. The need for formal communication to bring about a complete and coordinated understanding of the requirements and processes across a broad range of building projects and their members, when making IBS decisions is evident.

The formality of communication in terms of hierarchy was another important aspect to consider in IBS decision-making. Although in construction practices, the horizontal lines of communication were important, it was noted that the line of communication based on hierarchical authority was a means of achieving project integration and synergising diversified project members in IBS decision-making. Although that was the situation, most of the members in building projects had a contractual relationship with their client and therefore there were no clear hierarchical linkages with the project team leaders.

Specifically, the formal meeting was discovered as an important method of group communications which was held on-site, off-site and via telephone. Besides the formal meeting, other formal communication methods that were widely used in IBS decision-making were telephone, email, face-to-face discussion or conversation, fax, drawings and other written correspondences. Since the formal communication process was perceived as playing such an important role in IBS decision-making, proper interactions could lead to effective information flows among building project members and to other stakeholders outside the building project.

In seeking information from outside and inside a building project through a formal communication system or process, external events and internal developments were also important in IBS decision-making. Therefore, the influence of formal communication, with a clear reporting relationship, hierarchy, role and responsibility and communication methods, were revealed as relevant.

ii) Informal Communication

Although formal communication was an important aspect of IBS decision-making based on a formal structure, practices and protocols, informal communication was also considered an important aspect influencing IBS decision-making. Informal communication was related to any extra-formal mostly oral, spontaneous, casual, speedy and unofficial communication which facilitated IBS decision-making.

In addition to formal communication, the results indicated that building-project members encounter certain circumstances where informal communication can be justified for problem-solving, negotiation and professional relationship. Informal communication could influence IBS decision-making based on the fact that people who came to know one another through project activities or other inter-functional teams and inter-departmental projects, were more willing to communicate with each other and share information. As a result, building projects with an informal communication regime or environment were in a better position to take advantage of external information, since the members were capable of communicating across project boundaries without any of the constraints that formal communication methods could impose.

Summing up, it should be noted that formal communication was revealed as the most influencing factor by which the project members could keep abreast of IBS information, technical facts, technology, ideas, managerial input and other related developments, based on a formal system of authority and responsibility according to the hierarchical structure of the project or organisation. However, it was also verified that instead of relying on decision-makers to keep informed about IBS developments and building-project advances through formal communications, decision-makers were able to rely on their own external and internal relationships through informal communication.

e) Decision-making Style

The results indicated that it was fairly relevant to assess and address the decision-making style in a building project, when deciding on IBS technology adoption. However, the broad range of the decision process with detailed project analysis in IBS decision-making, was no longer a guarantee of a building project's success, as the priority was more on keeping pace with project's productivity and profitability.

In order to deliver the optimum decision, decision-making style was depending on the project goals and objectives. Consequently, these goals and objectives were considered necessary for the development of decision profile or guideline for IBS technology adoption. IBS decision guideline was an influencing factor in IBS decision-making as it could provide a guiding principle on how the performance of a building project could be evaluated and measured.

Therefore, it can be articulated that IBS decision-making should not be made in the fixed and normal patterns of decision-making approaches because new or changing situations in the construction industry, pertaining to IBS technology adoption, may require the customary ways of IBS decision-making to fulfil project requirements and achieve project performance. Specifically, this evidence revealed that the state of group- and individual decisions, besides the decision nature itself were regarded as impacting on IBS decision-making, as illustrated in Figure 6.5. Next, the analysis will look at the nature of both group- and individual influences on IBS decision-making and examine the ways in which these factors might be best utilised in arriving at effective IBS decisions.

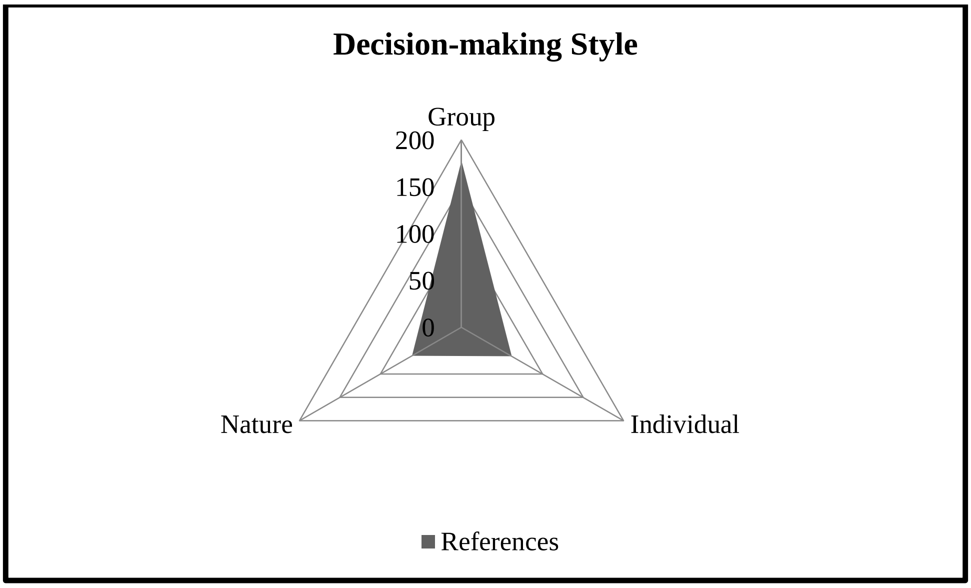

Figure 6.5 Priority Aspects of Decision-making Style

Overall, there was no single or dominant decision-making pattern underlying IBS decision-making, based on various decision-making styles, criteria, guidelines, decision alternatives and decision complexity. More appropriately, it was obvious that various building projects had different decision-making approaches or styles available when deciding on IBS technology adoption and fine-tuned them to suit distinct project objectives. In practice, the results showed that the decision-making style itself had a tendency toward minimising technical-, managerial- and financial risk in IBS decision-making.

i) Group Decision-making

IBS decisions within a building project were being made more frequently by groups rather than individuals. Thus, understanding the relative importance of group decisions in IBS decision-making was relevant, depending upon which group dynamics, inputs and values would be most directly oriented towards achieving project objectives. In order to make optimum and effective decisions, it was necessary to be aware of the group decision context that is related to IBS decision-making.

The results indicated that IBS decision-making was based on group decisions. In the competitive construction environment, project information was shared among project members, particularly about IBS projects, developments, issues and dynamics within the group. Therefore, for more complex decisions like IBS technology adoption, which is particularly of a strategic nature, a broader and analytical perspective of thoughts and analyses need to be used, thus IBS decisions within groups was required as it has a degree of technical and managerial judgment based on a high degree of complexity and uncertainty.

Consequently, in an attempt to determine the influence of group dynamics on IBS decision-making, the practice of group discussion was an important consideration, based on openness in interaction and collaboration in bridging into ideas and differences in various disciplines for IBS decision-making. It was discovered that group discussion became primarily a formal activity in which construction professionals working on their ideas from different perspectives.

It was noticed that informal groups in a project could occur spontaneously, naturally and voluntarily as project members interacted on a daily basis, consulting each other and sharing ideas, information and inputs for IBS decision-making. Since the members of an informal group have the capability of articulating similar ideas, beliefs and goals based on a consultative practice, they were able to act together in an organised manner with a known IBS goal, despite their differences or background.

ii) Individual Decision-making

Besides group decision-making, the results indicated that individual decision-making was another influencing factor to complement group decision-making due to the fact that individual members of the group had to reach an agreement or consensus if they were to arrive at a decision. This supported the fact consultative processes with various verifications were time consuming as IBS technology adoption was considered to be uncertain and risky in nature.

There was also a practice in IBS decision-making where certain project decisions should be made on a personal basis. However, although that was an individual’s decision, it was made on the basis or principle that a decision-maker must act in the interest of the project and its clients, based on the collectivism of all project variables and team numbers.

In conclusion, although individual decision-making pertaining to IBS technology adoption was related to personal aspects, such as an individual’s background, and involving personal judgments, it was governed by a variety of building-project factors such as project performance, skills, tasks, goals and objectives. Nevertheless, it was clearly important to consider how individual decision-making impinged on the decision-making process of IBS technology adoption and hence how the process could best be structured to accommodate it in building projects.

iii) Decision Nature

In describing the nature of IBS decision-making, basically there seemed to be project-team members, led by a project leader, who met to discuss the operational development of a building project. Further, the top management teams such as the board of directors, met to discuss and decide on matters pertaining to long-term- and strategic project development or business plans, including IBS decisions. It was discovered that IBS decisions derived from the board meetings were based on a combination of project needs and the interests of various construction stakeholders.

Once the general strategic direction on IBS technology adoption was decided upon, the plan of the building project was divided into project sections and organisational sections. Further, it was verified that building-project members had to further analyse operational-, managerial-, tactical-, resources-, procurement- and logistics issues pertaining to IBS decision-making. Based on their findings, considerations and implications, the project leader could then make recommendations to the top management of the project. However, it was acknowledged that common agreement was not essential at the low and middle levels of management because an acceptable consensus at the level of top management had to be reached since they would make the final IBS decision, at that level.

However, the board of directors was rather passive and acted more as a receiver, processor and evaluator based on related project information, before endorsing recommendations by the project team members. On the other hand, these views alleged that the team members of a building project were in the position of working in close collaboration with the board, making joint decisions based on consensus or agreement.

Further, the leader or director of a building project then gave an outlook on the overall building-project plan pertaining to IBS technology adoption, in which the board of directors made their justifications before making the final IBS decision. It was discovered that after the building-project development plan had been endorsed, the management team of building projects set about implementing the development plan to reach the stated project goals or targets. This shows that it was common for the operational plan of a building project to be subjected to periodical reviews, according to contextual changes and also any unexpected circumstances, if necessary, altered in procurement, managerial or operational areas. Hence, the decision nature of a building project could also impact on IBS decision-making.

6.3.2 Contextual Factors

Besides structural factors, the results revealed that contextual factors, with the emphasis on economic conditions, were the major influences on IBS decision-making. Additionally, it emerged that there were other contextual factors which also impacted on IBS decision-making such as technology development, government involvement, sustainability features and stakeholders' participation. As illustrated in Table 6.7, contextual factors consist of five major elements with their respective priority aspects.

Table 6.7 Contextual Factors Associated With IBS Decision-making

CORE FACTOR/ THEME: (As perceived by the participants)	**FACTORS:**	**Source:**	**Frequency of occurrence/ References:**	**PRIORITY ASPECTS:**	**Source:**	**Frequency of occurrence/ References:**
2. CONTEXTUAL *(54 Sources, 5918 References)*	Economic conditions	54	2127	Business	53	638
				Demand	52	296
				Opportunity	46	165
				Uncertainty	37	116
				Competition	42	112
	Technology development	54	1341	Productivity	53	379
				Quality	53	329
				Innovation	49	187
				Creativity	31	75
	Government involvement	54	986	Promotion	50	236
				Policy	49	171
				Requirement	46	138
				Rules	41	131
	Sustainability feature	53	683	Environment	50	264
				Efficient	48	164
				Waste	32	85
				Trends	36	73
	Stakeholders participation	54	606	Opinion	52	249
				Partnering	49	247

The levels of contextual analysis and IBS decision-making were highly dependent on the economic conditions. In this case, it was discovered that business issues represented the utmost concerns in IBS decision-making. There was a clear business consideration in IBS decision-making due to the demand in the construction sector such as housing, schools, hospitals and office buildings.

Overall, the results indicated that the dynamics of the construction business and industry, in terms of their contextual factors, were considered as relevant influences on IBS decision-making. Although the ultimate decision-making of IBS technology adoption was dependent on the board of directors or the top management team, as explained earlier, it has emerged that IBS decisions were also subjected to important factors in the context of the construction industry. This context has appeared to be a relevant factor in IBS technology adoption, in order to make more informed- and certain IBS decisions.

On this basis, construction professionals had to make careful analysis of contextual influences and their unique situations. IBS decision-making has to deal with a complex stream of decision processes, therefore, there are multiple contextual factors and their numerous aspects that must be acknowledged and considered by a decision-maker. The following analysis will specifically explore the influences of contextual factors on IBS decision-making, which involved factors such as economic conditions, technology development, government involvement, sustainability features and stakeholders' participation.

a) Economic Conditions

The results indicated that economic factors were highly considered as impacting on IBS decision-making in building projects. This situation was linked to the decision-makers who attached high absolute importance on economic features in IBS technology decisions. Additionally, it was discovered that the importance of economic considerations with their various changes could have impact on IBS decision-making. Many project decisions, particularly on IBS technology adoption, appeared to be based on the circumstances of the construction industry, particularly on economic issues related to the practice, growth, stability and dynamics of the construction industry.

Besides that, the results highlighted the most important economic and industrial elements which influence IBS decision-making, particularly in relation to general economic matters and industry development, as there were other specific economic aspects that also impacted on IBS decision-making. The findings indicated that other economic aspects such as business, demand, opportunity, uncertainty and competition, all parts of the economic conditions, had their impacts on the decision-making of IBS technology adoption, as illustrated in Figure 6.6.

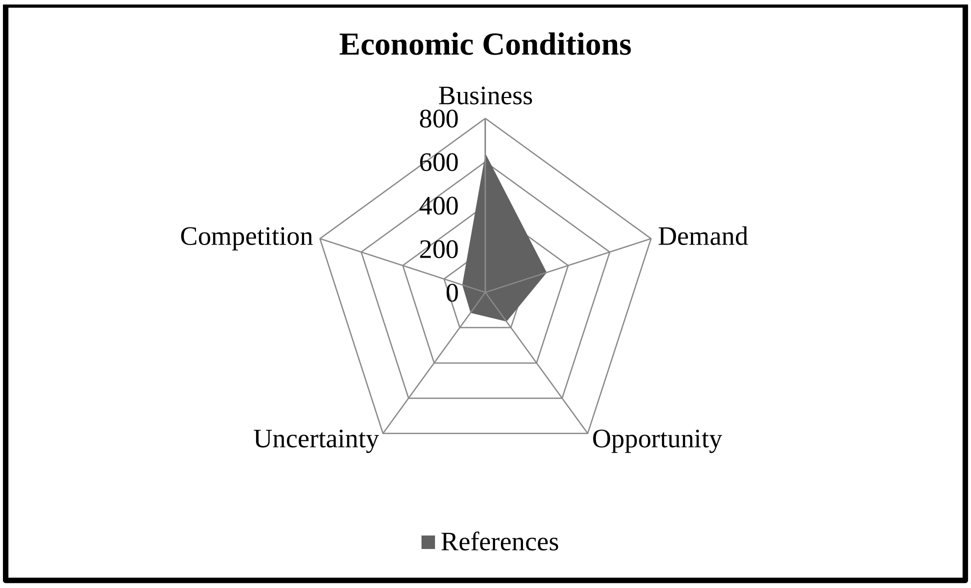

Figure 6.6 Priority Aspects of Economic Conditions

The consideration of economic conditions could be regarded as tangible and dynamic factors by construction professionals or project members as there was an expectation that the economic- and industry outlook would be either expanding and encouraging or shrinking and threatening. Nonetheless, the results indicated that economic conditions only became more critical in IBS decision-making when there were problems during the development of building projects, due to their long-term nature.

i) Business Dynamics

This part indicates the degree of consideration, integration and responsiveness towards business dynamics in IBS decision-making. The results highlighted that the entities of building projects were very sensitive to business issues that might have impacts on the decision-making of IBS technology adoption. Although the implementation of building projects usually took significantly long time, decision-makers must be optimistic in their business viewpoints based on market conditions, investment scenario, financial market and income growth, yet be highly cautious about IBS technology decisions due to changes in the development of the construction business. It was also discovered that decision-makers had to respond to the underlying forces or the primary influences of business factors in the construction industry.

Although the results did not indicate exactly what type of business constraints influence IBS decision-making, the fact that all project members must consider business constraints related to financial aspects. The deliberation of these financial aspects would allow decision-makers to generate the alternatives of building technology adoption from a business perspective. Hence, it was discovered that financial aspects were particularly relevant for construction professionals when deciding on IBS technology adoption, with the consideration of diverse industry changes to meet exceptional building project requirements.

Investment issues pertaining to IBS technology adoption were more likely to lead to higher project costs, due to additional resources allocation and despite the expectations of future benefits from the decisions of IBS investment. The decision to adopt IBS technology could be considered as an investment because it was related to the projection of income- or profit growth in a building project. Moreover, in many cases, project decisions were based on the potential return of IBS technology adoptions that had been invested and projected in building projects. This evidence revealed that the aspiration for building technology, coupled with the financial and business attraction of IBS technology adoption have influenced IBS decision-making that may not have been decided purely from the perspective of building-project requirements.

Conclusively, it was discovered that in the competitive nature of the construction industry, there were specific external business elements that had to be dealt with in IBS decision-making. In particular, not only were there issues relating to general business situations which had to be considered, but also judgments about the balance between market growth, financial aspects, investment trend, income, return and survival goals.

ii) Market Demand

In IBS decision-making, one of the important factors based on the economic perspective was to comprehend the market- or industry demand for building projects which could be completed in a shorter construction period by adopting IBS technology. Such comprehension was clearly considered as an essential consideration in IBS decision-making in order to discover, encourage and focus on the new segments of building markets.

Nevertheless, the results highlighted that decision-makers in building projects generally have limitations in forecasting building demand without the assistance of consultants or economic analysis, as the insights of some decision-makers pertaining to IBS technology adoption were constrained by their limited knowledge or involvement in this technology. In general, market needs and industry demand were becoming highly developed in conjunction with other growths in business-, education-, administrative-, health- and defence sectors. Although IBS decisions are made prior to the demand for IBS technology adoption in building projects or for the fulfilment of a project requirement, the potential growth of future construction sectors may have not contributed considerably to the subsequent IBS decision-making.

Another finding was about some differences, in terms of how the industry needs of buildings impact on IBS decision-making. The results indicated that in IBS decision-making, the influence of industry needs is given a greater consideration than demand factors. The success of IBS technology adoption would require building projects to link their technical and managerial capabilities with the demand of IBS technology standards which were required by the clients, and to fulfil the construction industry's aspirations.

In summary, the results highlighted the demands of clients, projects, markets and industry in terms of their needs, wants and requirements in the decision-making of IBS technology adoption within the capacity of project resources. It was also discovered that the development of building projects and IBS technology adoption were considered as equally influencing IBS decision-making. Hence, IBS decision-making was influenced by the continuous demands for project development or building products in general, and IBS technology adoptions in particular.

iii) Industry Opportunity

The results discover that generally, building projects have a philosophy of being proactive and opportunity seeking in the construction industry. IBS decisions had to consider new opportunities arising from recent project developments such as townships, research- or lab buildings, high-rise buildings and public facilities or infrastructures. Therefore, the aspect of attaining the industry opportunity in building-project developments, through IBS technology adoption, was considered as influencing IBS decision-making.

Although being technology pioneers was considered to be risky and uncertain, those pioneers in IBS technology adoption had been learning and improving themselves throughout other building projects' growth. Since IBS technology adoption could be considered as a comparatively new technology in the Malaysian construction industry, in IBS decision-making, there are various potentials for exploring more untapped building markets, particularly in residential- or housing markets, due to the opportunity of future growth in these markets, rather than competing in the existing commercial- and office-building markets.

There was an optimistic view that in IBS decision-making, with high potential building demand in the Malaysian economy, the existing construction market could be still relied upon. Therefore, it was encouraging for the construction entities to discover the opportunities of IBS growth, not only in terms of the breadth of geographic coverage, but through economies of scale, strategic alliances, manufacturing efficiency and a superior knowledge of IBS technical expertise. Summing up, all these situations were considered as having influences on IBS decision-making.

Subsequently, the results revealed that IBS decision-making was also influenced by the capabilities of building projects to implement IBS technology, based on the exploration of trade- or commercial opportunities which is carried out incrementally, mainly due to a number of concerns such as government policy, industry requirements and government regulations but also because of cost implications, market conditions and technology feasibilities. Therefore, it was evident that IBS decision-makers must develop understanding, commitment and skills to deal proactively with new building projects and construction-industry situations due to the influences of business opportunities.

iv) Industry Uncertainty

Another interesting finding is that the aspects of industry uncertainty was considered as another influencing aspect on IBS decision-making. Specifically, decision-makers in building projects were seeking to strike a balance between being prepared for uncertainties and taking rapid advantage of construction-industry opportunities, in order to make informed and optimised IBS decisions.

Apparently, uncertainties in the economic context of the construction industry were arising from a lack of future analysis and projections, particularly concerning IBS technology adoption in building projects. Therefore, it was vital to consider economic uncertainties, from the perspective of local and world economic development, when deciding on IBS technology adoption. The results revealed that if a decision-maker was unable to assign probabilities to any unexpected elements within the construction industry in particular, or the whole economic- and business changes in a broader spectrum, there was some possibility of those unexpected elements impacting IBS decision-making, in terms of the future performance of building projects.

Although the results pointed out that complete and comprehensive information on IBS technology adoption was rarely available, decision-makers must then utilise any available information regarding IBS technology. On the other hand, in IBS decision-making, the anticipation of future building markets should neither be considered as too optimistic nor pessimistic because it should not be expected that any particular uncertainties about the future of IBS technology adoption would be correct in every detail, nor necessarily very detailed in its conception. Therefore, in many cases, when dealing with future uncertainties in IBS decision-making, a balance must be maintained in dealing with the short-term and long-term future of IBS technology adoption in building projects.

On the whole, IBS decision-making had to consider the restructuring of the world economy and the restructuring of local economic conditions as they tend to impact on short-term financial goals intended for the determinant of long term results. However, despite the influence of economic- or industry uncertainties, the intensification of competition, via project cost-effectiveness and more focus on cost-benefit analysis, was creating an acceleration in the shift from a conventional building approach to IBS technology adoption due to technological imperatives in building-product- and building-process innovation, with an emphasis on new building concepts and shorter construction periods. In summary, the decision-makers had to be open to new opportunities and very alert to economic uncertainties, as well as ready to take on new challenges in IBS decision-making.

v) Industry Competition

Despite the fact that there were concerns regarding the element of economic factors like business, demand, the availability of opportunities and uncertainties related to IBS technology adoption, the element of industry competition was another consideration in IBS decision-making. The results revealed that another dominant aspect in the decision-making of IBS technology adoption pertaining to building projects was the competitive nature of the construction industry. The results also showed that in IBS decision-making, the industry standpoint towards competitive dynamics was obvious.

Additionally, it can be seen that competitive dynamics were influenced initially by demand and supply conditions, as discussed earlier, followed by the conditions of price, market, costs, strategies and bidding. This evidence shows that these elements in turn have determined the construction-industry structure, performance and conduct, including IBS decision-making.

The results indicated that despite generally being recognised as a threat in the construction industry, industry competition has emerged as a positive influence because it may generate high commitment and perseverance in the construction business. However, it was also noted that the impact of industry competition seemed to be larger if more experienced and powerful competitors could create a healthy competition in the construction industry. Likewise, it was inappropriate to count too heavily on competition as a long-term trigger in the construction industry because the element of competition was a part of the construction industry's nature.

Another competitive element that influenced IBS decision-making was related to the composition of value-added or the distinctive features offered by different suppliers in the building-market offerings. The added values of IBS technology adoption comprised of cost advantage, product quality, logistic or delivery efficiency, design flexibility and technical expertise. Therefore, it was discovered that in IBS decision-making, decision-makers could arrive at a measure of the nature or character of competition in the construction industry, particularly in IBS building markets, by considering the extent to which each supplier, or even other construction stakeholders, could develop total new demand, and the way in which they were competing with others for a share of the existing demand in the construction industry.

b) Technology Development

The next influencing factor on the decision-making of IBS technology adoption was technology development factors. The results revealed that decision-makers seemed to be driven by economic factors, as they not only had a detailed understanding of their current and potential markets, but also of the resources and project ability to capitalise upon the business opportunities in the construction industry, through building-technology development.

The implications of IBS technology development for building projects were not straightforward due to the complex nature of the construction industry. However, the relevance of technological change brought by IBS technology adoption needed to be seen not only at the project level, but also at the industry- and national level, since the economy's growth, as discussed earlier, was directly influenced by the level of technological advancement.

Likewise, the results highlighted the need to set base- or minimum levels of IBS technology transfer in order to manage and regulate the decision-making of IBS technology adoption in building projects. Therefore, IBS decision-making in building projects in Malaysia had to be more appropriate, in terms of a greater emphasis upon the regulation of technological change in order to minimise the undesirable effects of some new building concepts, as a step forward for IBS technology transfer.

The implementation of innovative technology in construction such as IBS has the potential to improve the industry in terms of productivity, quality and creativity. Constructive factors can facilitate the transfer of IBS technology to construction work process whilst destructive factors tend to create barriers to IBS technology adoption.

In summary, it was appropriate for decision-makers to consider IBS technology-related matters such as technology-management issues, technology-adoption problems and technology-transfer mechanisms. In many cases, IBS decision-making should be technology driven, with feedback from project members and the industry to determine the effectiveness and practicality of IBS concepts and the relative size of the market. In particular, the results on how technology factors influenced IBS decision-making are presented in the following way, as illustrated in Figure 6.7

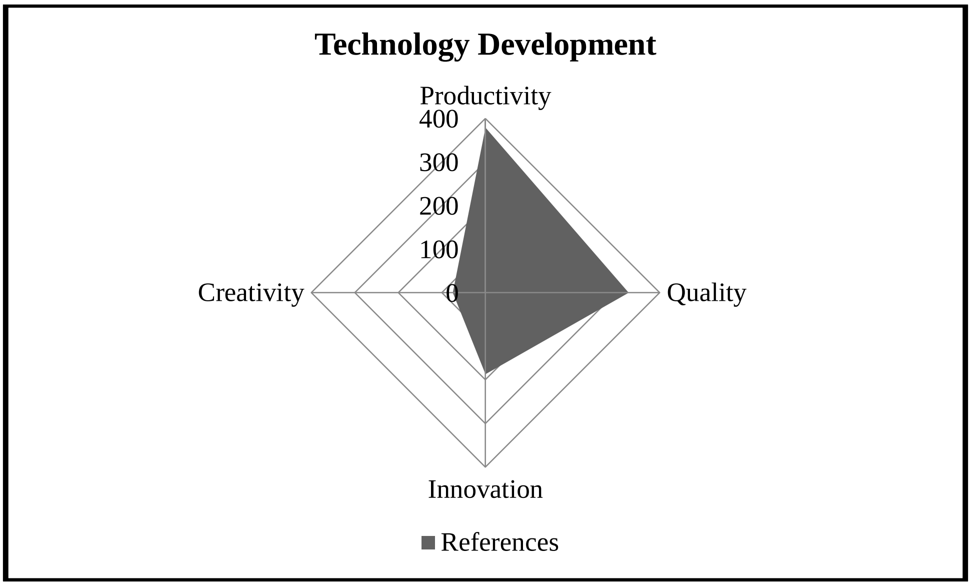

Figure 6.7 Priority Aspects of Technology Development

In IBS decision-making, the results revealed that it was important to refer to various technology-adoption issues in the application of a new technology like IBS, including not only the physical and technical aspects of the technology but also the attributes of IBS technology adoption such as productivity, quality, innovation and creativity. It was noted that IBS decisions were not solely based on the scenario of IBS technology transfer because there were always some problems and limitations, to a certain degree, based on the accelerating change of IBS technology developments.

i) Technology Productivity

This section shows the results on the way productivity improvement can be achieved by the adoption of IBS technology in building projects and the influence of productivity aspects on IBS decision-making. The results highlighted that the benefit of productivity improvements in building projects, created by IBS technology adoption, were essentially obvious and this situation has also impacted on IBS decision-making.

Specifically, throughout Malaysia, the construction industry was running short of skilled workers for building-project developments despite the abundance of cheaper and unskilled building workers. The effect of this situation was a shortage of qualified construction workers which would have to be resolved by a combination of an ever greater investment in building technology and the replacement of people with technology, which could be offered by IBS technology adoption with the advantages of productivity improvements in building projects.

Additionally, further development of IBS technology in the construction industry would ensure a higher level of building productivity. The technical revolution of IBS technology adoption in building projects would further allow a far greater range of building-project problems to be resolved, particularly those related to labour shortage, weather conditions, completion time and site management.

The results verified that, although the conventional method of building construction would still exist in the construction industry, IBS technology adoption with new building concepts, materials, manufacturing process and construction techniques would mean that every building project could be different in terms of productivity achievement, with the entities of building projects effectively able to design and construct a customised building project. All these developments were influencing IBS decision-making.

In summary, it was discovered that, from the perspective of technology development, to a certain extent, productivity concerns had impacted the decision-making of IBS technology adoption. The results highlighted that understanding and considering project issues such as improvements, output and performance, could improve productivity achievements in building projects, particularly as a part of the importance of competitive strategies in IBS technology adoptions, and how to acquire them, has made the adoption-of-IBS-technology loop clear and accessible to all.

ii) Technology Quality

This section will explain the aspect of quality pertaining to IBS technology adoption that impacted on IBS decision-making. It was apparent that the aspect of technology quality was considered to be associated to the physical or tangible nature, and output, of building projects despite project constraints, requirements and dynamics. Moreover, there was a strong case for the more widespread utilisation of standards in IBS technology adoption, as the origin of these standards was based on the quality achievements of IBS design features, in terms of project specifications and project performance.

Additionally, in IBS decision-making, the standards of IBS technology adoption were essential as a control mechanism in a building-project delivery. Moreover, the results showed that project implementation of these standards may benefit the building projects in accordance with a quality-management system to conform to the standards of the construction industry.

The attention to technical specifications and quality standards in IBS technology was an essential consideration in IBS decision-making. There should be clear interpretations of IBS technology standards to match the industry expectations and needs, in adopting IBS technology in building projects. The results also highlighted the importance of IBS component testing for the requirement of building project specifications. There was also the need to know and provide IBS technology specifications and its standards because they could be used as a useful tool to evaluate building-project performance.

Moreover, the results showed that, not only IBS components or products which were manufactured locally had to undergo the certification process, but also imported IBS products or components. Those components had to be verified on a case-by-case basis. Based on a different perspective, in many cases, certain building projects failed to achieve a high performance level because project requirements and standards were are not fully interpreted despite the availability of building- or industry standards. Therefore, these standardisation issues pertaining to IBS technology have also influenced IBS decision-making.

Further, by having such quality measures and considering them in IBS decision-making, this could facilitate and improve the IBS technology adoption process by increasing its durability and suitability. The results also highlighted the importance of quality management for defining and controlling the quality of building projects, with several intentions to maintain close relationships with the client and to manage the stakeholders in accordance with their influence and power. Thus, IBS decision-making would consider technology quality features as an approach for meeting client's requirements and expectations and that approach must be able to address quality matters if quality perceptions were not to fall short of expectations.

iii) Technology Innovation

The results also highlighted the influence of innovation aspects on IBS decision-making. Technical innovation in IBS technology has been imposed on the construction industry from time to time, not only from the perspective of IBS product development, but also in terms of its adoption and implementation in building projects. The implications of IBS technology innovation have shown that the elements of modernisation, improvement, advancement, transformation and revolution in building projects were relevant in IBS decision-making.

Additionally, the results pointed out that IBS decision-making was influenced by the technical innovations of IBS technology in terms of standardisation, durability and method, particularly of IBS components. This could be due to the government's emphasis on technological innovation to adopt new methods in building construction through research and development. Technologically, in IBS decision-making, it was necessary to consider innovative outcomes from IBS technology adoption such as modifications of existing buildings or entirely new building projects and project alterations or building modernisation.

However, the results indicated that the improvement of IBS technology should focus on various improvements including small-scale building projects such as residential sectors and public facilities. Besides anticipating the influence of innovation aspects on IBS decision-making, the results revealed that IBS innovation must be supported by the transformation of IBS technology through continuous research and development by all entities in the construction industry.

In summary, the results on IBS technology innovations and their subsequent effects on IBS decision-making were based on practical outlooks on technology modernisation, improvement and advancement. It was discovered that IBS innovations were occurring through technical efforts carried out primarily within, and from, an internal project context, but involving extensive interaction with external technological innovation as well as economic contexts.

iv) Technology Creativity

The results indicated that the aspect of technology creativity must also be anticipated in terms of its connection with IBS technology adoption. It emerged that IBS decision-making was also related to the element of technology creativity. The results showed that technology creativity in this context was referring to the aspect of IBS technology impetus and the distinctive, or unique, elements of IBS technology implementation in building projects.

However, creativity elements were considered as not so critical to the success of IBS technology adoption, and thus created less influence on IBS decision-making. The results indicated that the element of creativity was not a means of developing new ideas and solutions in IBS technology adoption that could influence IBS decision-making but related more to the artistic and aesthetic perspective of IBS technology adoption in building projects.

Summing up, results revealed different outlooks on the element of technology creativity which was considered, one way or another, in IBS decision-making. Despite the results that revealed creativity as a technology aspect that could be managed and improved, the results also showed that IBS technology was regarded as a project- or design constraint. However, the overall potential of creativity elements in IBS technology adoption for project developments was indicated as an influence on IBS decision-making.

c) Government Involvement

While the results highlighted two major contextual factors namely economics and technology, as presented earlier, there was also another contextual perspective, namely government involvement, which impacted on the decision-making of IBS technology adoption. The results indicated that decision-makers appeared to be well aware of the roles and influences of the government involvement in IBS decision-making.

In many cases, IBS technology adoption was subjected to some government directions or commands, particularly in government or public projects, with the emphasis of the government policy on IBS technology adoption in building projects. The results revealed that government involvement was an important consideration in the decision-making of IBS technology adoption. The government's roles included growth agendas for IBS technology acceptance in building-project developments, with specific ministries directed to undertake special tasks relating to these initiatives. This evidence revealed that the features of government roles in IBS technology adoption have been set with a vision of enhancing Malaysia's competitiveness in the construction sector.

It was discovered that IBS technology adoption in building projects has been achieved by the government's direct intervention, as one of the major clients for the construction industry, and indirectly through the government mechanisms to regulate IBS technology adoption in this industry. Further details on the aspects of government factors will be presented in the following sections based on Figure 6.8 as illustrated below:

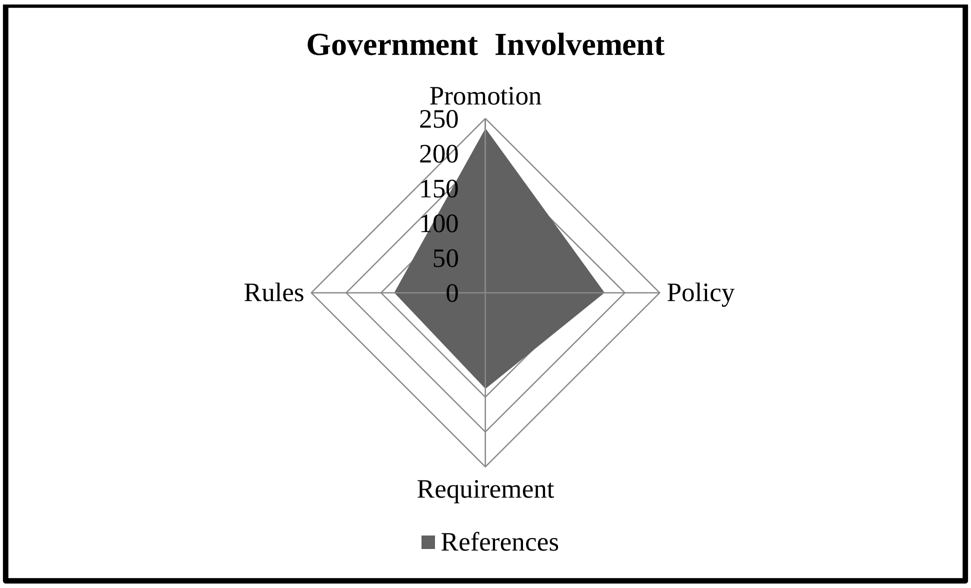

Figure 6.8 Priority Aspects of Government Involvement

Therefore, the results showed that the influence of the government's role could not be disregarded in IBS decision-making as the government involvement and roles were also linking to various rules and regulations in the construction industry. Besides that, the government has been active in its efforts to strategically manage the construction industry with the initiative of IBS technology adoption through the government bodies, especially the Construction Industrial Development Board (CIDB). The results pointed out that the government initiatives must be considered in IBS decision-making, reflecting that the adoption of IBS technology in building projects, to a certain extent could be supported and facilitated by the government.

In summary, the government's role in IBS technology adoption was considered as influencing IBS decision-making, based on the authoritative nature of the government's administration, control and aspiration for fundamental changes in the construction industry. By considering the government as a regulator for the development and adoption of IBS technology in building projects, this has reflected that the government's roles, directions and initiatives could be keys to the success of IBS technology adoption.

i) Government Promotion

In order to further describe and analyse the government's influence on IBS decision-making, the most important aspect of government's involvement in IBS technology development to be considered, is its promotional efforts. It was always obvious that promotional activities in IBS development by the government, including having clear policy on IBS technology adoption with various mechanisms of encouragement, support, guidance and incentives, were also influencing IBS decision-making.

The important role of the government to promote IBS technology could not be underestimated, in view of the requirements of building projects and technology needs within the construction industry. The results also showed that the government had been involved in IBS promotional activities and these activities had created impacts on IBS decision-making in building projects.

Consequently, the results showed that not only do levy exemptions, but other incentives must also be offered with more attractive and productive offers as promoted by the government to the construction industry. Therefore, all these kinds of promotional efforts by the government were identified as influencing IBS decision-making.

From another point of view, although major progress has been made by the government on IBS promotion, the results indicated that further progress was expected in order to accelerate IBS adoption, hence this idea was considered as an important input in the decision-making of IBS technology adoption. While the results showed the idea that IBS promotion efforts and other related activities by the government could further accelerate IBS technology adoption, they also indicated that it was difficult to adopt IBS without having better and clear guidance, incentives and encouragement from the government, in terms of standards, implementation system and operating procedures.

ii) Government Policy

Next, the results revealed that the aspect of government policy was another important consideration in IBS decision-making. The decision-making of IBS technology adoption, to a certain extent, was facilitated by the government policy on IBS technology innovations and directives to the construction industry. The government's role in the process of IBS technology adoption could be meaningfully represented by a more established technology policy, in providing better foundations for building project developments which could link the project strategies to their final outcomes. Therefore, it was obvious that the recognition of IBS policy, together with other related guidelines, procedures and outlines, have allowed IBS decision-makers to consider the government policy on IBS technology adoption, in its decision-making.

On the other hand, the results revealed that the availability of IBS guidelines was insufficient, and they were inconsistent or unclear. This result was supported by another on how IBS guidelines could be used in providing construction professionals, as project members, with essential procedures or guiding principles on how they could adopt IBS technology to support building-project development. Therefore, IBS guidelines could assist decision-makers in IBS decision-making.

In summary, it was discovered that one of the government's tasks was to account for, and to provide and develop as effectively as possible, the IBS policy with which it has been entrusted. However, it was also noticed that IBS policy did not devise an evolution through which it could satisfactorily assist IBS progress and achieve distinctive, or superior, project performance in any way other than in a passive sense, and further, this often had little relationship to IBS project developments.

iii) Government Requirement

The results also pointed out that even though the government policy on IBS technology possessed some of the approaches to develop and accelerate IBS technology adoption in building projects, as supported by various government agencies, it was uncertain whether to decide on IBS technology adoption if the building-project developments were not deriving the optimum advantages from IBS technology policy.

Therefore, despite the recognition of IBS technology elements, it appeared that the specific requirements of certain project types were perceived as important in IBS decision-making. Further, the results indicated that decision-makers in certain building projects did consider critically to adopt IBS technology based on the justification of fulfilling government requirements pertaining to IBS policy, particularly in public-project developments.

However, the institutionalised roles between the construction entities and the government bodies should be radically changed in order to increase the success rate of IBS technology adoption in building projects. One of the effective means to avoid disharmonies among the entities of the construction industry was dependent on the government roles to develop its mechanisms in generating and implementing the standardisation of IBS technology requirements and to inculcate this role as a part of its policy on IBS technology adoption in building-project settings. Therefore, in IBS technology adoption, fulfilling the government requirements of adopting IBS technology was considered as influencing on IBS decision-making.

Additionally, it was essential to consider the government requirements of adopting IBS technology due to the issue of labour shortages and the requirements for a cleaner and safer, built environment. Therefore, the establishment by the government, of project requirements to adopt IBS technology was considered as a step to overcome labour shortages and a part of the government's obligations in response to labour issues, automation and higher work productivity.

iv) Government Rules

As a continuation to the government requirements, there were various laws, regulations, instructions and approvals as a set of rules with their functions to control the development of building projects. Specifically, the results highlighted that the rules of construction activities pertaining to IBS technology adoption in building projects had to be considered in IBS decision-making as they must comply with those guidelines, particularly in the areas of project specification, safety and design. For the benefit of

IBS technology adoption in building projects, all relevant rules that require the strict compliance with standards as mandated by the government, must be fully considered in IBS decision-making.

From the results, it can be established that the government was responsible for setting some clearer rules on IBS technology adoption in building projects. The results also showed that building projects must be based on the rules of conduct for IBS technicalities, and administrative- and operational matters, at the outset, to help them achieve project purposes and performance goals more effectively. In IBS decision-making, as revealed by the results, the most critical initial rules pertaining to IBS were the legal aspects of building projects.

More specifically, building law and legislation could cause a building project to redefine and enrich its understanding of project performance and compliance, thereby helping the project team shape a common foundation on legal implications on project developments, and to set clearer role responsibilities and improve project implementations. Therefore, the results indicated that the aspects of building law and legislation were important considerations in IBS decision-making.

Although it was obvious that the government has established IBS procedures and guidelines for adopting IBS technology in building projects, in IBS decision-making there was some level of uncertainty on this matter, as the evaluation of the feasibility of IBS technology based on more stringent IBS procedures and guidelines must be made. Therefore by having, and referring to, IBS-related rules and regulations in IBS decision-making, it was discovered that IBS procedures could be used to track and monitor project progress or performance, diagnose weakness in meeting IBS technical requirements, to meet building standards and to plan for improvement in IBS building projects.

d) Sustainability Feature

Another interesting finding in this research was about the current developments in the context of the construction industry and the social economy which involve a long-term integration of building technology into the societal context. Although it was not highly relevant compared to other contextual factors, the support and environmental concern for human well-being had their influences on IBS decision-making.

IBS technology adopted by a number of building projects was accepted as the benchmark to sustain physical- or infrastructure development. The results showed that the more meaningful the development, the more likely for decision-makers to consider the element of sustainability in IBS decision-making. It was the case for some decision-makers who realised that further growth for IBS technology adoption would be impossible without major improvements in the economy to sustain IBS demand and IBS technology itself.

From the above results and analysis, it can be concluded that the consideration of sustainability issues in IBS decision-making has provided greater insight into concerns about the interaction between IBS technology adoption and the physical environment in the construction industry. One of the key points discovered from the results was the consideration of sustainable factors as important, which could be regarded as a way to assist and encourage construction entities in making IBS decisions. Thus, some interactions between other sustainability features such as environment protection, work efficiency, waste management and society trends were desirable in IBS decision-making, as illustrated by Figure 6.9 below, and they will be discussed in the next sections.

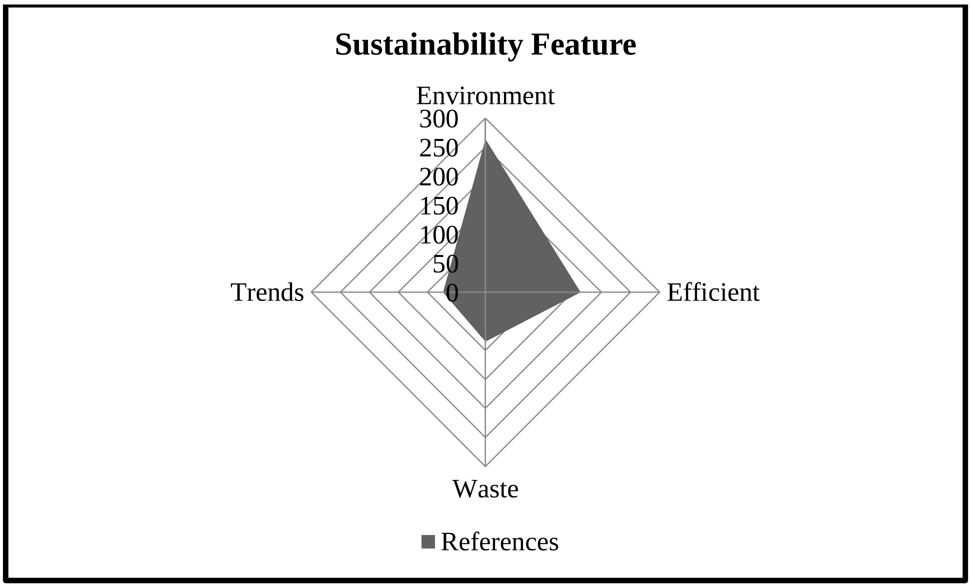

Figure 6.9 Priority Aspects of Sustainability Feature

When considering sustainability aspects in IBS decision-making, IBS technology adoption has worked best in sustaining future project needs in a compelling context of building projects. IBS technology could be seen as a driver of a sustainable future. The results indicated that modern building technology like IBS, and the proliferation of modernisation in building projects, may facilitate socio-economic development, gaining competitive advantages and sustaining future economic needs.

i) Environment Protection

The results showed that one of the key issues in sustainability features pertaining to IBS technology adoption was the acceptance of technology impacts on the environment, by the community. In this study, it was noted that the environment aspect refers to the surrounding, situation and setting of the construction activities, particularly on health issues, pollution problems and people concerns that impact on IBS decision-making. In certain circumstances, the results revealed that IBS technology adoption should be aimed at the connection of good infrastructure and urban development with the true success of building projects themselves and with the element of sustainability, if continuous social value was considered.

In addition, the results indicated that the increasing interest of society in sustainability matters, particularly those who believed that IBS technology adoption in building projects was in a unique position to be further developed. Equally, concerns over pollution had been changing over the past decade, and directly or indirectly seemed likely to influence the decision-making of IBS technology adoption, with a greater emphasis being given to environmentally friendly buildings and the adoption of green building-technology in the construction industry.

This could be seen as a result of IBS technology adoption and the possible shift in emphasis from traditional building methods to an eco-friendly society adopting IBS technology. Moreover, this trend was also supported by an increase in the number of people concerned with a healthy lifestyle and a greater concern with physical environment, brought by IBS technology as a green-technology provider.

ii) Work Efficiency

As indicated by the results, in IBS decision-making many building projects have taken their first step down the transformation path to suit the sustainability of natural environment by recognising the improvements of construction sites. A new approach brought by IBS technology adoption was needed to create a clean and hygienic environment with more efficient work methods, at the construction sites.

The results pointed out that in building projects, the recognition of work efficiency was leading to the recent rise in the acceptance of IBS technology adoption. Therefore, in IBS decision-making, the efficiency factors were considered as an influence because IBS technology could be adopted by building projects to provide a more efficient work flow in a better working environment. The results also showed that although IBS technology adoption was an important evolutionary step toward a better and sustainable environment, most practical applications of IBS had concentrated on the overall efficiency impact.

Therefore, in IBS decision-making, there were also considerations on the impacts of work efficiency brought by IBS technology adoption in building projects. However, this was reflected in a far deeper and more fundamental concern for physical efficiency and natural environment and the way in which these sustainability aspects have impacted the decision-making of IBS technology adoption. The results also revealed that the scope and significance of work efficiency as a part of social changes, were enormous and the interpretation of those changes was almost essential.

iii) Waste Management

In IBS decision-making, waste management issues such as recycling activities and cleaner working environment at construction sites were revealed by the results to be influencing on IBS decision-making. Therefore, from the outlook of waste management and waste reduction, IBS technology adoption appears as a new dimension of construction methods and approaches which were becoming another consideration in IBS decision-making.

This situation will continue to be the case of sustainability, due to its nature and developments, including waste management and recycling activities that could be anticipated in contributing to the increasing level of demand for efficient building-technology in the long-term. The results also revealed that the greater emergence of recycling awareness and programs would add to this. Certainly, in IBS decision-making, there could be the need to really think about the recycling possibilities of construction waste created by IBS technology adoption in the future.

iv) Society Trends

Apparently, in IBS decision-making an understanding of lifestyle trends was also of particular importance in the construction industry, as one of the major lifestyle changes which is currently taking place was the shift from rural living to urban living. Moreover, it seemed that changes in demographic movements especially population concentrations, in a way had influenced IBS decision-making because with the increasing demands for high-rise building, IBS technology adoption was considered as more suitable to fulfil such demands.

Although it was discovered from the results that the net effect of trend changes in the society was not highly relevant, decision-makers were optimistic about the IBS technology adoption and future trends being affected in one way or another. At their most fundamental, these changing trends have led the consideration of sustainability aspects in IBS decision-making, and as a consequence, would require more precise approaches to IBS decision-making.

e) Stakeholders' Participation

This section will discuss the least influencing contextual factor on IBS decision-making namely stakeholders' participation. Overall, the results highlighted that IBS technology adoption has required decision-makers to deal with the various and often conflicting views, demands and requirements of a number of powerful construction industry stakeholders. One of the best tools in IBS decision-making was to develop a realistic assessment of the construction-industry stakeholders, particularly identifying the principal stakeholders and their agendas.

The results pointed out that in the construction context, particularly those projects with important external or constituent groups, the number of stakeholders might be quite large, particularly when there were external groups that could drastically affect the potential for the success of IBS technology adoption, such as government agencies, environmental activists and project clients themselves. Therefore, in IBS decision-making, to a certain extent, it was important to articulate the impact of stakeholders' opinion, influence, power and perspectives, in order to minimise their effects by understanding their views, wants, and needs, and by fostering good relations with them.

Despite the presumed role of stakeholders' input as a source of information in IBS decision-making, the results showed stakeholders' input to be essential because adopting IBS technology and advancing the technical state-of-the-art in building technology, with the anticipation of specific monetary or commercial benefit, was the critical source of building-project success. Specifically, the elements of stakeholders' opinion and partnership development were shown to be important determinants of IBS decision-making, as illustrated in Figure 6.10.

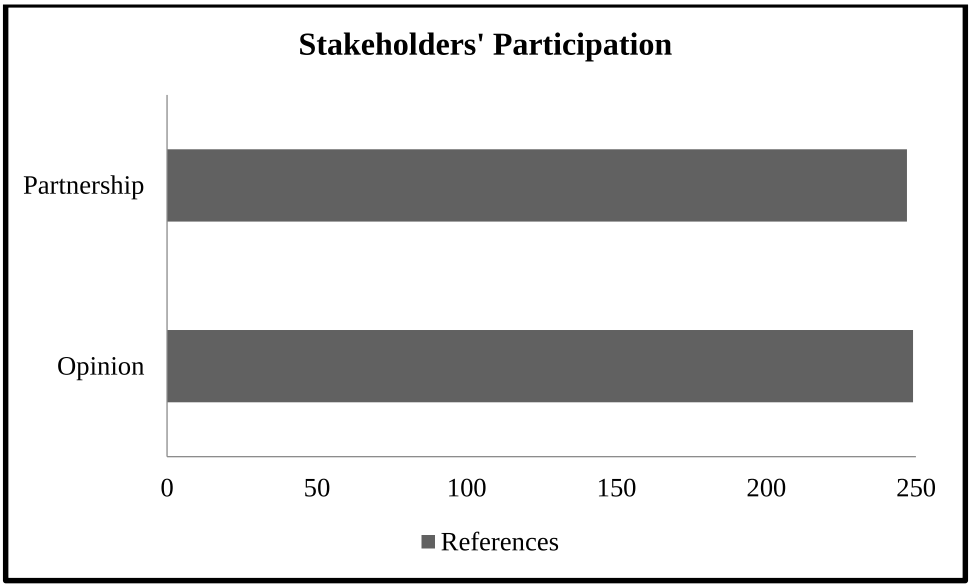

Figure 6.10 Priority Aspects of Stakeholders' Participation

Apparently, in IBS decision-making, stakeholders' inputs in terms of their opinion and partnering were considered as equally important for the improvement of IBS technology adoption in building projects because project members for instance, could utilise inputs from construction stakeholders' opinions or through partnership development.

i) Stakeholders' Opinion

The specific and prominent views of stakeholders on project developments, mainly on IBS technology adoption, were considered as a useful consideration in IBS decision-making. The results revealed that stakeholders' views or opinions were regarded as essential because generally, stakeholders' interest in the construction industry or building-project performance are also related to the overall growth or development of the construction industry.

Therefore, it was discovered that stakeholders' opinions on IBS technology adoption in terms of cost, logistics, risks and construction process are beneficial and must be considered in IBS decision-making, to meet industry expectations, generate expected returns and build a reputation for achieving superior project performance. By considering stakeholders' views and their related aspects, the results pointed out that to a certain extent, decision-makers in building projects need to satisfy stakeholders' interests, particularly the client's ultimate interests, reflecting their importance in the decision-making of IBS technology adoption to ensure the achievements of both the project and the industry objectives.

In this research, each of the primary stakeholders tended to concentrate their attention on different aspects of a building technology adoption, like IBS technology or they continued to use conventional building methods. Moreover, the results showed that the stakeholders had the ability to take actions which would be either supportive or detrimental to the construction industry and also the building project, based on their power, knowledge and associations. In many cases, the construction authorities could hold-up or stop some project rulings, therefore the impacts of these actions had to be considered in IBS decision-making.

However, it was also discovered that concerns about stakeholders' opinions could raise the issue of who were the most relevant construction stakeholders, their specific standards and expectations, how should they be represented and whether IBS technology adoption needed public support and acceptance. The results revealed that various stakeholders in the construction industry had different perspectives based on their areas of expertise, involvement and benchmarks.

ii) Partnering

In the construction industry, the results indicated that different stakeholders were involved at different project stages based on project type and industry nature. However, it was also noted that relationships between stakeholders were mostly indirect as each construction stakeholder might have different views, needs, impacts and interests in the construction industry. Thus, in IBS decision-making, it would be necessary for some projects to undertake or develop a partnering relationship to counter potential conflicts generated by the differences among the construction stakeholders pertaining to IBS technology adoption.

Therefore, the aspect of partnering was considered in IBS decision-making, as the construction stakeholders would be brought together to engage in the development and adoption of IBS technology based on contractual terms. Since the construction environment was uncertain in nature, therefore, IBS technology adoption would require a universal improvement through partnering developments in IBS projects as external and internal stakeholders could be working together in an environment of openness and trust which would certainly benefit IBS technology adoption. Therefore, this condition was considered as important in IBS decision-making because partnering could involve those stakeholders who might have been capable and responsible for contributing to the adoption of IBS technology.

In many cases, stakeholders' relationships in the industry must be based on a certain level of cooperation, openness and trust. The results highlighted that this situation must be based on teamwork efforts which should first be developed and then sustained for the goal of successful IBS adoption. Hence, the element of trust would lead to the better development of stakeholder relations. Additionally, the elements of openness and cooperation were also considered as they could further lead to genuine teamwork and generate positive results of IBS technology adoption.

In conclusion, partnering could be regarded as a strategic alliance among construction stakeholders in the construction industry for a more effective IBS technology adoption that may result in competitive advantages. The results showed that this could be an important factor that needed to be considered in IBS decision-making. This supported the concept that strategic alliance was often considered as a way to encourage more competitive performances in IBS technology adoption, both internal and external strategic alliance. Although the results pointed out that the extent and nature of collaborative ventures vary in the construction industry, building projects and their members could have substantially benefited from such collaboration in improving the adoption of IBS technology in building projects.

6.3.3 Behavioural Factors

Next is the result of behavioural factors which is to analyse the human side of IBS decision-making, from the social standpoint. The results indicated that behavioural factors were the least influencing factor on IBS decision-making, being non-economic and non-technical considerations in the decision-making of IBS technology adoption.

The results highlighted that not only have behavioural factors created impacts on building-project developments but also on the IBS decision-making. In particular, the influencing factors of IBS decision-making from the viewpoint of behavioural aspects are presented in Table 6.8 below, which will be discussed in further detail in the following sections.

Table 6.8 Behavioural Factors Associated With IBS Decision-making

THEMES: (As perceived by the participants)	**FACTORS:**	**Source:**	**Frequency of occurrence/ References:**	**PRIORITY ASPECTS:**	**Source:**	**Frequency of occurrence/ References:**
3. BEHAVIOURAL *(54 Sources, 4816 References)*	Bounded Rationality	54	1525	Learning	54	617
				Justification	52	362
				Choice	51	239
				Cognition	49	233
	Experience	54	1484	Success experience	54	571
				Failure experience	54	536
	Awareness	54	972	Values	50	298
				Support	50	233
				Culture	44	146
				Personality	41	100
	Attitude	54	719	Positive attitude	53	450
				Negative attitude	39	118

The results highlighted that there were some similarities as to whether some general behavioural factors other than specific behavioural factors did effect IBS decision-making. For example, human nature was considered to have various impacts on IBS decision-making as it played its own role within the people-related activities in building projects. As pointed out by the results, the resistance to adopt IBS technology was considered as one of the major issues concerning behavioural factors, as IBS has been a predominant concern in the construction industry.

Therefore, the results revealed that in IBS decision-making, to achieve a balance between complying with project requirements and achieving project goals, it was essential for decision-makers to also consider human factors, in dealing with IBS technology adoption. Interestingly, IBS decision-making was quite relevantly affected by human factors but decision-makers did not directly recognise human or behavioural factors as being part of IBS technology adoption. This situation has occurred because according to decision-makers, complying with project requirements was their priority in decision-making and inevitably overlooked these behavioural aspects.

As indicated by the results, the influence of behavioural factors on IBS decision-making was based on individual views, insights and meaning, based on various outlooks about behavioural influences that emerged. Specifically, it was discovered that there were four major behavioural factors which have impacted on the decision-making of IBS technology adoption, namely bounded rationality, experience, people awareness and attitude which will be discussed in further detail in the following sections.

a) Bounded Rationality

The results indicated that decision-makers' capacity for analysing and using information is limited to a certain level of rationalisation. Due to various structural and contextual factors that have also impacted on IBS decision-making, decision-makers had to be reasonable in their judgments on IBS technology adoption. This was based on the limitation of human aspects known as bounded rationality. The results also indicated bounded rationality as having reasonable impacts on the decision-making of IBS technology adoption.

The results highlighted that being rational in IBS decision-making was subjected to the sense of a certain limit or boundary. Such a condition was due to several reasons revolving around the complexity and dimension of IBS technology, besides other dynamics in the construction industry. This result was supported by the fact that IBS decision-making had to be rational and well-justified although the reality was subjected to the degree of rationality which was limited to a certain extent due to the limitations of human thinking capability and information-processing capacity in discussing issues, analysing problems and generating alternatives for IBS decision-making.

The results showed that rationale boundaries would generate more realistic IBS decisions. This was indicated by the concern for, and awareness of certain limitations in decision-making capabilities. It was also discovered that there are four major elements of bounded rationality aspect, namely learning, justification, choice and cognition, as illustrated in Figure 6.11. Detailed analyses on each bounded-rationality aspect will be presented in the following sections.

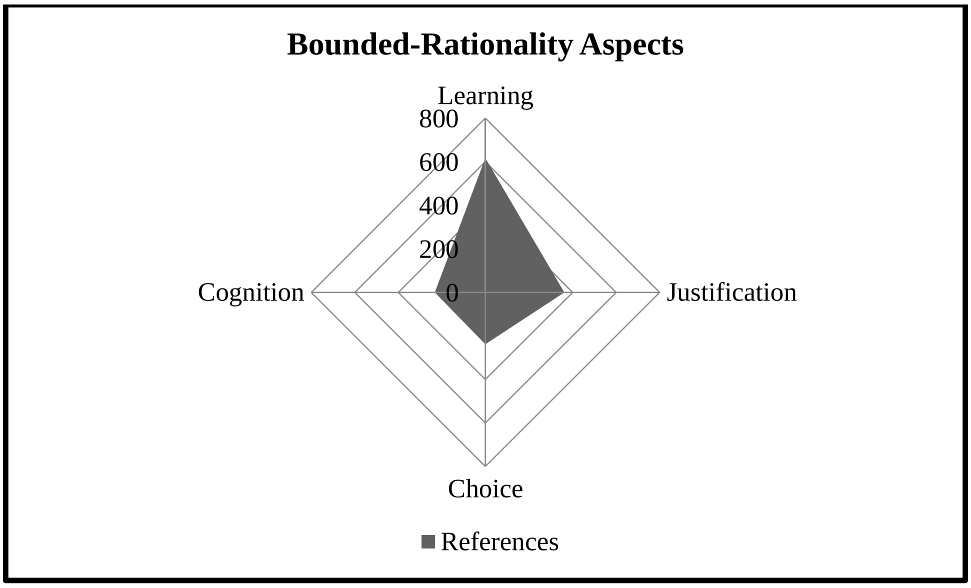

Figure 6.11 Priority Aspects of Bounded Rationality

In addition, there were limits upon how rational decision-makers could actually be, in the decision-making of IBS technology adoption. This was largely due to pragmatism or common sense and resources constraints such as financial, manpower, materials and time. The results revealed that to a large extent, decision-makers placed their concern on these constraints while maintaining their professional integrity in IBS decision-making.

i) Learning

Decision-makers learned not only from a portfolio of project developments but also throughout the progress of IBS technology adoption in various building projects, through training, instruction and guidance. The results indicated that the element of learning was important in IBS decision-making based on the involvement of various development and improvement stages in different types of building projects.

Specifically, the results pointed out that IBS decision-making had to be based on a good foundation of knowledge and understanding, not only of technical viewpoints but also of other aspects such as project management, business environment and other industry dynamics. Therefore, it was discovered that decision-makers must keep up with the development and changes of internal and external context related to building-project developments, through a continuous learning process during their involvement in the construction industry, due to their limitations in information processing, particularly pertaining to IBS technology adoption.

In addition, continuous learning and training in building-project development, particularly on IBS technology adoption, could develop the familiarity and know-how level, and thus strengthen the foundation for IBS decision-making. Although the results showed that these kinds of learning were more focused on the technical aspects of IBS technology adoption, knowledge obtained from any IBS progress could also assist in IBS decision-making and problem-solving in building project developments.

ii) Justification

Further, the results revealed that any justified actions were having impacts on IBS decision-making in one way or another. It was discovered that the justification of a building-technology choice or building-construction method played an important role in IBS decision-making, based on specific reasoning or explanation. Definitely, by focusing on strong justifications in determining a building-technology choice, decision-makers were able to describe not only rational reasons or actions but also irrational reasons or actions, by the means of their justifications.

The results indicated that the adoption of IBS technology in building projects normally required a significant initial investment, backed by convincing argument or strong justification for such a decision. Additionally, the results highlighted that decision-makers were unable to act in a wholly objective way as a result of their tendency to use subjective judgments in IBS decision-making. Therefore, justifications on building-project matters have the strongest and the most direct effect on IBS decision-making.

Consequently, such as positive reaction on building-project matters was regarded as an important justification in IBS decision-making. However, the results also pointed out that besides the justification on project matters, the personal justifications of decision-makers had a real impact on IBS decision-making.

iii) Choice

As indicated by the results, another bounded-rationality aspect that influenced IBS decision-making was the element of choice. The results pointed out that every IBS decision-making process had to generate several choices or alternatives in order to arrive at a final and definite choice of building method, specifically whether or not to adopt IBS technology. Therefore, the results revealed that IBS decision-making has to be tailored to a better choice and optimised decision outcomes in the short and long run.

In the decision-making of IBS technology adoption, the concepts of choice, option or alternative are given reasonable thought by decision-makers. The results highlighted that decision-makers were obviously acquainted with the two main types of building construction methods, namely conventional or traditional building method and IBS or modern building technology, as their major choice. As indicated by the results, IBS decision-making was not always based on the same building-project requirements, scenario and background, as the adoption of IBS technology was always tailored to the project-development nature, its context and available choices.

Therefore, when considering the choice of building technology and other related project options in IBS decision-making, the results pointed out that different types of alternatives or options were related to the roles that decision-makers performed within a building project. The results revealed that decision-makers had to synchronise the choice of building technology with other important characteristics in a building project, besides its major specifications and requirements. Additionally, the results showed that IBS decision-making was based on several alternatives or options that are more relevant to the nature of building projects.

iv) Cognition

In conjunction with the element of choice in IBS decision-making, another element which was related to bounded rationality, as indicated by the results, was cognition. In the outlook of IBS decision-making, cognition refers to a preference in gathering information and evaluating alternatives based on ideas, inspiration and thought pertaining to IBS technology adoption for further thinking and decision-making. The results revealed that the process of acquiring knowledge through thinking was important for good information attainment, analysis and evaluation in order to arrive at a more comprehensive and rigorous IBS decision. Consequently, the understanding of project and non-project information in IBS decision-making was an important consideration for the purpose of being prepared for any arising uncertainties or opportunities in IBS technology adoptions.

In summary, the results indicated that information analysis with thinking and cognition process, based on the knowledge and understanding of IBS related variables, was considered as a desirable way to comprehend the nature of building-technology choice, particularly in IBS decision-making. However, the results also revealed that such a way was not always practical, nor efficient, largely due to the differences in professional background and project experience of the project decision-makers. Moreover, different knowledge and understanding levels, expectations, views and requirements among project members were the evidence of variations in IBS decision-making.

b) Experience

Experience, with regard to knowledge of, and familiarity with, IBS technology adoption in building projects in particular and other construction areas generally, was another important consideration when deciding on IBS technology adoption. The results indicated that the element of experience refers to the level of exposure to previous IBS projects or any construction projects that influence IBS decision-making.

Specifically, it was discovered that there were two major categories of experience that impacted on IBS decision-making, namely success experience and failure experience in various building projects, particularly related to IBS technology adoption. With regard to the influence of experience in IBS technology decisions, the results revealed that the aspect of experience was relevant in IBS decision-making. Therefore, it was important to explore and determine the decision-makers' concerns about their project exposures, in terms of project success and failure. The results indicated that decision-makers have evaluated the nature of their experience more positively in the perspective of success and failure experience in project development and IBS technology adoption. Further analysis on the aspect of experience will be presented in the following sections, based on the results presented in Figure 6.12 below:

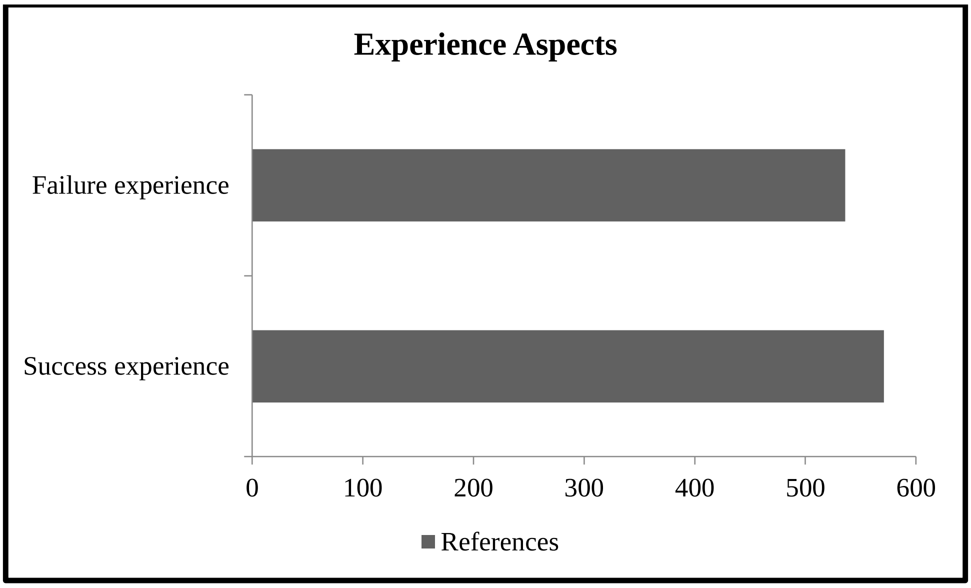

Figure 6.12 Priority Aspects of Experience

The results revealed that there was an equal importance on the consideration of both success and failure experience in IBS decision-making. Decision-makers believed that the level of their project experience, industry experience and other related project- or construction exposures, to a certain extent have impacted on the decision-making of IBS technology adoption. In many cases, the results highlighted that it was important to have the necessary knowledge, experience and exposure needed to facilitate IBS decision-making and further IBS technology adoption.

i) Success Experience

In essence, as revealed by the results, positive experience was considered as playing a more important role in the human side of decision-making in the construction industry since decision-makers with more success experience could contribute their knowledge, skills, understanding, effort and energy more positively toward the adoption of IBS technology. Hence, the results pointed out that the need to exploit or utilise the success experience of project-team members was an essential consideration in IBS decision-making

Additionally, the results indicated that project success as experienced by decision-makers was intrinsically tied up with the attributes of trust and confidence. Even, their success experience of building- and other construction projects, particularly in IBS projects could create a higher trust level as a foundation to decide on IBS technology adoption.

Therefore, in the decision-making of IBS technology, it can be articulated that with such a strong emphasis on the success experience in building projects, decision- makers could find ways to make their decisions across a broad range of fields of knowledge, skills and understanding in technology adoption, project management, and business and technical aspects. The research results also revealed that in order to achieve this, decision-makers could also rely upon certain performance benchmarks which are obtained through successful IBS or other building projects.

Summing up, the attribute of successful project experience was considered as an important consideration in IBS decision-making. As a consequence, although the consideration of decision-makers was well-justified, the results also showed that encouraging, positive and good experiences in project developments, building construction or with IBS technology adoption itself, were considered as influencing IBS decision-making.

ii) Failure Experience

Besides success experience, the results pointed out that the attribute of failure experience in building projects or other construction projects was also important in IBS decision-making. It was discovered that expectations regarding the performance capabilities of IBS technology adoption could be changed over time. Specifically, in IBS decision-making, IBS expectations could be adjusted to fit the actual performance of a building project. Overall, IBS decision-making was also influenced by the failure experience in a building-project development and IBS technology adoption or transfer. Therefore, the results indicated that as time went on, the element of trust and confidence in decision-makers was often diminishing, not because IBS technology adoption was not highly improved, but due to the low expectations of IBS technology performance. In particular, decision-makers in building projects have considered a variety of ways in which their failure experience with IBS technology could affect their insight and expectations of potential problems, further risks and difficulties in adopting IBS technology, hence impacting on the decision-making of IBS technology adoption.

From another point of view, the results highlighted that when one of the IBS projects had failed some time ago, although IBS technology had been improved and was again employed, the expectation of decision-makers was adjusted. In many cases, decision-makers were quite explicit and positive in describing what they could expect from their experience in project failure, particularly when dealing with IBS projects. From the results, it was discovered that another obstacle to IBS technology adoption in building project settings was that decision-makers had been slow in adapting themselves to new building technologies due to others' failure experience in IBS technology adoption.

However, the results showed that, as project members gained more experience in IBS technology adoption, they would establish norms and tendency for adopting IBS technology which would increase the need for effortful IBS decision-making. In this case, within any particular failure experience, decision-makers should make their efforts to opt for improvements. It was discovered that project members were very optimistic in perceiving the failure experience of IBS technology or project development. As indicated by the results, a bad experience with IBS technology adoption did not mean that the decision-makers were unlikely to adopt the same technology again. The results also pointed out that the experience of IBS project failure reflected on either the optimistic or pessimistic view of a decision-maker and it was essential for project members and decision-makers to understand this situation.

c) People Awareness

Another finding on behavioural factors is related to the aspect of awareness where the results revealed that people's awareness and even decision-makers' awareness of IBS technology adoption could influence IBS decision-making. In this study, awareness was based on the basic process of responsiveness to, and insight and observation of IBS technology adoption and project variables that influence IBS decision-making. As indicated by the results, the element of people awareness was viewed as an important consideration in IBS decision-making as their awareness could lead to a certain level of technology acceptance, hence, knowing this aspect was considered as a supporting information inadequacy.

Based on the behavioural viewpoint, from the results, it was discovered that the element of people awareness that dealt with people's response towards IBS technology adoption in particular, had influenced IBS decision-making. The results pointed out that in IBS decision-making, some behavioural factors and even other structural or contextual factors could not directly influence decision-makers, but only through the awareness or insights of decision-makers themselves. Therefore, it emerged that the personal- or group awareness among the construction professionals or entities was regarded as influencing the decision-making of IBS technology adoption.

Accordingly, people's awareness of IBS technology adoption was also related to their mind-set, that is, their specific outlook on this technology based on a comparison between the conventional building method and IBS technology, in building projects. The results revealed that, principally, IBS decision-making was based on the mind-set of the decision-makers themselves.

The results also indicated that, before an IBS technology adoption decision could be made, the importance of this technology were based on the awareness of values, support, culture and personality elements that the decision makers encompassed. Therefore, it was discovered that the aspects of people awareness were related to the elements of values, support, culture and personality, as represented by Figure 6.13 below.

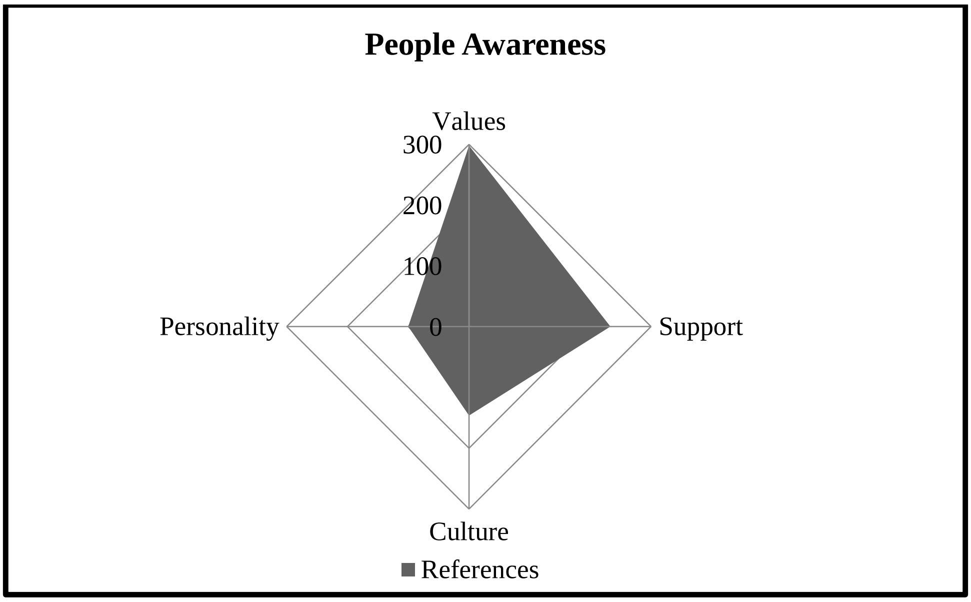

Figure 6.13 Priority Aspects of People Awareness

The results indicated that the consideration of people's awareness was based on the type of decision behaviour deriving from insight of, shared beliefs in, and mind-set on IBS technology adoption. Based on this condition, it was apparent that IBS decision-making in a building project had to be based on a certain level of awareness of the construction dynamics and, more specifically, on changes in building-project development particularly regarding IBS technology adoption. Confirming this view, in the sense of people's awareness or insights of IBS technology adoption, the results discovered that this aspect was relevant in IBS decision-making although it was seen as unattainable and difficult to deal with.

Additionally, the results pointed out that people's awareness or insights were also related to the element of culture in building projects and in the society. The underlying idea was that the project members or construction professionals who were interacting closely during a building-project development emerged with increased awareness or insights about the reality of IBS technology adoption, based on their way of thinking relevant to their roles in a building project.

i) Values

According to the results as illustrated in Figure 6.13, the element of value that relates to people's awareness pertaining to IBS technology adoption was the most influencing aspect on IBS decision-making. In this case, it was discovered that values refer to the principles and philosophy of project members or construction professionals concerning the adoption of IBS technology that influence IBS decision-making.

These results revealed that decision-makers were able to explore their appreciation in various dimensions pertaining to IBS technology adoption and their values would have been taken into account in IBS decision-making. However, it was discovered that although a number of decision-makers were not very sure about their own values. Nevertheless, from the results, it was also identified that the values of the decision-makers were also established from the nature of project requirements and developments.

Summing up, although it was discovered that the element of people's values has its impact on IBS decision-making, the recognition that values could play such a prominent but unpredictable role in IBS decision-making may encourage decision-makers to consider decision alternatives based on project philosophies and analysis, as being adequate in IBS decision-making. It was also discovered that in a way, IBS decisions were not made entirely on the basis of economic rationality as IBS decision-making has been influenced by decision makers' values.

ii) Support

Additionally, in conjunction with the element of values in IBS decision-making, the results indicated that IBS decision-making was also influenced by the element of support based on decision-makers' encouragement and motivation towards IBS adoption. The results highlighted that support towards IBS technology adoption has also influenced IBS decision-making in terms of the inspiration and enthusiasms of decision-makers.

It was discovered that the element of support has influenced IBS decision-making as this situation corresponds to decision-makers who attached an absolute importance to their passion for IBS technology adoption, due to their professional background and involvements. In relation to motivation, the results highlighted that project members must be highly motivated in order to face the challenges in the adoption of IBS technology based on their level of commitment, initiative, and optimism.

The results also showed that the commitment of project members in supporting IBS technology has its impact on IBS decision-making. In this matter, decision-makers verified that the level of dedication among project members must be extensive when dealing with the technicalities of IBS technology adoption. Additionally, the commitment of decision-makers in building projects, when deciding on IBS technology adoption, was due to their obligations towards the project clients and the government's policy in implementing IBS technology adoption. The results also highlighted that if the commitment of decision-makers was not accompanied by the support from other project members, in IBS decision-making, there were tendencies for the disturbance of project commitment towards IBS technology adoption.

From the results, it is essential to acknowledge that in IBS decision-making, the support for IBS technology adoption and its related circumstances has appeared to be influenced by the enthusiasm, commitment and initiative of building-project members towards the adoption of IBS technology. The results also showed that the intangible element of IBS decision-making was progressed from the support of the decision-makers and project members, particularly top management team.

iii) Culture

As indicated by the results, another factor which impacted on IBS decision-making was the element of culture. From the results, the element of culture in a building project and society as a whole, were perceived as influencing IBS decision-making based on the project norms or common construction practices. Furthermore, in IBS decision-making, the results showed that the awareness of cultural aspects was also associated with working culture, including discipline practice and responsibility in a building project.

Further, it was discovered that when deciding on IBS technology, the influence of the culture aspect was also related to the traditional- and heritage features of a building. The results pointed out that the nature of building projects has required restoration works to preserve heritage elements, therefore the consideration of this kind of project condition has a certain impact on IBS decision-making. Therefore, the consideration of heritage culture was viewed as an important element in IBS decision-making as it was related to the restoration, conservation and preservation of community and building image. From the results, there seemed to be an underlying level of cultural consideration as different project members would prefer different building technology or building methods because they had different fundamental cultural outlooks about building projects.

It is summarised that project culture was far more important than the element of building traditions. Those overarching cultural elements could be present, to greater and lesser extent, in different projects and also would determine the appropriateness of IBS decision-making. Therefore, these cultural elements have influenced the decision-making of IBS technology adoption according to their relevancy and suitability in building projects.

iv) Personality

Nonetheless, the results revealed that the perception of personality attribute has less relevancy, importance and influence than the perception of values, support and culture attributes. With respect to personality attribute, the results indicated that the element of personality has its influence on certain areas of IBS decision-making. The character, qualities and traits of a decision-maker have only an indirect influence on IBS decision-making. It was discovered that in any unit of a building project, people with different characteristics or individualities must work to complement each other and definitely, each person must understand his or her expected role in a building project and appreciate the roles of others in the decision-making process of IBS technology.

Confirming this view, which emerged from the results, one of the key features of decision-makers was related to their personal traits. In particular, besides their role of responsibility as decision-makers, there was also the need for positive personal traits in IBS decision-making. More specifically, it was important for IBS decision-makers to explore the importance of other people's attributes, not only for the purpose and process of IBS decision-making, but also for the project implementation of adopting IBS technology.

Lastly, in relation to the attribute of personality, the element of confidence was considered as influencing IBS decision-making. As indicated by the results, a building project tended to adopt IBS technology when project decision-makers were certain and assured that IBS technology adoption was a realistic development in building projects.

However, in many project circumstances, it was crucial for decision-makers to develop strong confidence levels among project entities, concerning IBS technology adoption, to face the challenges throughout the implementation of IBS projects.

d) Attitude

The subsequent result on the human side of IBS decision-making is on the element of attitude, more specifically, human attitude. The results indicated that the element of attitude was less relevant to IBS decision-making. This situation was corresponding to decision-makers who attached less importance to the attitude element as a consideration in IBS technology decisions. However, the results revealed that, although the perception of the general public associates the construction industry's interest in building-technology adoption like IBS, as strictly economic and profit-oriented, this condition was not always applicable to the attitude of project members based on their different principles, justifications and outlooks.

Therefore, the nature of attitude among building-project members could be due to their unique project-related experience, exposures, knowledge and understanding, besides the learning processes that have shaped their attitudes, as explained earlier. Further discussions on the element of attitude are uncovered by analysing two of its main dimensions, namely positive and negative attitude. The degree of these two types of people's attitude toward IBS decision-making is presented in Figure 6.14.

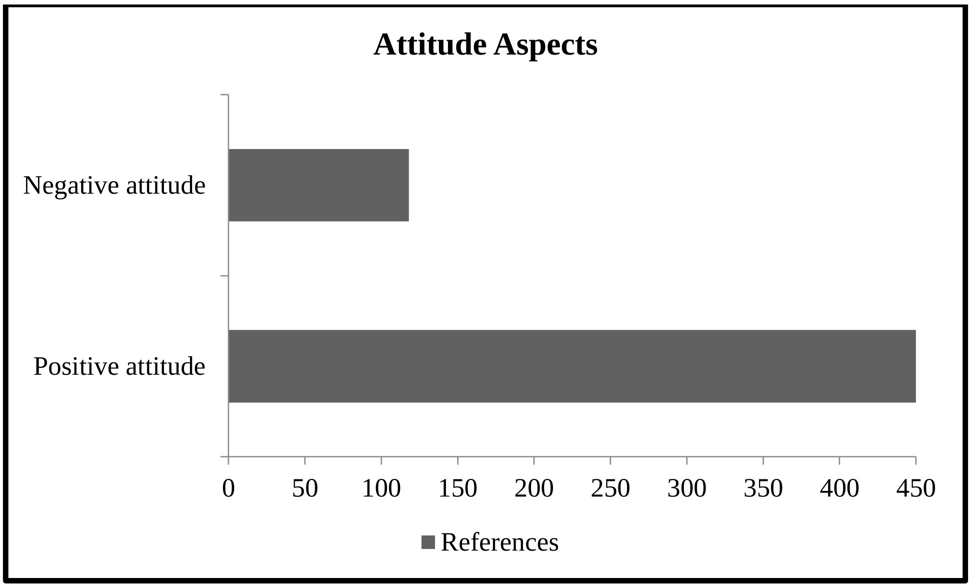

Figure 6.14 Priority Aspects of Attitudes

From the results, it was discovered that these attitude features, in terms of people's approach or outlook towards IBS technology adoption, have appeared to be relevant for the project members or construction professionals when deciding on building-technology choice.

The general results on the influence of attitude on IBS decision-making has confirmed that IBS decision-making was somehow affected by several behavioural factors including attitude toward IBS adoption technology. The results indicated that the acceptance of project members or construction professionals towards IBS technology adoption was based on the response and outlook of the project members in a positive or negative manner. These attitude features are then classified into two major categories, namely positive and negative attitude, which are further explained in these following sections.

i) Positive Attitude

Based on the features of positive attitude as indicated by the results, it was discovered that the influence of positive attitude on IBS decision-making was based on the tendency of people to concentrate on a more optimistic dimension when considering complex multifaceted IBS issues. It was also discovered that the influence of attitude was reflected by the decision-makers' expectations and viewpoints in IBS decision-making.

Besides that, the way that people were confident in, and convinced by IBS technology adoption was seen as part of people's attitude which has also influenced IBS decision-making. Importantly, the results showed clearly that, once a construction-industry entity was convinced by IBS technology adoption, they were able to boost the confidence of decision-makers to adopt it. In particular, the convinced construction entities would further create a sense of confidence with IBS technology adoption. Apparently, based on the trust and confidence among the construction entities concerning IBS technology adoption, it was apparent that these aspects could play a role in the decision-making of IBS technology adoption.

Additionally, positive attitudes about IBS technology adoption were also related to the attribute of proactivity and responsibility. In essence, it was discovered that the attribute of proactivity and responsibility were important from the outlook of obtaining a strong stand in making IBS decisions. Furthermore, the results revealed that IBS acceptance among project members was an indication which could also influence IBS decision-making, as it represented the positive attitude of construction entities either towards changing people's mind-set about, or improving people's recognition of, IBS technology adoption.

In summary, all attributes of positive attitude were considered as relevant to IBS decision-making. As a consequence, these attributes were rather unbiased and well-justified, thus the positive attitude among construction entities was considered as more relevant in IBS decision-making than negative attitudes.

ii) Negative Attitude

Nevertheless, with regard to IBS technology decisions, negative attitudes were also explored to verify their influences on IBS decision-making. Clearly, the results revealed negative attitudes to be the reluctance and resistance of construction entities towards IBS technology adoption. Particularly, the results highlighted that although it was not very important compared to the elements of positive attitude, there were a number of negative-attitude elements among the construction entities who were reluctant, and resisted, when dealing with IBS technology adoption. Therefore, these negative attitudes could provide insights into how project members could build cohesive connections and deal with negative attitudes when making IBS technology decisions.

Based on the results of this study, a variety of explanations were given for the apparent reluctance of construction entities to adopt IBS technology in building projects. Thus, the influence of negative attitude towards IBS technology adoption could contribute towards explaining the drivers of, or barriers to IBS technology adoption that were manifesting in IBS decision-making.

Therefore, the results indicated that people's outlooks had to be revolutionised by changing their attitude towards IBS technology adoption before any key IBS technology decisions could be made. Although there were variations amongst decision-makers, it appeared that understanding and considering human nature, human attitudes and their related factors were essential in IBS decision-making.

6.4 Summary

This chapter described the integrated data analysis phase of the research, specifically the content analysis of the interview data as a qualitative study of the current research. It also reported on the results and analysis of the qualitative study. The results were presented in two phases. In phase one, the cross-concept analysis of the impact of influencing factors on IBS decision-making was performed. The findings highlighted that in IBS decision-making, the concern of decision-makers on selected structural, contextual and behavioural factors is likely to determine IBS decisions in the construction industry. The second phase highlighted and categorised accordingly, factors that influence IBS decision-making in a hierarchical way. This phase consisted of three main sections which sought to establish factors associated with IBS decision-making. The analysis of the interview data was framed around three identified key factors, namely structural, contextual and behavioural factors. These factors were further expanded to include relevant priority aspects, which were subsequently categorised according to their frequency of occurrence within the interview transcripts and the amount of significant information gathered. The results revealed that structural- or project-related aspects were the most influential factors in the decision-making of IBS technology adoption, followed by contextual and behavioural factors.

CHAPTER 7 - DISCUSSION

7.1 Introduction

Chapter 6 presented the syntheses of results from the analysis of construction-profession stakeholders, in exploring inter-project perspective, and the supply-chain members of IBS projects, in exploring intra-project perspective (as presented in Chapter 5). The purpose of Chapter 7 is to draw further synthesis and discuss the results in the context of existing literature. This process will draw different component elements together to illustrate the findings of this study. As this study is underpinned by the interpretative phenomenological analysis (IPA) through the representation of "making sense of the world" of IBS decision-makers (Smith et al., 2009), findings will be discussed in an interpretative manner. The focus of this discussion is also to clarify the concept of IBS decision-making, describe the various elements involved and to discuss its applicability and limitations.

The results of this research deal with the focus of contextual and behavioural outlooks in IBS decision-making, with particular emphasis on structural or managerial concern in building projects. Having developed a theoretical framework to determine the influencing factors of IBS decision-making, as described in Chapter 3, together with the interpretative phenomenological analysis of IBS decision-making in the construction industry, particularly in building projects, as explained in Chapter 4, it is now feasible to discuss further on the decision-making of IBS technology adoption and its influences. In addition, this chapter aims to develop a major IBS decision-making model and describe its facets or manifestations of the same basic model distilled from qualitative analysis of data integration from inter-project and intra-project perspectives.

Reaffirming this concept for the interpretative phenomenological analysis of IBS decision-making, especially when the decision-making is customised to the specific type of building project and other specifications, optimised IBS decisions will result. From an intra-project perspective, with direct involvement in an IBS building project, the members of the IBS supply chain are exposed to the elements of a real-world situation in that they are able to recognise factors that impact on IBS decision-making.

From an inter-project perspective, although the stakeholders of the construction industry are contemplated to adopt IBS technology, their exposures and involvements in various building projects across the construction industry are of value in perceiving IBS decision-making and its influencing factors.

The chapter is presented in nine sections. First, a discussion is presented on IBS decision-making and its influences (section 7.2). The third section presents the IBS decision-making criteria drawn in this thesis regarding the three influencing factors on IBS decision-making. Section four presents the integration of IBS influencing factors for the development of IBS decision-making models. Section 7.5 describes IBS decision-making models, extending the model developed in section 7.4. Following this, section 7.6 presents the cross construct method for the IBS decision-making frame and section 7.7 presents the information composition for IBS decision-making. Section 7.8 describes on testing the developed models of IBS decision-making. The chapter moves on to discuss the emerging progression in IBS decision-making from this research (section 7.9). The chapter concludes with several outlooks in the dynamics of IBS decision-making (section 7.10).

7.2 IBS Decision-making and Its Influences

IBS decision-making is influenced by structural, contextual and behavioural factors and it should be tailored according to decision-making nature and progression and conceptually related to Simon’s concepts. Two elements are necessary in order for optimised IBS decision-making to occur, namely the IBS decision-making frame and the impact of influencing factors on the IBS decision-making frame. The synergy of decision-making and decision influences has to be considered in a mindful and justifiable way. Therefore, the first step towards the better understanding of connections between IBS decision-making and its influences is to verify the way construction-profession stakeholders and supply-chain members of IBS projects perceived structural, contextual and behavioural factors in their “phenomenological context”, as illustrated in Figure 7.1.

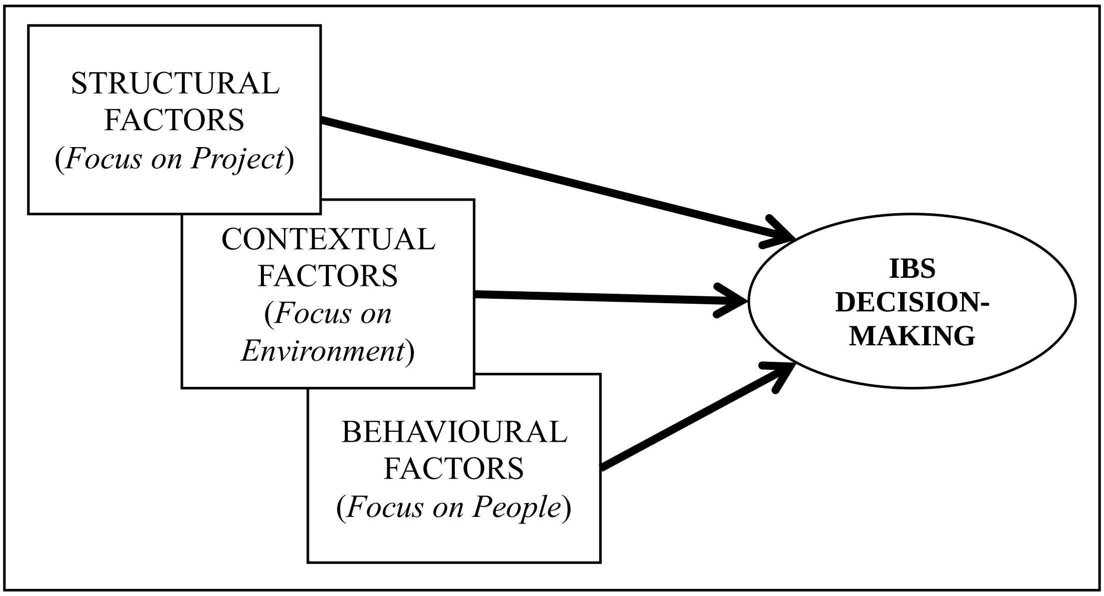

Figure 7.1 Factors Influencing IBS Decision-making

The focus of structural factors is on project-related matters, contextual factors on the environment or surroundings of building projects, and behavioural factors on people, therefore IBS decision-making can be viewed as being influenced by a combination of those influences. Therefore, in order to understand the impacts of structural, contextual and behavioural factors on IBS decision-making in the phenomenological context, it is necessary to understand the construct of these factors, their roles in IBS decision-making and specific aspects that impact on them. Each of these factors will now be discussed in terms of the classification of each influencing factor on IBS decision-making, based on the degree of influence of each factor.

7.2.1 Structural Factors and IBS Decision-making

Structural theme, with its constructs arising from the construction-industry context and the broader project landscape, also have influence on IBS decision-making. The results identify managerial influences as part of structural factors, are akin to project or organisational perspective, not limiting to socio-economic and technical factors. The aspects of structural factors are presented according to the degree of influence of each factor on IBS decision-making, based on the perception of the participants, as illustrated in Figure 7.2.

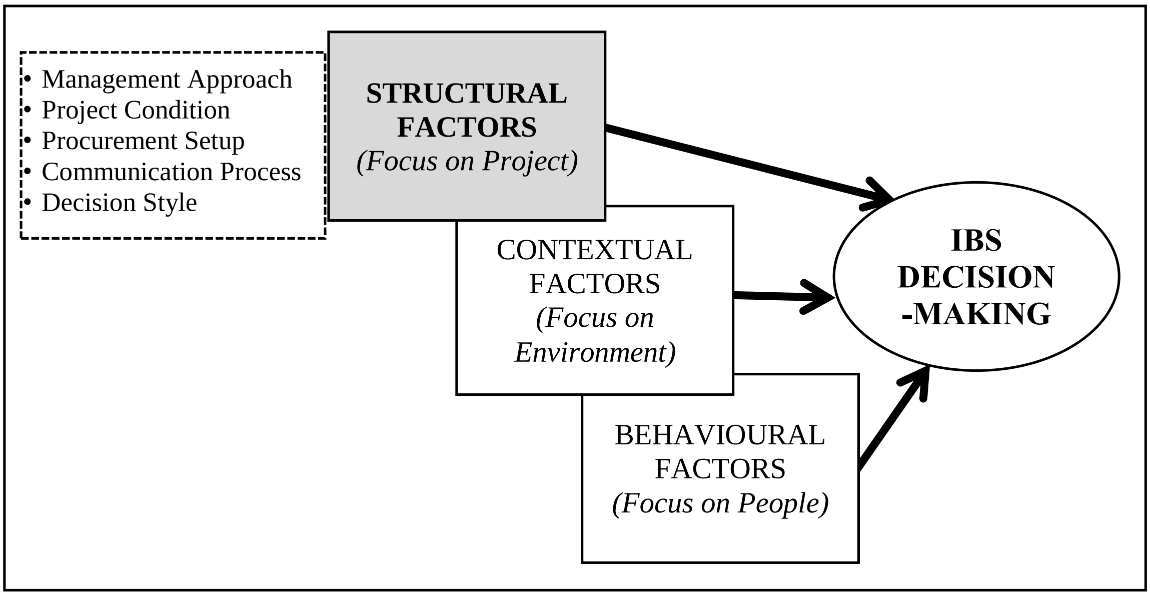

Figure 7.2 Structural Factors Influencing IBS Decision-making

In the construction industry, IBS decision-making covers the entire spectrum of a building project, from simple to highly complex project features. Specifically, in this research, the structural aspects, as they related to the factors deemed to be important in the management of building projects, consist of management approach (Kerzner, 2013, Nieto-Morote and Ruz-Vila, 2012), project condition (Sears et al., 2010), procurement setup (Kumaraswamy and Dissanayaka, 2001; Odeh and Battaineh, 2002), communication process (Love et al., 2009) and decision style (Tam, 2007).

In IBS decision-making, structural factor is mainly characterised by management approach such as management process, planning, strategy, goals and leadership. Project plan is a mechanism to assist IBS decision-making, which can be devised for reaching the project goal, using the expected capability of IBS decision-making (Ning et al., 2011). A project plan is deemed completed when the forecasted position, and when the expected outcomes of an IBS project are available for executing the selected project plan, then this particular plan will be employed (Pan et al., 2007). When the expected outcomes of a building project are not available, actions will have to be devised to allow for the establishment of a project plan.

Therefore, project plan is vital in the decision-making process of IBS technology adoption. As an ongoing process, decision-makers observe the current state of building projects when deciding on IBS technology adoption. Consequently, their attention and actions are directed by the project goals. IBS decision-making with the consideration of management factors allows for future projections of key contextual elements and expectations concerning future events in IBS projects (Fernandez-Ceniceros et al., 2013).

When these expectations match with what is observed, this is an indication of achieving IBS project performance. If they do not match due to the values of some IBS project parameters that are different whereby an event occurs that should not, or does not occur and it should, this signals to the decision-makers that something is wrong and indicates a need for a change in the goals or plans of IBS projects, due to a shift in project strategy (Haponava and Al-Jibouri, 2010).

Hence, IBS decision-making is based on the current project goal and strategy but there is a need to adjust the relative importance of IBS project goals (Tam et al., 2007), as each project goal can have certain rules governing a project situation in which each needs to be highlighted over other project features (Aritua et al., 2009). There is also a need to understand that when multiple IBS goals are compatible with each other, several may be active at once. As a result, when IBS goals are incompatible with their associated priority level for the identified project situation, it is important to determine which project goal shall be prioritised. Similarly, IBS project plans may be altered or new plans shall be selected if the feedback provided indicates that the project plan is not achieving results in accordance with its projections. However, through learning, these processes can also serve to assist IBS decision-making and allow for better IBS projections in the future.

Therefore, in IBS decision-making, project factors are concerned with the decision-makers' ability to be in charge and in command of internal project dimensions, and this will become increasingly important as the decision-making concept is more widely applied as IBS technology adoption becomes more dominant. The cost-quality-time factor is particularly inherent in the high-activity-, technically intensive- and high-cost settings of building projects as there is a high concern for cost-saving or cost-effectiveness in the adoption of IBS technology. This resulted in production- or operational pressure to do more and be more productive in a given period with economical, weather and financial constraints. The emphasis on reducing project costs introduces a factor that impacts IBS decisions in the construction industry, as discussed by Chen et al. (2010a).

According to Pan and Sidwell (2011), it is assumed that these costs and benefits are generally known beforehand and remain relatively stable over time, moreover, they are qualitatively distinct issues. Moreover, time is money and financial performance is linked with productivity, thus, building-project operation compounds time-quality-cost pressure with the resultant impact on the decision-making of IBS technology.

Additionally, IBS decision-making is also impacted by formal and informal communication, which are useful in disseminating information, getting feedback and exercising control. In IBS decision-making, formal and informal communication could assist decision-makers although their influence is quite low. Generally, formal communication predominates in the decision-making of IBS technology adoption.

Finally, in order to integrate these multi-dimensional aspects of IBS decisions into a more practical IBS decision-making, the decision style is based on individual and group decisions in a specific IBS or other building project. However, the finding of this research indicated that IBS decision-making is made in the group setting of building projects. Decision-makers rely on the project members in recognising the key attribute of a project situation pertaining to IBS technology adoption and applying known solutions, through expert consultations.

7.2.2 Contextual Factors and IBS Decision-making

Decision-making in the construction sector is affected by several elements such as economic constraints, political conditions, decision-makers' values and perception and their surroundings. According to Ashford et al. (2010), social adaptation describes values as a type of social cognition that facilitates an individual's adaptation to the environment. These competing contextual elements create a complex situation for IBS decision-making. This includes decisions not only about why and how to decide on IBS technology but also decisions about complying or not complying with the policy- and specification requirements of building projects.

The environments are inherently dynamic, with high demands for skilled performance and teamwork, high uncertainty because of the complex processes (Lafond et al., 2011). Concurrent with the growing interest in IBS decision-making and its managerial aspects, contextual factors have also been developed as a research focus in the study of decision-making, largely in the construction environment, and particularly on business- and economic domains. In this study, as illustrated by Figure 7.3, contextual factors therefore involve factors such as economic condition, technology development, government involvement, sustainability feature and stakeholders' participation.

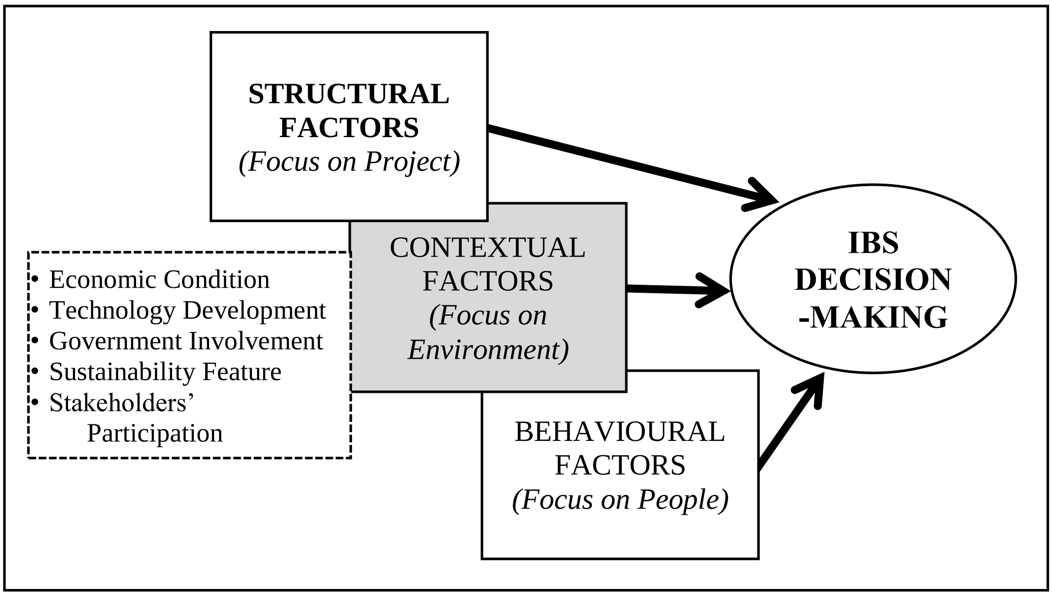

Figure 7.3 Contextual Factors Influencing IBS Decision-making

In IBS decision-making, decision-makers perceive contextual factors in the construction environment according to their involvement in various building projects. Thus, there should be an understanding of those factors, particularly when integrated together in relation to the building-project's goals. At the highest level, IBS decision-making also requires an understanding of what will happen with the construction industry in the near future. That is, contextual data are likely to adjust and influence the IBS decisions to be made, so the decision-makers tend to discover and search for, a variety of alternatives, instead of relying on their pre-existing domain knowledge and skills concerning IBS technology adoption.

The first step in IBS decision-making is to identify the status, attributes and dynamic of relevant elements in the contextual setting. The participants perceive important elements such as general economic conditions, in terms of business, demand, opportunity, uncertainty and competition, with their relevant characteristics as relevant considerations in IBS decision-making. A person who is involved in IBS decision-making must be aware of the status of various variables in the environment of the construction industry. Additionally, a decision-maker on IBS technology adoption also should recognise other contextual obstacles and their dynamics, and the status of the construction-industry environment.

Consequently, in the decision-making of IBS technology adoption, the understanding of the contextual situation is based on a synthesis of technology factors. Technology factor in IBS decision-making goes beyond simply being aware of the elements which are present, such as productivity and quality, to include an understanding of the significance of those elements in light of project goals.

The results bundle aspects of innovation and creativity in a holistic concept of technology factors in IBS technology adoption, including a comprehension of the significance of IBS technology adoption in the construction industry. For instance, a member of a building project also needs to comprehend IBS technology failure in a particular building project. Therefore, it is necessary to put together IBS technology with project variables to determine how well different contextual factors and IBS technology are performing. In a dynamic environment, project members must be capable of anticipating technology factors, in order to integrate various contextual elements along with project goals.

It is also important to notice that government involvements such as government promotion, policy, requirements and rules are acknowledged as influencing factors of IBS decision-making. Besides considering the current condition of government involvement, IBS decision-making also requires the projection of future status on these factors. It is the ability to anticipate the future changes of the elements in the government involvements, at least in the very near-term that influences IBS decision-making. This is achieved through knowledge of the status and dynamics of the governmental elements and a comprehension of the situation in IBS decision-making, and therefore involves far more than simply perceiving the influence of government factors in the environment; it includes the need to comprehend the meaning and consequences of those factors in an integrated form, compare them to project goals, and provide a forecast of the future state of IBS technology adoption. These considerations of government factors are particularly critical for effective decision-making pertaining to IBS technology adoption in the construction environment.

IBS decision-making is also dependent on sustainability features such as environment protection, work efficiency, waste management and living trends, based on the similarity between sustainability features in the contextual surroundings and elements in the building projects. The crucial feature in considering these aspects in IBS decision-making is the ability of decision-makers to recognise sustainability features and to evaluate these key features related to IBS technology adoption in building projects. However, the concern about physical environment, particularly concerning environment protection, is regarded as a critical indication that maps to the key features of sustainability factors when deciding on IBS technology adoption.

Lastly, when major contextual factors such as economics, technology, government and sustainability have been considered for a given typical building-project situation, the influence of stakeholders' opinions and the intention of partnership development are also considered in IBS decision-making for generating better alternative courses of action. Associated inputs or opinions from the construction-profession stakeholders can be used to support IBS decision-making and building-project performance. This process is destined to be a mechanism allowing decision-makers to efficiently process a large amount of contextual information and to make rapid and effective IBS decisions, in challenging construction circumstances.

7.2.3 Behavioural Factors and IBS Decision-making

Although the behavioural aspect of IBS decision-making has become impoverished through the lack of theoretical development, its application may be best suited to economic- and construction-management study where the quantification of economic- and managerial-related factors is necessary for linking behavioural factors to the IBS decision-making process, besides other project factors in the construction industry. Generally, a primary concern of behaviour science is the relationship between behaviour and the environment in which it occurs (Clark, 2010). The areas of application for behavioural approach in decision-making are broad and diverse, thus it will be discovered that behaviourism shows it in a new perspective (Birnbaum, 2008).

Therefore, in order to explore the subjective factors affecting the decision-making of IBS technology adoption in the construction industry, it is vital to explore IBS decision-making through behavioural aspects, besides economic and managerial aspects. According to Custers and Aarts (2010) and Furnham (2012), most behavioural scientists operating in the field of cognitive psychology stated that the best predictor of human behaviour is a person's conscious decision to perform the behaviour. Although the understanding of the IBS decision process may have little prescriptive value, researchers generally often assume that prescription follows directly from theoretical understanding of a phenomenon (Schank and Abelson, 2013; von Krogh et al., 2012). Based on this study, it is vital to acknowledge behavioural factors in IBS decision-making, as illustrated by Figure 7.4, by explaining them with practical developments in the aspects of contextual and structural factors, from the perspective of social psychology and construction management.

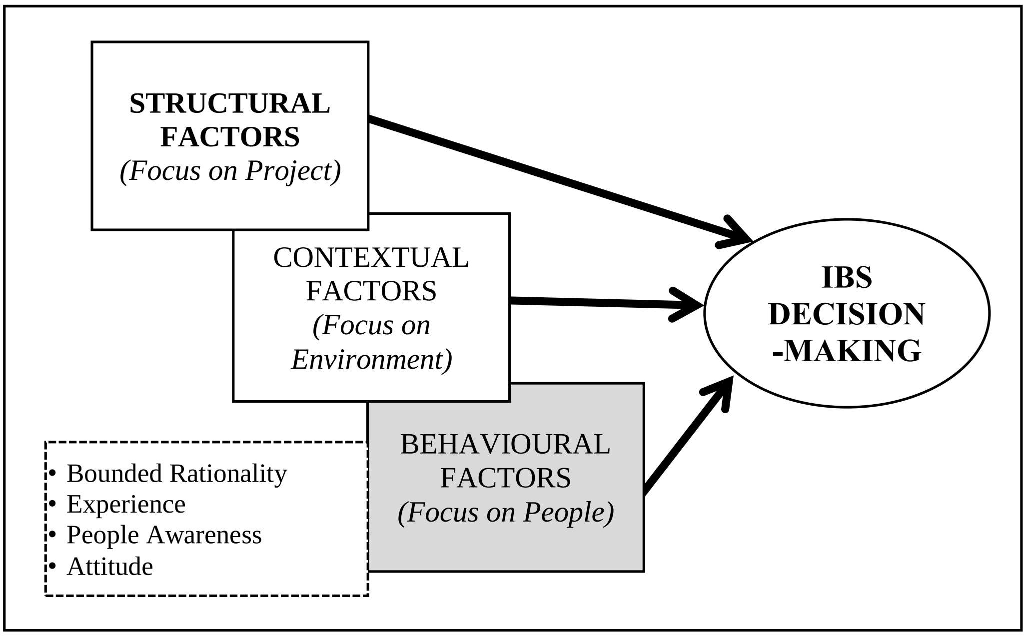

Figure 7.4 Behavioural Factors Influencing IBS Decision-making

It was verified that IBS decision-making is related to decision-makers' behaviour and the identification of this behaviour can help to enhance the utilisation of these research results in technology decision-making in the construction industry. Moreover, according to Michael (2006) and Salvendy (2012) generally, humans have had a fascination and complex relationship with technology, since the dawn of their existence. Three case studies relate to the bounded rationality in IBS decision-making. The research results on the influences of behavioural factors on IBS decisions are characterised as being rationally bounded in nature as decision-makers have many constraints and needs to be made, with incomplete and inadequate capabilities resulting from limited resources.

The factors of bounded rationality are highly derived from learning aspects, followed by justification, choice and cognition. From the behavioural perspective, this study is based on the cognitive–science concept of mental models which stated that mental models are our internal representation of the external world (Giere, 2010; Mohammed and Dumville, 2001). In practice, when deciding on IBS technology adoption in building projects, decision-makers refer to, and utilise their experience in building projects, IBS buildings or even concerning IBS technology, based on their short-term or long-term recollection or available information, most likely in the form of mental models or even project portfolios.

Like the learning aspects, IBS decision-making is based on the success experience from building projects, particularly in the adoption of IBS technology. This mechanism provides for the integration and comprehension of information and the projection of future events in the construction industry, which also allow for IBS decision-making on the basis of know-how, despite incomplete information and uncertainty. According to Ho et al. (2010) and Liu et al. (2008), stakeholders and experts are valuable resources in developing evaluative criteria for the improvement of the decision-making process, based on their experience and exposure as they are able to understand and process technical information and to articulate well-balanced recommendations.

Experienced construction professionals often have internal representations of the building projects they are dealing with, with a mental representation. In IBS decision-making, a well-developed mental representation provides the means of integrating project elements to form an understanding of their natures and performances. Moreover, repeated experience in a building-project setting allows people to develop expectations about future events that also guide them to perceive the information accordingly.

Therefore, knowledge about the relevant elements of building projects and IBS technology adoption, besides other related factors, can be used in directing IBS decisions and classifying information based on the awareness of decision-makers. During IBS decision-making, the awareness of decision-makers towards the current state of IBS can be matched to related representation in memory that illustrates the typical situations of IBS decision-making. These typical situations provide the classification of circumstances and understanding of previous project performance, either of IBS or non-IBS projects, current industry situation and projection of what is likely to happen in the future pertaining to IBS technology adoption. Particularly, decision-makers should be aware of IBS technology adoption as important elements that are recognised as project developments based on their values, support, culture and personality.

Moreover, personal values have long been associated with decision behaviour and they are the most abstract of social cognitions which reflect the most basic characteristics of adaptation (Hastie and Dawes, 2010). The very fact that the decision-maker is a human being allows a strong postulation that he or she must be influenced by his or her own subjective values, beliefs and norms. The current approaches of behavioural science, however, assume that an individual’s beliefs, attitudes and values comprise an integrated conceptual system or personal moral philosophy (Lerner, 2013).

Although, the study of behavioural aspects among decision-makers within an IBS decision-making scenario presents big challenges due to different entities and backgrounds in the construction industry, the decision-making of IBS technology adoption should not be based only on structural and contextual enforces. This means that decision-makers must anticipate human elements or factors in IBS decision-making for the long-term gain of building-project performance and such a situation requires knowledge and understanding of the surrounding of the IBS decision process, to ensure such reinforcement.

In the field of behavioural studies, the mass of theoretical works is realised for the benefit of business, health care and other social sectors whose main objective is behavioural prediction (Davies et al., 2012). The theory of planned behaviour by Ajzen (Fishbein and Ajzen, 2011) was originally developed to explain social behaviour, but has in recent years been successfully applied to explain aspects of consumer behaviour as well. This has resulted in the development of an excess of theories that make up what is commonly known as the behavioural approach. Therefore, this approach can be applied in IBS decision-making based on two major reasons:

a) Since an IBS building project is a group-based activity, those who are involved in IBS decision-making should realise that they are consciously or unconsciously influenced by some behavioural- or human–related aspects when making IBS decision.
b) In the decision-making of IBS technology adoption, behavioural influences on IBS decision-making in relation to contextual factors, is comparable to the influences decision-makers have to confront in relation to IBS projects and other structural factors. However there are differences in the degree of these influences which depend on the nature of IBS decision-making and its surrounding factors.

Some behavioural approaches have been used to study the behaviour of individuals in various fields. This is significantly true when it comes to the adoption of the use of information technology (Venkatesh et al., 2008) and health-care technology (Holden and Karsh, 2010). Moreover, the theory of planned behaviour (TPB), postulated that the behavioural choices are well-thought of, reasoned and acted upon (Fishbein and Ajzen, 2011; Montano and Kasprzyk, 2008). The behavioural approach, however has not been exploited in the field of the utilisation of research results, as a support to the decision-making process of IBS technology adoption in the building construction sector. Therefore, by incorporating behavioural dimensions relevant to the individual's psychological characteristics, this study leads to a larger perspective of this decision-making framework.

The various perspectives of IBS decision-making that are built into this study have allowed it to explore IBS decision-making process within a behavioural perspective, besides contextual and structural perspectives. According to Armitage and Conner (2001) the theory of planned behaviour stated that a person's behaviour is basically determined by three factors, namely the attitude that the person holds toward behaviour, the degree of social pressure felt by the person with regard to the behaviour and the degree of control that the person feels he or she has over performing the behaviour. Moreover, politics, government, law, education, economics, international relations and preserving the environment, all these need a new perspective as behavioural approach aims to demonstrate that behaviour analysis can help decision-making in ways that lead to solutions in those fields.

7.3 IBS Decision-making Criteria

The discussions on IBS decision-making and its influences in the previous sections put forward that the process of IBS decision-making is tailored to final IBS decisions, namely to adopt or not to adopt IBS technology. If the construction industry is promoting IBS technology adoption for infrastructure development, particularly in building projects, there should be some empirical evidence about its decision-making process. In this study, the exploration of IBS decision-making and the formation of group judgement on building-technology issues, mainly IBS technology adoption have reported a variety of factors that influence people's decisions.

Therefore, the new dimension of existing knowledge and evidence development are generated through decision-making research to provide information and guidance for decision-makers to enhance efficiency and effectiveness in the decision-making process (Anderson, 2012; Wallenius et al., 2008). Generally, many human errors that are attributed to poor decision-making actually involve dilemma with the structural, contextual and behavioural factors of IBS decision-making as opposed to the building-technology choice.

Specifying the criteria of IBS decision-making by which choices are to be made among competing building alternatives, is a fundamental step in working towards improved performance in the decision-making of IBS technology adoption. Therefore, it is also important to understand the role of decision criteria in the decision-making of IBS technology adoption and its related choices, distinguish between structural, contextual and behavioural criteria and recognise the limitations of using single criterion for making IBS technology decisions.

With this kind of limitation, it is possible to identify IBS decision-making criteria that are regularly applied in choosing among the alternative plans of IBS technology adoption for specific requirements of a building project. Consequently, it is essential to appreciate the relevance of multiple-criteria approaches to the decision-making of IBS technology adoption. A selection of structural, contextual and behavioural criteria is presented in Table 7.1, many of which are discussed in this chapter. This classification more accurately reflects the role of structural, contextual and behavioural factors in making decisions pertaining to IBS technology. These criteria are also presented according to the relevancy and priority of each factor and aspect that impacted IBS decision-making.

Table 7.1 Decision-making Criteria of IBS Decision-making

DECISION-MAKING CRITERIA IN IBS TECHNOLOGY ADOPTION						
FACTORS:		**PRIORITY ASPECTS:**				
1.STRUCTURAL	Management Approach	Process	Planning	Strategy	Goals	Leadership
	Project Condition	Operation	Development	Risk	Information	
	Procurement Setup	Costs	Clients	Resources	Supply-chain	
	Communication Process	Formal	Informal			
	Decision-making Style	Group	Individual	Nature		
2.CONTEXTUAL	Economic Conditions	Business	Demand	Opportunity	Uncertainty	Competition
	Technology Development	Productivity	Quality	Innovation	Creativity	
	Government Involvement	Promotion	Policy	Requirement	Rules	
	Sustainability Features	Environment	Efficient	Waste	Trends	
	Stakeholders' Participation	Opinion	Partnership			
3.BEHAVIOURAL	Bounded Rationality	Learning	Justification	Choice	Cognition	
	Experience	Success experience	Failure experience			
	People Awareness	Values	Support	Culture	Personality	
	Attitude	Positive attitude	Negative attitude			

Table 7.1 above, suggests that IBS decision-making processes are mainly driven by structural factors, particularly management approach, project condition and procurement setup. In addition, the research results show how structural, contextual and

behavioural factors can provide an evolutionary understanding of change in IBS decision-making processes. There are three major areas, namely structural, contextual and behavioural where change in a system that involves humans can be enacted. The first two really deal with the structural systems of building projects and their contextual setting. These are the systems that humans use to achieve project outcomes. However, this is not only about IBS technology adoption but also about its implementation.

Changes at this level can be either be static, that is, they deal with the procedural aspects of building projects or they can be dynamic, that is, they deal with the practical aspects of the construction industry context. Simply because these changes are desirable does not make them implementable. This is where the third area of change, which deals with people' behaviour, becomes important. When dealing with systems that interface with humans, people's attitudes, for instance, are vitally important if change is to be enacted. Furthermore, people act according to their perceptions, experience, attitude, awareness and limitations and are usually motivated by rewards and penalties. Even though structural and procedural prescriptions in building projects may be desirable, unless people's behaviour is also changed, little improvement in decision-making may occur. In addition to these findings, it is materialised that other important aspects concerning these factors were also interconnected.

The constant examination and anticipation of contextual factors are driven by the perception of economic conditions, technology development and government involvements. An alternative approach in using IBS decision-making criteria which gives more justifiable insights is one that relates the existing basis of benefit to the achievement of profitable competitive positions and hence superior performance in building projects, by adopting IBS technology. By relating causes, that are the sources of project success, to effects, these criteria emphasise various connections in a more explicit way when deciding on IBS technology adoption. It has been the case that management- and project criteria have dominated IBS decision-making irrespective of the initial emphasis that may have been given to financial- and non-project criteria. Recent changes in IBS decision-making, as reported by Blismas et al. (2006), Pan et al. (2012a) and Park et al. (2011), have suggested that the dominance of financial measure may no longer be appropriate when deciding on IBS technology adoption in building projects.

It is apparent that another major factor influencing IBS decision-making in building projects is behavioural factor. The most relevant behavioural factor in IBS decision-making is bounded rationality, mainly through learning and justifications that have aided the perception of participants. Management and project factors are particularly important to a certain extent as they are largely determined by management process, planning, and strategy; and project operation and development respectively as was shown above, whereby the IBS decision-making process is derived from formal communication and group consensus due to the effects of contextual factors based on behavioural aspects. Behavioural aspects, through bounded rationality, experience, perception and attitude, work hand-in-hand in IBS decision-making.

For that reason, the extent of decision effectiveness can be based on a multiple-success criteria in IBS decision-making and it is also important to avoid the error of focusing too sharply on one contributing factor for a building project success. It would be too optimistic to presume that decision effectiveness would be achieved simply through relying on structural factors only, without having a holistic project plan.

Consequently, it is sensible to widen our perspectives, look at more broadly based and considered criteria that go beyond the single criterion or multiple criteria to evaluating alternatives in the decision-making of IBS technology adoption. The use of a single criterion in IBS decision-making is inadequate because:

a) Members of building projects behave ineffectively from some points of view if a single criterion is used, as building projects also involve various stages and parties.
b) Members of building projects have to fulfil multiple functions in terms of technical, managerial, legal and clients' requirements, and have some multiple-project interests and goals, some of which may be in conflict. Therefore, it would be inappropriate to assess IBS decision criteria purely on the basis of any one criterion.

This kind of complexity will be obvious when there are project circumstances related to the identification of those multiple criteria in IBS decision-making that are necessary and sufficient to ensure organisational- or project well-being, growth and survival. In order to manage these conflicting project conditions pertaining to IBS technology adoption, IBS decision-making can be based on the use of Pareto's Law (Gigerenzer and Gaissmaier, 2011; Hardy, 2010). Pareto's Law is widely thought to apply to a range of situations in which most of the behaviour is supposed to depend on only a little of other factors (West and Grigolini, 2010). For example, it is often claimed that 80 percent of construction performance within a building project is attributable to 20 percent of timely work completion, or 80 percent of building projects come from 20 percent of private clients or 80 percent of profits are derived from 20 percent of project consultancies.

The main point here is that a decision-maker can effectively control project performance if he or she can focus on the critical 20 percent of essential and significant features, or one can control the goal achievements of building projects if project resources are appropriately allocated and properly utilised when deciding on IBS technology adoption. This can be greatly valuable both in terms of project productivity and quality, through eliminating unnecessary control effort on the insignificant 80 percent of long-term maintenance effort that only makes up 20 percent of building project issues and in terms of improved project effectiveness due to better control of project planning and strategy.

7.4 The Integration of Structural, Contextual and Behavioural Factors in IBS Decision-making

The factors identified in Section 7.2 are directly or indirectly, and consciously or unconsciously influenced by the decision-makers. Although decision-makers intuitively understood that there are different types of influencing factors in IBS decision-making, they found it difficult to characterise and integrate these diverse types of factors. However, it is important to note that decision-makers also intuitively understood that they would not foresee the same factors, features and circumstances on different types of building projects and IBS decisions, whatever these types were.

Hence within the interpretative phenomenological analysis of IBS decision-making there is a basic understanding that all decisions and their influencing factors are not the same and that the processes used to make IBS decisions will not be the same, but these factors can be integrated more precisely to guide and assist the decision-making of IBS technology adoption. Furthermore, they become the excellent points of observation and foundation to advance the research areas. In developing models of IBS decision-making based on phenomenological context, it would thus be important to recognise that the influencing factors of IBS decisions are based on the contribution and integration of variables from various aspects. The perceptions and concepts of IBS influencing factors are distilled using all the available data from the semi-structured face-to-face interviews and are presented in the dimension and models of IBS decision-making.

The reality is that IBS decision-making should be based on the feedback and anticipation of structural, contextual and behavioural factors. Whatever a group is, in the construction industry and whatever a project member or construction professional thinks, perceives and does when deciding on IBS technology adoption, they depend, to some degree, on their perceptual and conceptual surroundings. Thus, IBS decision-making deals with principles that govern decision-makers' reactions towards their surroundings.

7.4.1 Multiple Dimensions of IBS Decision-making

The study on IBS decision-making, in terms of its technical- or managerial development and application is vast, but decision-makers' perspectives vary on a number of factors. The participants who acknowledged the importance of these factors responded with a very similar perception of the decision-making of IBS technology adoption that can be mapped in a three dimensional diagram, as shown in Figure 7.5. This diagram centres on the influencing factors of IBS decision-making based on the perception of the construction-profession stakeholders and the supply-chain members of IBS projects. In framing these dimensions, the sequence of important aspects in each factor is derived from the analysis of data sources and references.

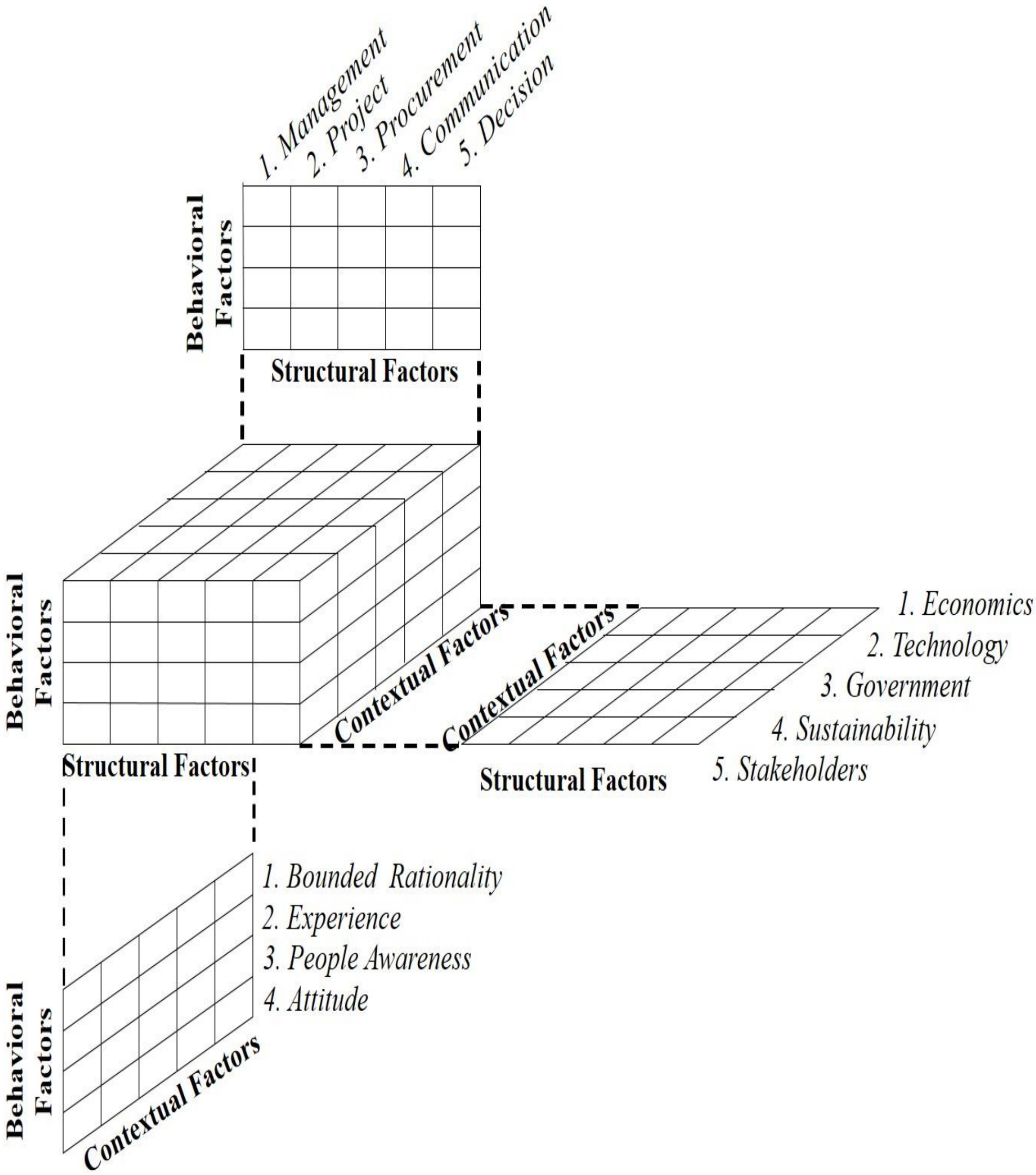

Figure 7.5 Dimensions of IBS Decision-making

Figure 7.5 illustrates an interactive progression of IBS influencing factors, which are explored and developed in three dimensions namely structural, contextual and behavioural factors. The dimensions provide a basis for understanding, appreciating and anticipating the decision-making of IBS technology adoption as these dimensions imply the most and the least important aspect from different perspectives for evaluating the influencing factors of IBS decision-making.

The dimensions offer insights into how the construction-profession stakeholders and the supply-chain members of IBS projects think about, and perceive IBS technology adoption issues and its decision-making, which provide a way to create a typology of IBS decision-making phenomenon based on structural, contextual and behavioural perspectives. The interactions among these factors are based on the specific aspects of these dimensions which are specified in an order based on their perceived importance and relevance. The dimensions of IBS decision-making can add to the conceptual base needed to develop a research agenda for the future investigation of IBS decision-making in the construction industry.

The use of a dimensional diagram with structural, contextual and behavioural factors is to classify their influences on the decision-making of IBS technology adoption in an integrative approach, rather than establishing it as a predictive model in the development of IBS decision-making criteria. Like the customised IBS decision-making, as illustrated in Figure 7.5, IBS decisions are also made within various dependency factors. These types of factors rely on the decision-maker recognising the key attributes of a factor and applying known solutions in IBS decision-making.

From the perspective of structural factors, the use of synergistic dimension provides guidance and information for decision-makers, based on management approaches, project management, procurement setup, communication process and decision nature. These factors, particularly the characteristics of structural elements based on their classifications, may be used by decision-makers to predict IBS technology adoption and building-project performance under incomplete or uncertain information, unless some specific exception is triggered in providing a more refined classification. This allows experts and decision-makers to have access to reasonable information about IBS decision-making, yielding more effective decisions than novices who will be more hampered by the absence of data.

Meanwhile, from the perspective of contextual factors, the major attention is that the current situation does not need to be exactly like the one encountered before, due to the use of categorisation mapping based on these contextual factors, particularly on economic conditions, technology development, government involvement, sustainability features and stakeholders' participation. Therefore, in IBS decision-making, the best fit between the characteristics of the internal and external situation of building projects, synergising contextual and structural factors using the characteristics of known categories of IBS technical and managerial specifications, and the characteristics of decision-makers themselves, can be achieved by the means of these dimensions.

Lastly, from the perspective of behavioural factors, perceptions towards the IBS decision-making and its influencing factors are almost instantaneous due to the natures of human abilities as matching mechanisms among these dimensions or factors and aspects, particularly based on bounded rationality, experience, awareness and attitude. When a decision-maker has a well-developed thinking capability for the actions of particular IBS decision-making or its related domains, this will provide:

a) For the dynamic direction or attention to critical indications in IBS technology adoption.
b) Expectations regarding future states of the contextual dimension, including what to expect as well as what not to expect, based on the matching mechanisms of the dimensions based on similar or different building projects or industry aspects.
c) A direct, single-step link between recognised aspects, situation classifications and typical actions.

These dimensions may provide important coping mechanisms for IBS decision-makers in adopting IBS technology within challenging construction domains where information is inadequate. In addition, decision-makers may include and consider information from the external or contextual surroundings of building projects to raise their degree of certainty about their mapping of the information of the construction world to their internal or behavioural perspectives, so that their ambiguity about future projections can be managed based on these dimensions.

This feature will allow project members or construction professionals to make decisions effectively, despite numerous uncertainties. Small shifts in these uncertainties, however, can dramatically change resultant conclusions. In framing IBS decisions, the participants investigate the situation by consulting with other project members as IBS decision-making is particularly a group-based activity or process. However, if the decision-maker is highly experienced in the construction industry, with specific decision authority, it is likely that they appear to come to a decision directly, but still need to consider the current and ever-changing dynamics of the construction industry.

7.4.2 On a Role of STUCONBECH© Model in IBS Decision-making

Decision-making is one of many managerial activities which appears to bring out certain kinds of human reactions (Alvesson and Willmott, 2012; Klein, 2008), including in IBS technology adoption. The process of technology decision-making, its consequence and the contextual pressure have been the topic of numerous written efforts in the past (Bagozzi, 2007; Jasperson et al., 2005; Venkatesh, et al., 2000). This model offers a focus on the decision-making of IBS technology adoption which is developed from the perspective and analysis of structural, contextual and behavioural factors. Incorporating these three aspects in the study of IBS decision-making sounds new, but in fact, the adaptation of different aspects when understanding IBS decision-making is valuable in the domain of IBS technology adoption. Among them is the potential to understand how people perceive IBS decision-making in the phenomenological context in order to determine the impacts of internal and external influences. Obviously, it is against the dominant empirical and quantitative approach for studying IBS decision-making.

This part sets out to develop a decision-making model of IBS technology adoption from results obtained from data and information analysis on the influencing factors of IBS decision-making. In the literature review, the concept of the decision-making frame (Byrnes, 2013; Gold and Shadlen, 2007; Pastötter et al., 2013) was briefly discussed to highlight the determination as to how contextual, structural and behavioural factors impact on IBS decision-making, thus causing readjustment in the IBS decision-making model. Based on the findings in this thesis, it is discovered that structural factors act as a main concern as there are project-related influences that determine IBS decision-making and there are project forces that mainly recognise IBS technology adoption.

Besides structural factors, IBS decision-making is also influenced by contextual and behavioural factors with a different degree of influence of each factor. Therefore, an exploration of these factors, as perceived by construction professionals would lead to readjustment and improvement of the IBS decision-making model. This model puts forward that some interrelations between constructs of IBS decision-making put forward in Chapter 3 (Figure 3.1) are possibly flawed. The interconnectedness between IBS decision-making frame and its influencing factors as shown in Figure 7.2, Figure 7.3, Figure 7.4 and Figure 7.5 should therefore be transformed and incorporated into Figure 7.6 below. Therefore, in the dynamic of construction environment, an IBS decision-making model is developed, known as Structural-Contextual-Behavioural (STUCONBEH©) based on the influence of contextual factors, structural factors and behavioural factors on IBS decision-making, illustrated by Figure 7.6.

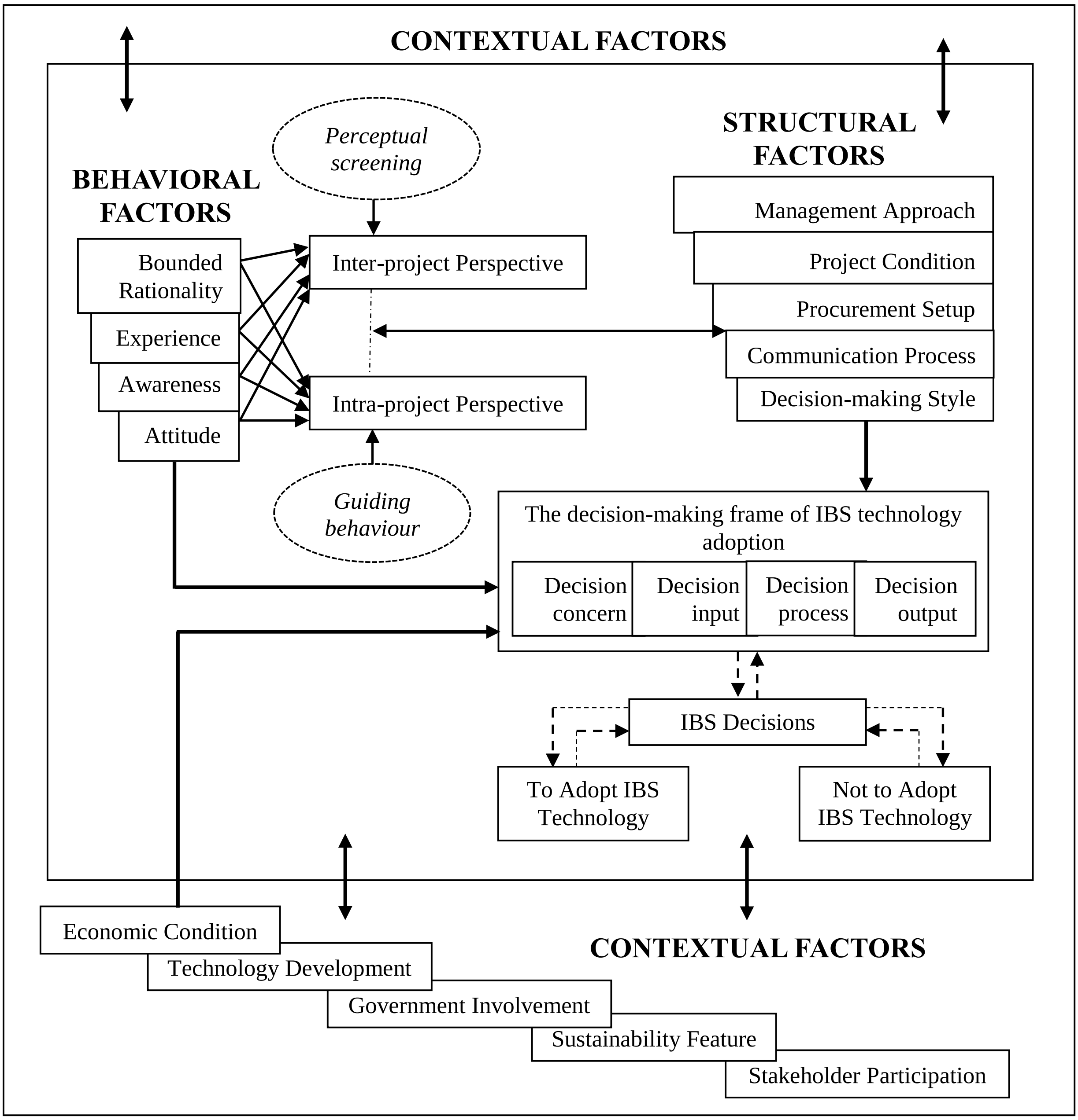

Figure 7.6 STUCONBEH© Model of IBS Decision-making

As illustrated by Figure 7.6, this figure clearly emphasises the central role IBS decision-making frame in responding to structural, contextual and behavioural factors in building projects. Additionally, a validating mechanism is applicable in IBS decision-making and this is represented by the dotted arrows leading from the IBS decision-making frame to IBS decisions and vice versa. This is due to changing conditions and there are possibilities for decision-makers to re-evaluate IBS decisions with project features.

It is important to note that Figure 7.6 is only a simplification of a complex process of IBS decision-making since many of the aspects (factor's components) are often interchangeable and all are highly interactive. Moreover, the decision process of IBS technology adoption is a mere summary of Table 7.1, further revealing the non-linear complexity involved. Specifically, Figure 7.6 comprises of:

a) First, the term structural is meant to indicate project management influences on IBS decision-making, regarding information acquisition concurrent with the dynamics of the construction industry, from the micro perspective.
b) Second, the term contextual is meant to reflect an outlook which captures the dynamics of socio-economic dimensions as surrounding influences on IBS decision-making, regarding the major and vibrant components of the construction industry, from the macro perspective.
c) Third, the term behavioural is the one which captures the intangible and internal aspect of human dimensions that is characterising the decision-making of IBS technology adoption, from the personal or human perspective.

Figure 7.6 provides a 'framework' or model in the decision-making landscape of IBS technology adoption within which to place the setting of IBS decision-making in building projects. The figure builds on analysed data in the IBS decision-making of construction players, namely inter- and intra-project perspectives. Figure 7.6 involves 4 different components; the decision-making frame of IBS technology adoption, structural factors, contextual factors, behavioural factors and inter- and intra-project perspectives.

The decision-making frame of IBS technology adoption shows that the decisions made within these phases – the people who make this decision are based on various concerns such as economic development, people' attitude and management process – is then progressed to more specific decision inputs such as success and failure experience in projects, planning and costs information. Next, the people who make the decision at the following phase are going through a decision-making process which involves the element of rationality, choice, cognition, justification and learning. After the decision is produced and outcomes are known, the final phase looks at outputs at each phase of the decision frame such as project development, productivity and quality to help improve future IBS decision-making. In order to make use of the ‘framework’ as a decision-making model more practical, however, two IBS decision types can be envisioned, namely to adopt IBS technology or not to adopt IBS technology. These two primary decision types occur when only the end points of the frame of IBS decisions are used in the characterisation.

Several important areas that influence the frame of IBS decision-making are also under covered. These include structural, contextual and behavioural factors. The most significant consideration in IBS decision-making deals with the impacts of structural factors in a hierarchy of influence. As each aspect of the factor is according to its priority, structural aspects allow for a particular degree of project related influence on IBS decision-making based on this order: first, management approach; second, project condition; third, procurement setup; fourth, communication process and finally, decision-making style.

Contextual factors then has four particular aspects in a hierarchy of this following order: economic condition, technology development, government involvement, sustainability feature and stakeholder participation. In order to display the contextual factors as a macro or an external influence which varying IBS decision types, it is necessary to display contextual aspects as a comprehensive scope with various constraints and uncertainties. Any IBS decision-making scenario can thus be mapped in terms of the properties within these five contextual factors and thus be characterised as belonging in a particular area of the decision-making of IBS technology adoption.

Next, behavioural factors consists of four major aspects in a sequential style which is according to the hierarchical order of each influencing aspect on IBS decision-making, namely bounded rationality, experience, people awareness and attitude as perceived by construction players from inter- and intra-project perspectives. From an inter-project perspective, there is the need for perceptual screening by building project members to analyse various external factors that impacted upon IBS decision-making. It also discovered that decisions which deal with major building projects, however, are very clearly scrutinised by most organisations in the construction industry. This leads to the assumption that organisations are able to screen and monitor their perceptions in IBS decision-making and what they should do to adopt or not to adopt IBS technology. From an intra-project perspective, behavioural factors act as a guiding behaviour that facilitates IBS decisions being made at the lowest point where the resources needed to implement the decision are available and enables individuals to clearly understand the project's aims and objectives. As a result, IBS decisions are made based on behalf of the project or organisation, not individual basis.

A transformation, then, should be implemented involves having decision makers stop and step back prior to jumping into the phases of IBS decision-making frame. The emphasis could be directed to taking time carefully consider various influencing factors. Most importantly, scenarios at different components in the model will likely involve different decision-making tools, data and progressions for the achievement of optimal IBS decision-making. For instance, the decision to adopt IBS technology may be subjected to a long, rigorous, complexity, involving multiple objectives and have new source of information to reduce uncertainty.

Direct attention is needed for perceiving and processing the external contextual factors for selecting actions and executing responses. In complex and dynamic construction environments, information insufficiency, task complexity, technical tasks and multi-tasking can easily exceed an individual's or group's limited attention and capacity, hence requiring perceptual screening and guiding behaviour respectively, in IBS decision-making.

Due to the limited capability of decision-makers, more attention to some information may mean an attention of decision-makers on structural factors which involve other project and managerial elements. The influence of structural-, contextual- and behavioural factors can result in IBS decisions leading to adoption or non-adoption of IBS technology in building projects. Most of a person's active processing of information must be combined with existing knowledge and a composite picture of the situation developed. Therefore, projections of future status, and subsequent IBS decisions as to appropriate courses of action, must access behavioural factors as well. IBS decision-making based on the STUCONBECH© model offers an opportunity to reduce the general uncertainty and to ensure efficiency and effectiveness in the decision-making of IBS technology adoption. In this study, the STUCONBECH© model is presented for explaining structural, contextual and behavioural perspectives with regard to IBS technology decisions. The construction technology revolution, particularly IBS, may not have revolutionised research in behavioural aspects to the extent it has in construction management, but it did provide an answer to one of the most persistent questions in the field: how the behavioural aspects of human judgment can impact the decision-making of IBS technology adoption.

Therefore, the STUCONBEH© model provides a starting point for the understanding and analysis of IBS decision-making structural, contextual and behavioural perspectives. It also conceptually distinguishes between structural, contextual and behavioural influences on IBS decision-making. Hence, this model is an accomplishment which integrates these influences into a procedural framework that enables and supports the generation of consensual IBS decision-making criteria.

Specifically, within this framework, a person's situational behavioural factors, as an internal and personal conceptualisation of contextual environment, becomes the driving factor of the IBS decision-making process. According to Mullainathan and Thaler (2000), behavioural economics is the combination of psychology and economics that investigates what happens when some of the agents display human limitations and complications. This model of STUCONBEH© provides a description of mechanisms for project goal achievement, attention to critical indications, expectancies regarding IBS future states, and ties between structural, contextual and behavioural factors, and IBS decisions.

This study is equipped with an understanding of how people make decisions in the realistic IBS settings of building projects, in order to fully understand the processes involved in IBS decision-making in the complex and dynamic construction environment. Therefore, the link between structural, contextual and behavioural factors and IBS decision-making is multi-dimensional and is viewed using a holistic concept.

There are four general foundations in using the STUCONBEH© model:

a) First, the use of multiple paradigms, holistically, could be used for explaining the different perspectives of IBS decision-making. Incorporation of key factors influencing on IBS decision-making and ranking of these factors allows for comparison in terms of their application or significance.

b) Second, the use of the STUCONBEH© model aids in the determination of IBS decision-making patterns, because it is easier to identify pre-defined patterns than to discover unknown patterns.

c) The use of a domain-specific model serves as an important function in this study. The model focuses on the phenomenological context of IBS decision-making in the construction industry with strategies and knowledge specific to that domain.

d) The use of the STUCONBEH© model facilitates greater precision in thinking, synthesising and helping to identify implicit assumptions.

In addition to establishing the basis for IBS decision-making, key situational or contextual factors verify the development of the mental model and judgement that directs to the selection of alternatives in building technology. Consequently, this situation is linked to the structural aspects of IBS decision-making. In the absence of an appropriate model, people may be unsuccessful in making decisions wisely, even when it requires the same logical processes. Specifically, the link between structural and behavioural factors with the contextual factors, and hence to IBS decisions, is developed by the decision-making process of IBS technology adoption.

Therefore, the tendency towards increasingly unexpected- or unpredictable and irregular changes implies that IBS decision-making needs to be considered as long-term and subject to appropriateness in response to any changes or influences in the contingencies that underpin them, which reflects the turbulence of external context. The result is a new model of IBS decision-making that emerged from the result analysis, synthesising the concepts of decision-making paradox, structural and contextual influences besides behavioural dimensions within the domain of IBS technology adoption in building projects. The perspectives of the STUCONBEH© Model of IBS decision-making can be viewed as follows:

a) STUCONBEH© Model – A Practical Approach in IBS Decision-making

Generally, decision theory offers an overly narrow and hypothetical view of managerial tasks including decision-making. Since the development of this decision model is based on the interpretative phenomenological analysis of this research, the STUCONBEH© Model has its credibility as a practical aid for IBS decision-making. Decision-makers are assumed to face decision situations in which they make preference-driven choices among alternatives. However, not all managerial tasks culminate in a decisive art of choice.

If an existing implementation of IBS technology adoption is not performing acceptably, the key challenge is diagnosis to determine the cause of the IBS performance shortcomings. Many IBS decisions may not be made while solving project problems but few could be usefully addressed with behavioural perspectives. Basically, this model represents the IBS decision-making scenario based on two premises. First, that there are understandable structural, contextual and behavioural regularities in action-oriented thought, and, second, that a clarification of the decision process will lead to improved direction and recommendations.

b) STUCONBEH© Model – A Holistic Concept in IBS Decision-making

A continuum of decision strategies might more appropriately be represented on a scale ranging from subjective to systematic to holistic. Understanding and aiding IBS decision-making in a dynamic environment rests on clearly understanding the factors associated with the development of the STUCONBEH© model. The model outlined here provides an initial attempt at establishing further advances in the decision research of building-technology adoption. Even within a single problem or issue in IBS decision-making, a holistic concept may be used for those parts of the problem for which a sufficient knowledge base exists. Since the development of this decision model is based on the phenomenological context of IBS decision-making with a holistic concept, the STUCONBEH© Model has a comprehensive outlook that can be a foundation in IBS decision-making.

In IBS decision-making, other parts of the problem which are related to technical aspects may be solved analytically, if rules and processes are known, or arbitrarily, if not deemed important enough to merit the extra effort required by analytic processes.

However, in non-technical or managerial situations, decision-makers may be obliged to use the arbitrary- or subjective processes of low decision accuracy and reliability, or analytic processes that emphasise limited internal resources.

The key to effective decision-making in all these cases rests in correctly understanding the whole situation and perspective of IBS decision-making, in a holistic concept. Although both subjective and holistic concepts may be preferred over systematic decision-making processes by decision-makers in situations involving uncertainties, a holistic concept can only be used when the decision-maker has a sufficiently developed knowledge base. In situations without uncertainties, any style could be used.

c) STUCONBEH© Model – A Thinking Approach in IBS Decision-making

Models that represent thinking as a part of decision-making process are related to studies conducted by Betsch and Glöckner, (2010), Ham and van den Bos (2010), Manktelow (2012) and Moxley at al. (2012). Some models depict problem-solving such as problem formulation or alternative generation at the front end, and decision-making such as evaluation or choice, at the back end, of a unitary process. Many decision-process researchers focus on particular elements of thinking (Betsch and Glöckner, 2010; Fenton-O'Creevy at al., 2011; Manktelow, 2012; Thompson et al., 2009).

IBS decision-making based on structural aspects, behavioural factors and contextual environment is emerging as a field of study providing a descriptive view of how people, particularly construction-profession stakeholders (in exploring inter-project perspective) and the supply-chain members of IBS projects (in exploring intra-project perspective) make decisions in the actual construction settings of building projects that feature unstructured problems embedded within complex and dynamic systems.

Decision-making in these settings tends to differ significantly from the analytic style of structured laboratory decision tasks that form the basis for traditional or common decision-theory research. Since the development of this decision model is based on the use of phenomenological method in exploring IBS decision-making from a multiple-perspective approach, the STUCONBEH© Model has its credibility as a practical aid in the thinking process of IBS decision-making. Even if this is the situation, more research is needed in order to fully explore the construct of the STUCONBEH© model and to develop an understanding of its role in the IBS decision process.

7.5 Extending the IBS Decision-making Model Through Detailed Analytical Representations

In addition to the impacts of structural, contextual and behavioural factors on IBS decision-making, a closer examination suggests that IBS decision-making is also driven by decision concerns, inputs, process and outputs and the perceptions of structural, contextual and behavioural factors that can lead to the success or performance of building projects. In order to develop a substantive foundation in IBS decision-making, there is a need to develop its revolutionary, real and somewhat extensive outlook in the search for links to other research and theory of judgment, decision-making, or problem solving and various other domains that has been done on people condition and their surroundings. The following sections will provide detailed discussion on the elements of cross construct synthesis.

7.5.1 Cross Construct Synthesis of IBS Decision-making Frame

The analysis of interview data presented in Chapter 6 indicates that the decision-making of IBS technology adoption is based on decision concerns, input, process and output. What is clearly noted from the analysis of the interview data is that the aspects of IBS decisions vary along the different dimensions of the decision-making frame. Therefore, a new taxonomy of IBS decision-making is established from the perspective of input-output method based on structural, contextual and behavioural factors classification in IBS decision-making. A useful point regarding this classification is that it is a continuum with is presented in the taxonomy of IBS decision-making. The various concerns, inputs, process and outputs of IBS decision-making derived from the cross construct synthesis of IBS Decision-making frame is shown in Table 7.2.

Table 7.2 Cross Construct Synthesis of IBS Decision-making Frame

DIMENSION: / FACTORS:	CONCERNS/ SPHERE OF CONSTRUCTION DYNAMICS	INPUTS /SUCCESS CRITERIA	IBS DECISION-MAKING PROCESS	OUTPUTS / PERFORMANCE
STRUCTURAL FACTORS	• Management approach • Clients • Risk • Decision Nature	• Planning • Costs • Project Information • Resources • Strategy	• Operation • Communication • Management • Group and individual decision • Leadership	• Project development • Procurement • Goals • Supply chain
CONTEXTUAL FACTORS	• Economics • Business • Government • Environment • Promotion • Policy • Rules • Uncertainty • Competition • Waste • Creativity • Trends	• Technology • Stakeholders Opinion • Demand • Technology Innovation		• Productivity • Quality • Partnership • Opportunity • Efficiency • Requirement • Sustainability
BEHAVIORAL FACTORS	• Attitude • Values • Support	• Success experience • Failure experience	• Bounded Rationality-choice, cognition, justification and learning • Culture • Personality	• Awareness

In general, this study varies considerably in focus and at the beginning, it seemed impossible to drive general conclusions. Therefore, despite the condition that decision-making with regard to IBS technology adoption is complex, it is necessary to develop a new approach on building-technology-adoption decisions in order to obtain valid results in its subsequent empirical research. In Chapters 5 and 6, it was suggested that structural, contextual and behavioural factors have various impacts on IBS decision-making. However, in Table 7.2, based on the evidence found in the research, it is suggested that these factors can be classified into decision concerns, inputs, process and outputs.

Specifically, the classification may impact IBS decision-making, depending on how the classification or taxonomy is perceived, i.e. as a support or a hindrance. This will determine what decisions are made and how they are made pertaining to IBS technology adoption. Concern about IBS influencing factors such as management process, economics and attitude was revealed as an important driver when making IBS decisions based on the inputs or success criteria of project performance. Clearly, the classification or taxonomy of IBS influencing factors in this study was perceived as a support or guidance in IBS decision-making rather than a hindrance or barrier. This principle can be further discussed based on various dimensions of IBS decision-making.

7.5.2 Influencing Factors on IBS Decision-making Frame

Another prevalent idea in this study concerns the ways decision-making research is applied in the decision-making of IBS technology adoption across the construction domain. From Table 7.2, a range of twelve IBS decision output or success performance was emerged from this study. While these twelve criteria might seem to be generally applicable in the decision-making of IBS technology adoption, it is their specific description within the context of a particular building project activity that determines how important they are according to priority.

This highlights a fundamental aspect of developing decision criteria in IBS technology adoption, as they must be highly situational if they are to be effective. They must be tailored and customised to the specific features of the building-project nature or situation, which means the project development, procurement, goals and supply chain. The focus of this kind of IBS decision-making is an ability to account richness of output-directed thought in the interpretative phenomenological analysis of IBS decision-making.

a) Structural Factors

In IBS decision-making, the structural elements, typically, range from very complex to very simple. Regarding the concern of structural factors, most participants perceived IBS decision-making as essentially being identification of construction dynamics in terms of management process, clients, risk and decision nature, as depicted in Figure 7.7.

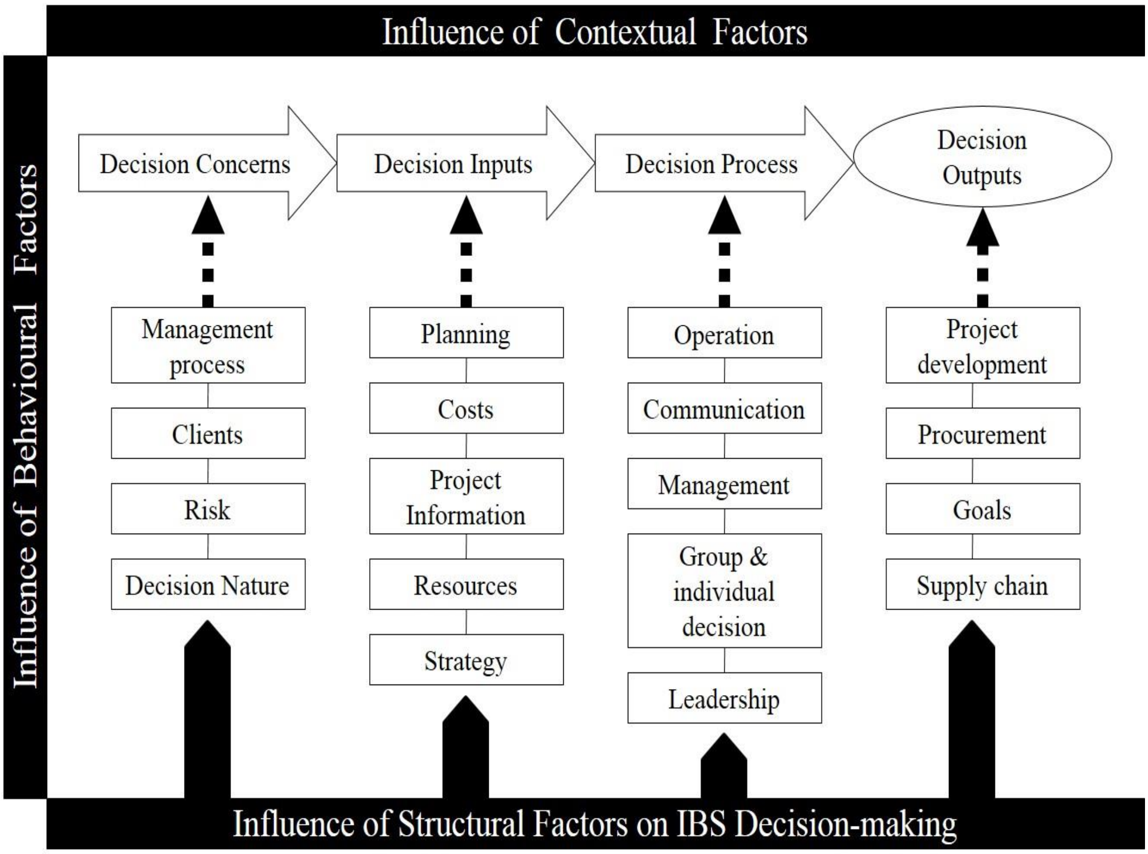

Figure 7.7 Structural Factors and Decision-making Frame

As illustrated in Figure 7.7, as the complexity increased, there were inputs for the decision-making process of IBS technology adoption. These inputs in relation to planning, costs, project information, resources and strategy may be specific to building projects. This clearly means getting more facts and figures in the process of IBS decision-making and to further analyse and review an IBS decision ahead of it receiving final endorsement. Hence, when faced with an IBS decision that may involve a more complex approval process, that is, the more definite the decision-maker is of obtaining the right outputs in terms of project development, project procurement, project goals, supply-chain integration, project operation, communication, management, group- or individual decision and leadership.

Briefly, as the complexity of structural factors changes, the process of IBS decision-making or the hierarchical approval process is altered according to the project operation, communication, management, group or individual decision-making and leadership based on the delegation of authority within the building project or organisation. Within the existence of IBS decision-making frame, each of the developments (concern, input, process and output) is impacted by structural factors. IBS decision concerns shift from simple management process to major decision nature. Consequently, IBS decision inputs shift from the aspect of planning to strategy aspects with various structural aspects in between. Within the process of decision-making, this phase involves a move from project- or organisational operation to the integrated assessment of leadership aspects. Finally, the progress of IBS decision-making is aimed at achieving project or organisational performance.

b) Contextual Factors

Probing on how the decision-making process of IBS decision-making takes place, given the dynamics of the construction industry in terms of contextual factors such as economics, business, government, environment, promotion, policy, rules, uncertainty, competition, waste, creativity and trends, led to the importance of decision inputs, as depicted in Figure 7.8.

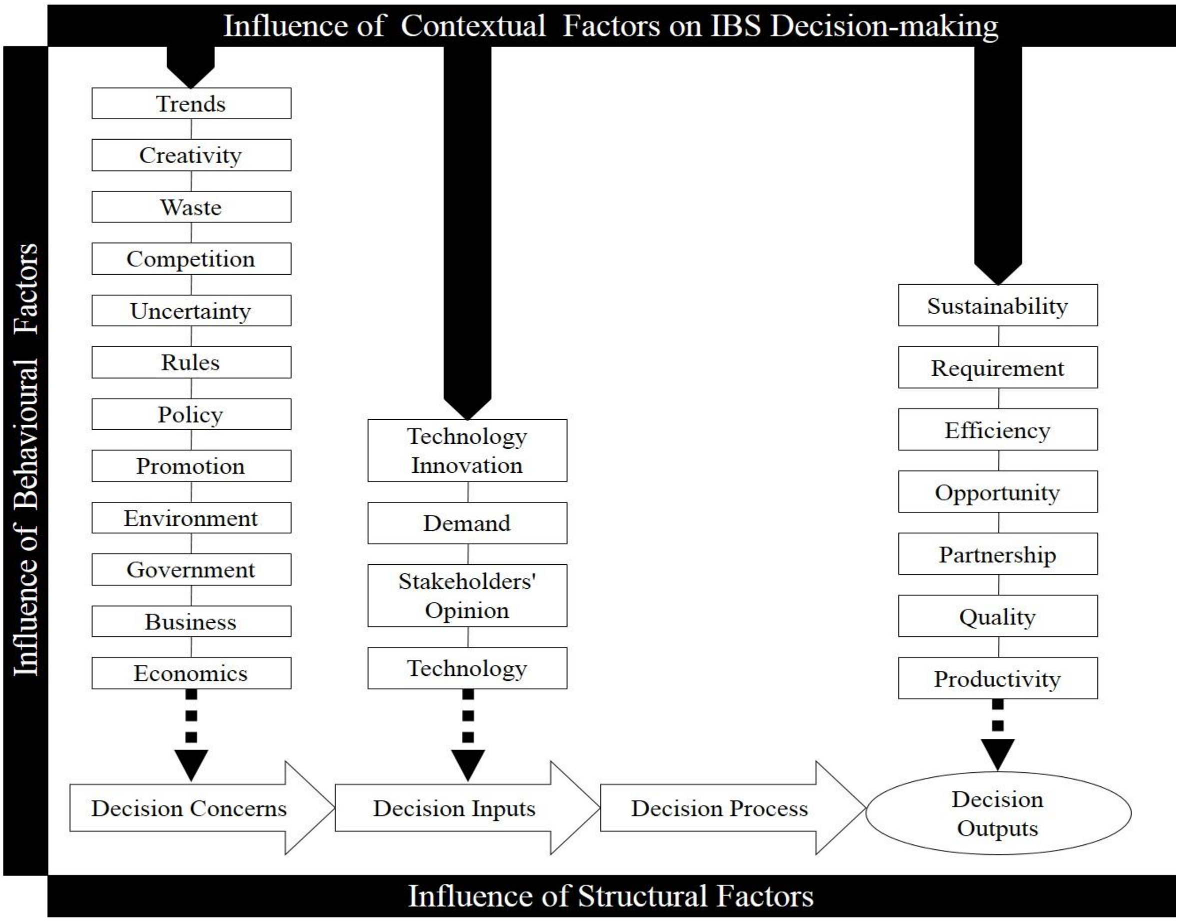

Figure 7.8 Contextual Factors and Decision-making Frame

Most participants clearly felt the need to have inputs from IBS technology advancement, stakeholders' opinions, demand conditions and technology innovation when deciding on IBS technology adoption and facing the dynamics of contextual factors. It is therefore advantageous for the decision-maker to identify that if the characterisation of construction dynamics and decision inputs indicates that there are going to be several constraints, they must anticipate the consequences of these elements. If this is not possible, IBS decisions will need to be adjusted in such a way as to keep the constraints at a minimal level.

One of the ways to regulate IBS decision-making is through the orientation of decision outputs concerning contextual factors i.e. technology productivity, quality, partnership, opportunity, efficiency, requirements and sustainability. Clearly, decision-makers rely on contextual concerns, inputs and outputs in IBS decision-making. It shows that the IBS decision-making process is mostly impacted with these contextual elements, since the participants did not recognise these elements in the decision process, as shown in a shadow box in Table 7.2, but the decision-making process of IBS technology adoption is mostly based on, and impacted by, contextual elements.

c) Behavioural Factors

The subjective perspective of IBS decision-making relates to the behavioural factors of people's aspirations and actions to make the decision. As the consideration for behavioural factors materialised, there were major concerns about the elements of attitude, values and support in IBS decision-making because it is complex for the decision-maker to weigh the relative importance of each IBS decision criterion, since IBS decision-making is also related to the perception of awareness of attitude, values and support, as depicted in Figure 7.9. The participants also recognised the success and failure experience of decision-makers in building projects and IBS technology adoption as inputs in the process of IBS decision-making.

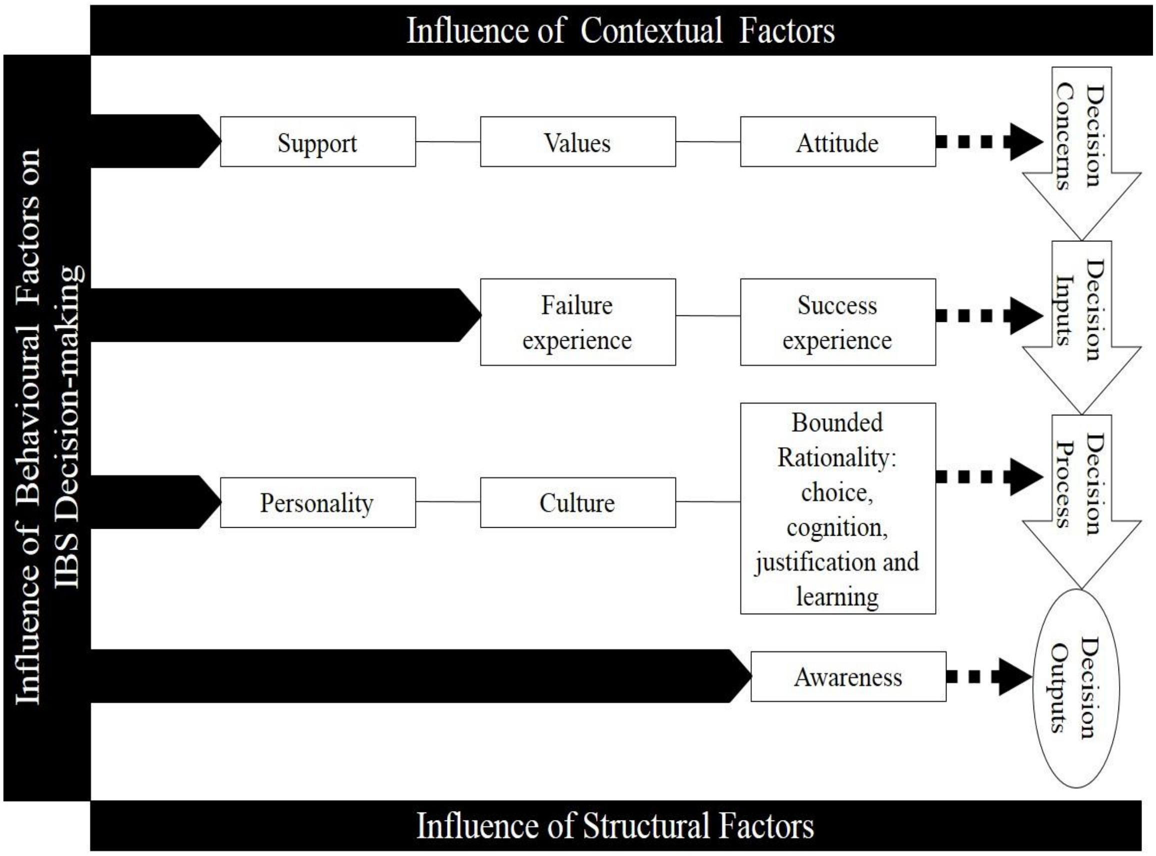

Figure 7.9 Behavioural Factors and Decision-making Frame

Consequently, in the decision process, there are three major categories of behavioural factors namely bounded rationality, culture and personality, related to the judgments of decision-makers. Firstly, bounded rationality, invoked during the process of IBS decision-making, or during the hierarchical or procedural approval process itself, needs to be well thought-out.

The bounded rationality, as reflected by the elements of choice, cognition, justification and learning, and discussed by the participants, relates to the point within the overall IBS decision-making process where it emerges from the basic process of IBS decision-making to the major and hierarchical approval process. More specifically, bounded rationality is well thought-out above the other behavioural factors during the process of IBS decision-making. Secondly, there are also needs for ensuring the compatibility of culture aspects concerning the organisation, project, society and industry. Thirdly, it is possible that the personality of decision-makers is also considered. This line of concern presumes two essential points.

The first is that just about everyone can (and does) consider behavioural factors in decision-making about IBS technology adoption. The second point is that IBS-decision-making use at least partially compensates for a lack of knowledge or information on behavioural influences. According to Krebs and Davies (2009) and Saaty and Vargas (2012), there are several elements that influence decision-making: i) the decision-makers' beliefs and values, ii) the decision-makers' agenda of goals and iii) the decision-makers' ongoing plans that are being implemented in an effort to attain the goals of the organisational agenda, and selected options must not seriously violate beliefs or values nor significantly interfere with implementations of plans that are aimed at goals achievements.

Clearly, in IBS decision-making, it is essential to draw on IBS decision taxonomy and as changes or constraints occur, IBS decision-making is easier to handle. In particular, IBS decision-making is most impacted by concerns about structural and contextual factors. At the least significant level, behavioural factors shape which characteristics are to be emphasised as the IBS decision-process function, particularly on the aspects of bounded rationality. By comparison, at the most significant-level end of the spectrum, high levels of consideration are placed on structural factors, mainly on management process, planning, operation and project development.

Within the process of IBS decision-making, this process is the most impacted by operations in building projects as there are specifications, requirements and objectives that need to be clearly weighted and pursued. Weighting of the different project objectives in advance, with project analysis will allow an appropriate approach which can prevent more uncertainty in the decision process.

7.5.3 Representation of IBS Decision-making Frame

In order to provide an understanding of the processes and factors that influence IBS decision-making in the complex settings of the construction industry, a triangular diagram describing factors underlying IBS decision-making has been developed. Therefore, the following discussion of this study is based on IBS decision-making using this newly developed triangular diagram. This synergistic triangular diagram brings together a great deal of exploration on IBS influencing factors into an organised representation for conceptualising IBS decision-making.

Even though considerable discussion exists within the construction field on the exact structure and nature of the IBS decision-making process, there are factors that are outside of the scope of IBS decision-making which directly or indirectly influence it. Therefore, a useful triangular diagram showing the role and influence of each factor, as generally understood, in understanding IBS decision-making can do much to guide research in this area.

Key features of the triangular diagram are summarised here and shown in Figure 7.10. From the results of this study, the landscape of IBS decision-making, as illustrated by Figure 7.10, can be grouped into three main areas.

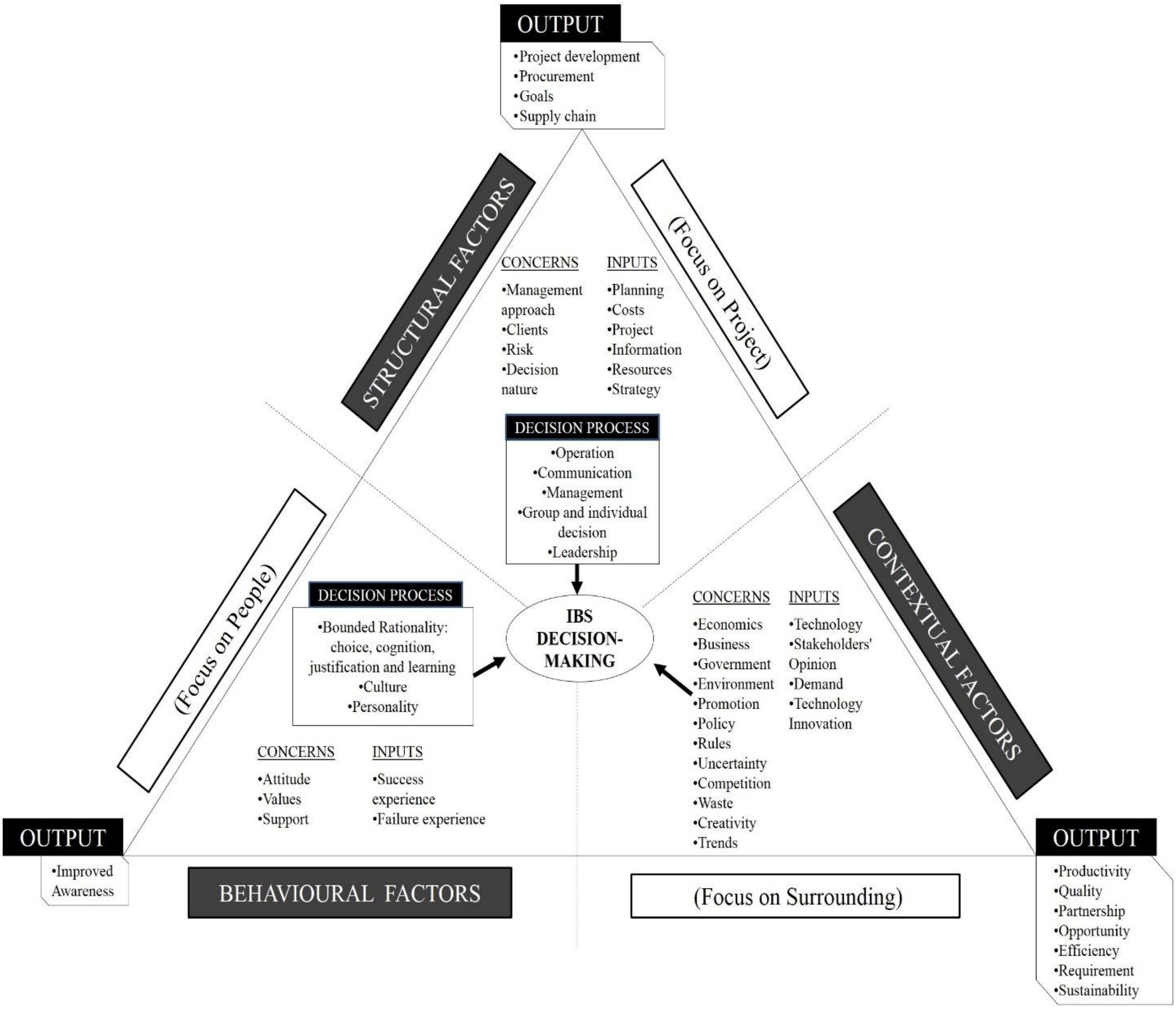

Figure 7.10 Representation of IBS Decision-making

The triangular diagram entails structural factors (focus on projects), contextual factors (focus on surrounding) and behavioural factors (focus on people). The range of various factors with different focuses impacting IBS decision-making is also shown in this figure and this is a comprehensive representation of the influence of structural, contextual and behavioural factors on IBS decision-making.

Within the resulting section there are:

a) Structural aspects of internal to organisation and project with focus on management process, clients, risks and decision nature that create forces for change in building projects practices. Whereas, IBS decision inputs, from the perspective of structural factors, involve several aspects such as planning, costs, project information, resources and strategy. From the structural perspective, the process of IBS decision-making involves managerial and project aspects such as operations, communication, management, group- and individual decision, and leadership.

b) Contextual aspects of external to organisation and project with focus on economics, business, government, environment, promotion, policy, rules, uncertainty, competition, waste, creativity and trends. Meanwhile, IBS decision inputs include aspects such as technology, stakeholders' opinion, demand, technology and innovation.

c) Behavioural aspects of internal organisation and project forces with focus on people; this involves concern on several aspects such as attitudes, values and support. From this perspective, success and failure experience are the major inputs for IBS decision-making. Meanwhile, the process of IBS decision-making includes several aspects such as bounded rationality, with the elements of choice, cognition, justification and learning, culture and personality.

It can be contended that in IBS decision-making, project success or performance is achieved through productivity, quality, partnership, opportunity, efficiency and the accomplishment of government- and project requirements, which covers only a part of what decision-makers will need to consider to build sustainable competitive advantage when deciding on IBS technology adoption.

Therefore, existing capabilities must be supplemented by structural- or organisational- and project potential which reflects on the organisation and project's ability to, manage their activities and people for building-project development, organise project procurement, achieve project goals and develop supply-chain integration through IBS decision-making, by establishing internal structures and behavioural aspects that influence project- and organisational members to generate and develop organisational- and project-specific competencies to achieve these aspirations. This requires more than simply depending on top management for IBS decision-making, as it requires deliberate development of competencies by which IBS decision-makers will act, to ensure the organisation and project stay ahead of their competitors.

Some of the primary features of the triangular diagram include a consideration of the role of behavioural factors that involve the tie between behavioural factors and contextual factors in IBS decision-making. While human behaviour, especially thinking and judgment, is now discussed and materialised in terms of a decision-making process, behavioural factors appropriate for investigating the dynamic and complex process of IBS decision-making such as bounded rationality, culture and personality, are explored together with contextual factors including the aspects of technology, stakeholders' opinion, demand and technology innovation. This collective exploration will lead to better and improved awareness of these factors concerning IBS decision-making.

7.6 Cross Construct Method for IBS Decision-making Frame

Therefore, practically, these dynamic and complex issues of IBS decision-making are investigated via a cross construct method. The exploration of the determinants of IBS decision-making, in this study, namely the individual, group, organisational and project behaviours of construction-profession stakeholders (inter-project perspective) and the IBS supply-chain members (intra-project perspective), has developed an integrative framework on IBS decision-making.

However, the concept of technology paradox is not simply a relabeling of the cost-benefit equation that has controlled decision-making research including prior work on innovation (Bagozzi, 2007; Birnbaum, 2008; Porter et al., 2011; Schwartz, 2009). The cognitive process involved in the decision-making of building technology like IBS has been a subject of interest to those seeking to understand why and how those in the construction business, or industry, make the decisions they do. According to Marewski et al. (2010) and Tomasello (2009), one of the major elements in cognitive process is categorisation, which allows individuals to use beliefs about similar past events to make inferences about current events. Sequentially, structural factors, contextual factors and behavioural variables have an effect, so it is important to visualise illustrations which incorporate all sets of variables, in order to understand and explain the decision-making of IBS technology adoption.

7.6.1 Decision Effectiveness

Within the decision-making landscape of technology adoption, there is little coverage of decision effectiveness (Jansen et al., 2013; Venkatesh and Bala, 2008). Nevertheless, it is implicit in the extensive coverage of IBS technology adoption in building projects that IBS decision-making should be effective although it is not suggested that decision effectiveness should be traded-off for greater efficiency. However, the concern that has existed with decision inputs rather than outputs tends to indicate that projects' outputs, as a result of adopting IBS technology such as project development, procurement attainment, goal achievement and supply-chain integration, are taken as being self-evident measures of decision effectiveness.

However, it can be conferred that any effort to deal with the effectiveness of individual or group decision-making in a building project is challenging due to two major reasons. First, it is not possible to separate the impact, for example of project planning, on the attainment of project goal based on structural factors, from the impacts of other contextual and behavioural factors that are also fundamental in IBS decision-making. Therefore, in IBS decision-making, it would not be rational to try to consider building-project effectiveness at any level below that of the achievement of project goals. For example, the integrated set of construction activities embracing the entire project goals are organised to pursue a given project strategy directed at a particular project stage.

Second, most IBS decision-making aspects relating to individual- and organisational- or project elements of building construction involve the determination of efficiency rather than effectiveness, focusing on the maximisation of output or project success performance for a given IBS-decision input or the minimisation of IBS-decision input to achieve a given level of output or project success performance.

One exception to this situation is the use of benchmarks or indicators of the construction industry based on building standards which represent project-output measures and performance, evaluated by reviewing how close each construction activity pertaining to IBS technology adoption helps to achieve the required building standards.

The perspective of using efficiency criteria in the decision-making of IBS technology adoption relies on the views of stakeholders, supply-chain members and other experts within the construction industry. It is normal in this approach that its validity is questionable and it does not represent a clear foundation for IBS decision-making. It is helpful in the construction industry, from the viewpoint of formulating action plans and making decisions, to identify that structural factors are the prescribed relevant factors, as in Table 7.1. However, it might be complex to know how they will impact on a building-project performance in terms of its competitive position and other performance or success measures.

7.6.2 Cross Construct Approach of Influencing Factors on IBS Decision-making Frame

In IBS decision-making, all facets of the decision progress require the concern of various aspects as the inputs of IBS decision-making have consequences on its decision process and the outputs of building project functions, stages and activities, such as timely project completion which has a significant bearing on the project's cash-flow situation. These outputs of other building project functions, stages and activities in turn affect subsequent outputs of the overall building project in terms of its performance, as a deprived cash-flow may lead to stringent financial control and hence to a lower profit.

Consequently, the interface of structural factors and behavioural factors formed by external or contextual driving forces is loaded with complexity, since the decision-maker must attempt to implement some degree of control over structural factors with the consideration of contextual factors and the focus on human aspects. The behavioural or human factor that is a part of IBS decision-making generates setbacks of control because of the difficulties involved in understanding or appreciating human factors in the context of the building industry, as well as coordinating the activities of different building-project members and supply-chain members, all of whom are essentially all of whom naturally have a fundamental standpoint and a certain degree of individualism and bias.

Therefore, the usual dilemma associated with any IBS decision-making in building projects is especially noticeable in the construction industry as a result of the human element and the external interfaces. Considering all these three dimensions of structural, contextual and behavioural factors in IBS decision-making can be a slightly difficult task due to a number of issues including: i) the nature of IBS decision-making as a complex area having many elements and interfaces in building-project development, both internally and externally, with IBS suppliers, architects, developers, installers, government agencies, contractors and sub-contractors, each of which has an impact on IBS project performance. ii) the need for IBS decision-makers to behave in an adaptive way in the light of contextual changes such as competitive activities or shifts in the pattern of clients' requirements or end-users demand, or changes in government regulations, which call for the changes or adjustment of project benchmarks and targeted project performance. iii) the tendency to focus on IBS decision inputs rather than outputs with the assumption being that the desired output, such as project goals achievement is obvious, thereby playing down the importance of both project performance and the implementation of IBS technology in building projects.

In IBS technology adoption, decision-makers must find means of securing better coordination among the various functional sub-system- and project members that are not directly under their control in a building project. This may be achieved by improving inter-organisational understandings and communication about what is the interest and focus of the building project as a whole. In addition, IBS decision-makers should make every effort to deal with external and internal elements as well as to manage other project members to carry out their responsibilities in the project's best interests.

This requires both flexibility, in terms of project implementation or strategies, and adequate feedback from project operations. Therefore, an input-output approach in IBS decision-making as illustrated in Figure 7.11, involves a close coordination on the concerns of structural, contextual and behavioural factors. The need for this close coordination is due to elements of decision concerns being the starting point for IBS decision-making with inputs from structural, contextual and behavioural perspectives for IBS decision process and outputs. Therefore, the consideration of external and internal elements in the construction industry is the foundation of IBS decision-making. Figure 7.11 shows the degree of relevancy and influences of structural, contextual and behavioural factors on IBS decision outputs as perceived by the participants, based on an input-output approach.

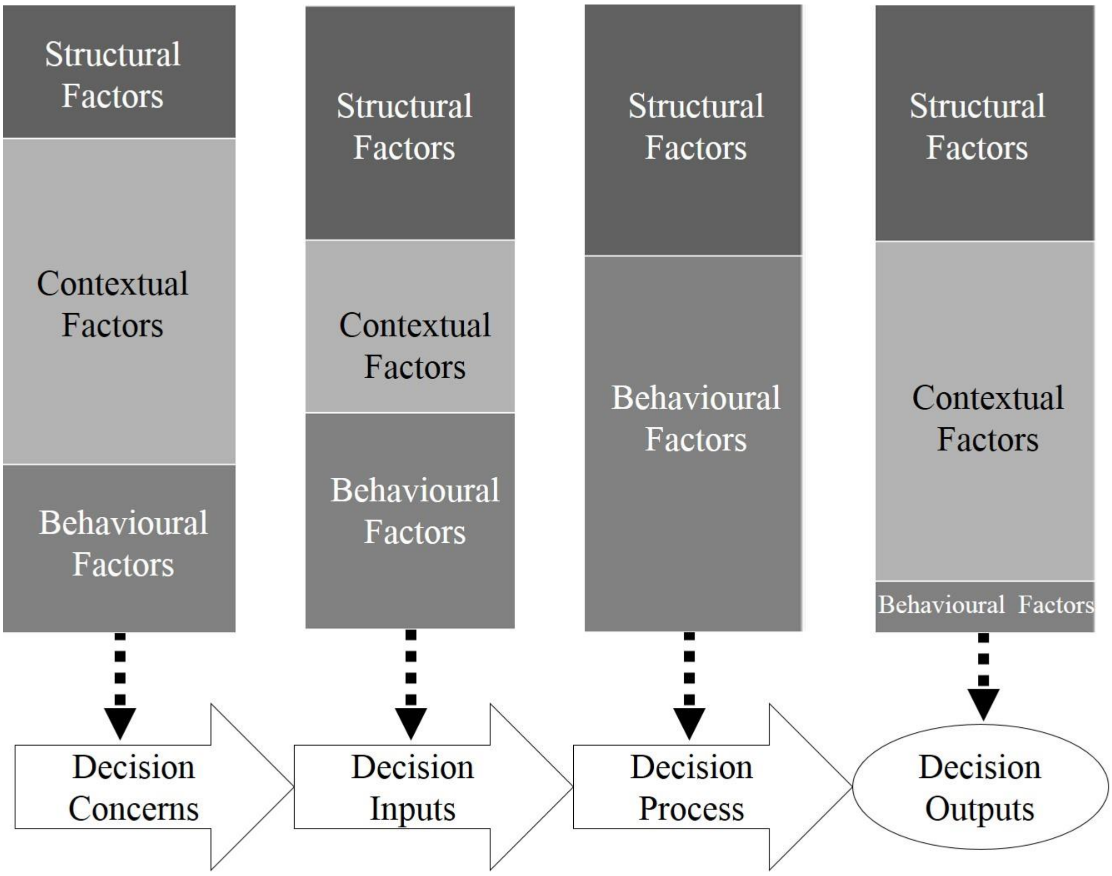

Figure 7.11 Influences of Structural, Contextual and Behavioural Factors on IBS Decision-making Frame

The focal point that emerges from this approach is that in IBS technology adoption, decision-makers should be concerned to develop distinctive competencies within the context of IBS projects that are appropriate for implementing prominent project strategies within the context of IBS projects, while at the same time considering other structural factors with contextual and behavioural factors throughout the decision process. Hence, it is important to match these factors in a balanced way.

Additionally, it will be obvious and apparent that IBS decision-making, which also involves the choice and priority of project outcomes or outputs, should be more objective, since in IBS technology adoption, a decision-maker should not be indicating his or her personal view regarding factors that are considered important in the control process of this input-output approach. Therefore, in IBS decision-making, there are three principal components in dealing with decision progress to improve the overall performance of:

a) IBS building projects as economic entities based on building performance indicators relating to both short- and long-term goals.
b) Construction activities at each construction stage within the building project based on a minimum goal that must be achieved.
c) Departmental or divisional activities that are involved in the building project based on factual inputs to support judgments in IBS technology adoption.

As a new way for exploring IBS decision-making, the input-output approach described here, and its dynamic process, offer an exciting avenue for research. Given the importance construction-profession stakeholders and the supply-chain members of IBS projects have placed on the ultimate outcome of their perception towards the decision-making of IBS technology adoption, it is important to realise that little research exists explaining the role of an individual's understanding about the nature of decision input and output in the decision-making of IBS technology adoption.

Therefore, this approach seeks to balance any conflicting tendencies in IBS decision-making, since from one perspective there is the diffusion over structural, contextual and behavioural factors, and from another perspective there is the tendency to emphasise on IBS decision concerns, inputs, process and outputs, with the result that other project goals are achieved. Consequently, the tendency in IBS decision-making is to focus on the long-term optimisation of project performance while also considering the effect that this might have on the short-term operation of the building project.

The consideration of project performance as an appropriate output measure in IBS decision-making, can be related to research conducted by Chen et al. (2010a) and Wu and Low (2011). Thus, project development, procurement attainment, goals achievement and supply-chain integration for instance, resulting from the decision-making of IBS technology adoption, can be considered as a dependent variable on the decision output with project developments playing a key role in the following sequence:

a) Superior building quality is established by a project by adopting building technology.
b) This superiority facilitates the business expansion of construction activities in terms of future procurement attainment, goals achievement and supply-chain integration particularly on building-project developments.
c) Greater business expansion in the construction industry, with the promising prospect of project developments and more successful supply-chain integration, bring cost advantages due to higher volume, turnover, mass production and experience-curve effects (Cheng et al., 2010; Cox and Townsend, 2009). However, the concept of technology paradox is not simply a re-labelling of the cost-benefit equation that has controlled decision-making research including prior work on innovation (Priemus et al., 2008).
d) Superior project performance based on IBS technology productivity and quality allows premium prices to be charged which, in association with cost effectiveness and the accomplishment of project requirements, ensures higher profits.
e) The overall performance well above the industry norms on almost every feasible project dimension, based on long-term sustainability, work efficiency, partnership development and improved awareness, lead to providing excellent value to the clients and strong profit growth in ensuring the return on investment. However, the relationship between values and decisions must be systematically investigated rather than assumed on the basis of theory, as differences in behaviour could be presented by different subjective values (Lynam et al., 2007; Polasky et al., 2011).

7.6.3 Cross Construct Approach of Operational and Managerial Connections in IBS Decision-making

Whatever measures of IBS decision input and output are used in an attempt to evaluate the efficiency of IBS decision-making, Figure 7.11 only offers a limited number of each, and the overriding emphasis is typically on readily quantifiable factors. This gives a means of considering whether, in the decision-making of IBS technology adoption, decision-makers are achieving as much output per unit of input as they should, or whether the efficiency of IBS decision-making might be improved.

However, this concern with IBS-decision effectiveness raises the issue of whether the correct approaches are being adopted, which, in turn, requires a careful and analytical consideration of the effectiveness of IBS decision-making based on the operational and managerial connections of IBS decision concerns, inputs, process and outputs, as depicted in Figure 7.12.

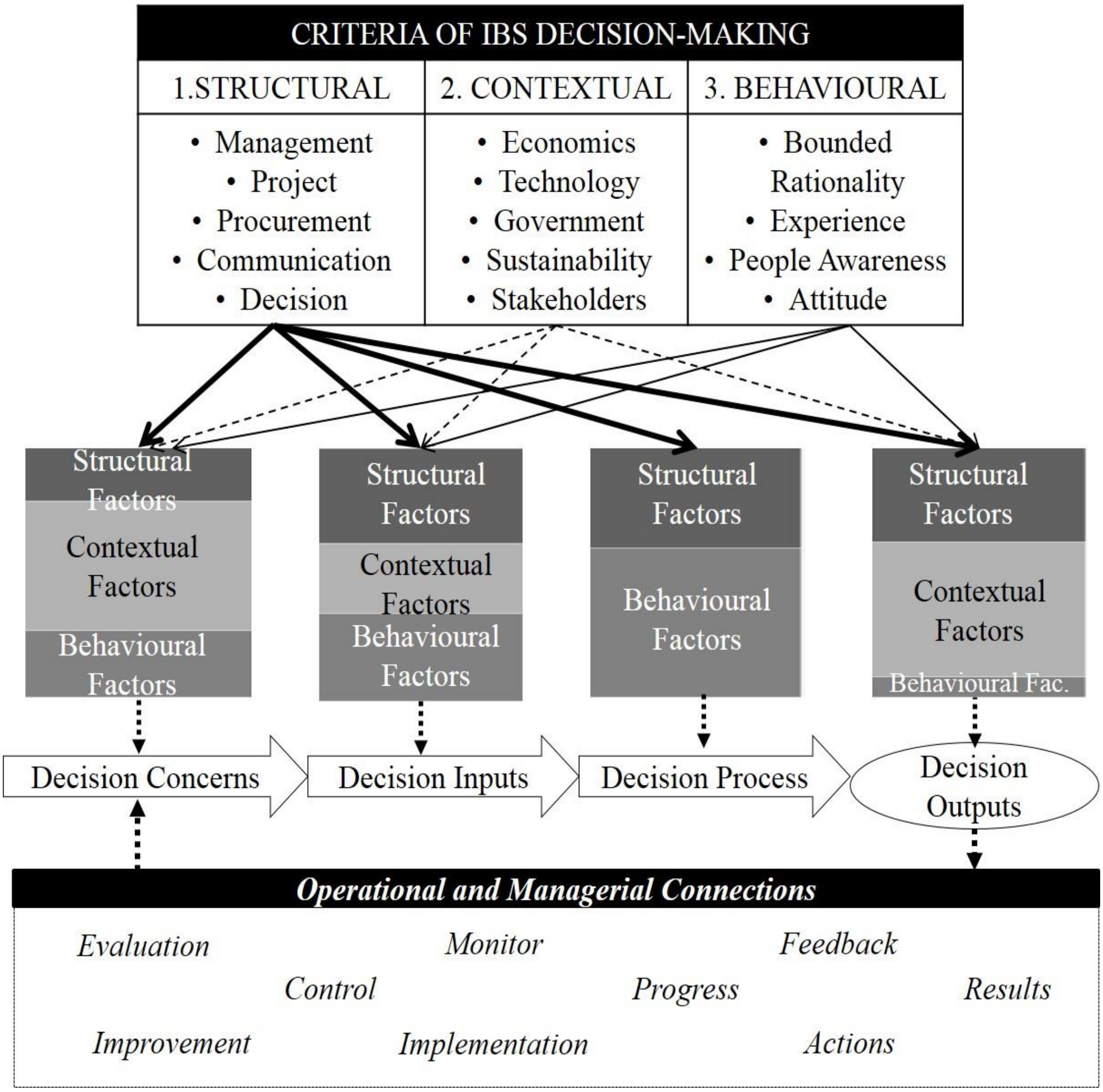

Figure 7.12 IBS Decision-making with Operational and Managerial Connections

Other project members, particularly the construction-profession stakeholders and the supply-chain members of IBS projects then identified the mechanisms of project-operational- and managerial connections in building projects. While project results can serve as a basis for choosing among available project alternatives and competing strategies in the decision-making of IBS technology adoption, they are not equivalent to project performance indicators or benchmarks. Figure 7.12 shows the development of IBS decision-making with a selection of a project's operational and managerial connections which comprise the elements of results, feedback, actions, progress, monitor, implementation, control, evaluation and improvement.

Therefore, under normal circumstances, project members must give equal focus and consideration to their internal and external surroundings, along with giving attention to both project output and input. When there is a slow growth in building demand for instance, the decision-making of IBS technology adoption should focus on the other invulnerable aspects of decision-makers' contextual surroundings. As a result, in IBS decision-making, it is also important to consider relationships between the criteria of IBS decision-making, the development of IBS decision-making and the operational and managerial connections of building projects which vary according to the types of building project, types of project procurement and the major or predominant strategies that should reflect the industry benchmark.

Therefore, Figure 7.12 presents various factors that are likely to be of some major significance to the goal achievement and performance of building projects. Consequently, in IBS decision-making, each influencing factor has further financial, managerial and technical implications, and if they can be handled, it is feasible that the overall building project or organisation can be well managed.

Decision inputs that are significant and critical are those that are fundamentally related to desired project outcomes concerning IBS technology adoption. In seeking to determine the significance and implications of IBS decision inputs, major concern must be given to decision input that are more adaptable or less intimidating to project success or performance. Similarly, IBS decision inputs that replicate the short-term focus, such as market or industry speculation, should not be permitted to control or dominate the

IBS decision-making process when decision inputs with a longer-term focus, such as project or organisational strategy are being overlooked in that process.

7.7 The Information Dimension of IBS Decision-making

In addition to yielding the criteria and progress of IBS decision-making, specific information and data on the IBS decision process are also important elements as IBS decision inputs, as presented in Table 7.2. Underlying this standpoint is the assumption that IBS decision-making is based upon the integration of structural, contextual and behavioural influences with the acquisition, evaluation and integration of their related information as decision concern, input, process and output.

Although a single decision-maker in a building project is required to acquire information from the business environment, in the process of arriving at current or future IBS decisions, the application to overall project- or group decision-making is necessarily different, in that it involves an interaction between two or more individuals with the influences of behavioural factors, directly or indirectly, besides the related information available in the construction industry.

The role of more specific types of data and information in IBS decision-making revolves around controlling, planning and directing, whereas conduct information is more important in understand in and dealing with people, besides perceptive information. In summary, optimised IBS decision-making is a means of bringing to each level of project or organisation, the necessary and complete information that is accurate, relevant, timely and sufficient so that a decision-maker can fulfil the project requirements efficiently and effectively.

Effective IBS decision-making requires various types of information resources, flows, management, systems and communication and technology. Basic information only, therefore, is insufficient in IBS decision-making, but if the coordination function exists within a building project or an organisation, it can be ensured that information needs are closely integrated with an optimised IBS decision-making. Deriving from the triangular diagram of IBS decision-making, Figure 7.13 outlines the general information shift in IBS decision-making towards more specific types of data and information within the construction industry.

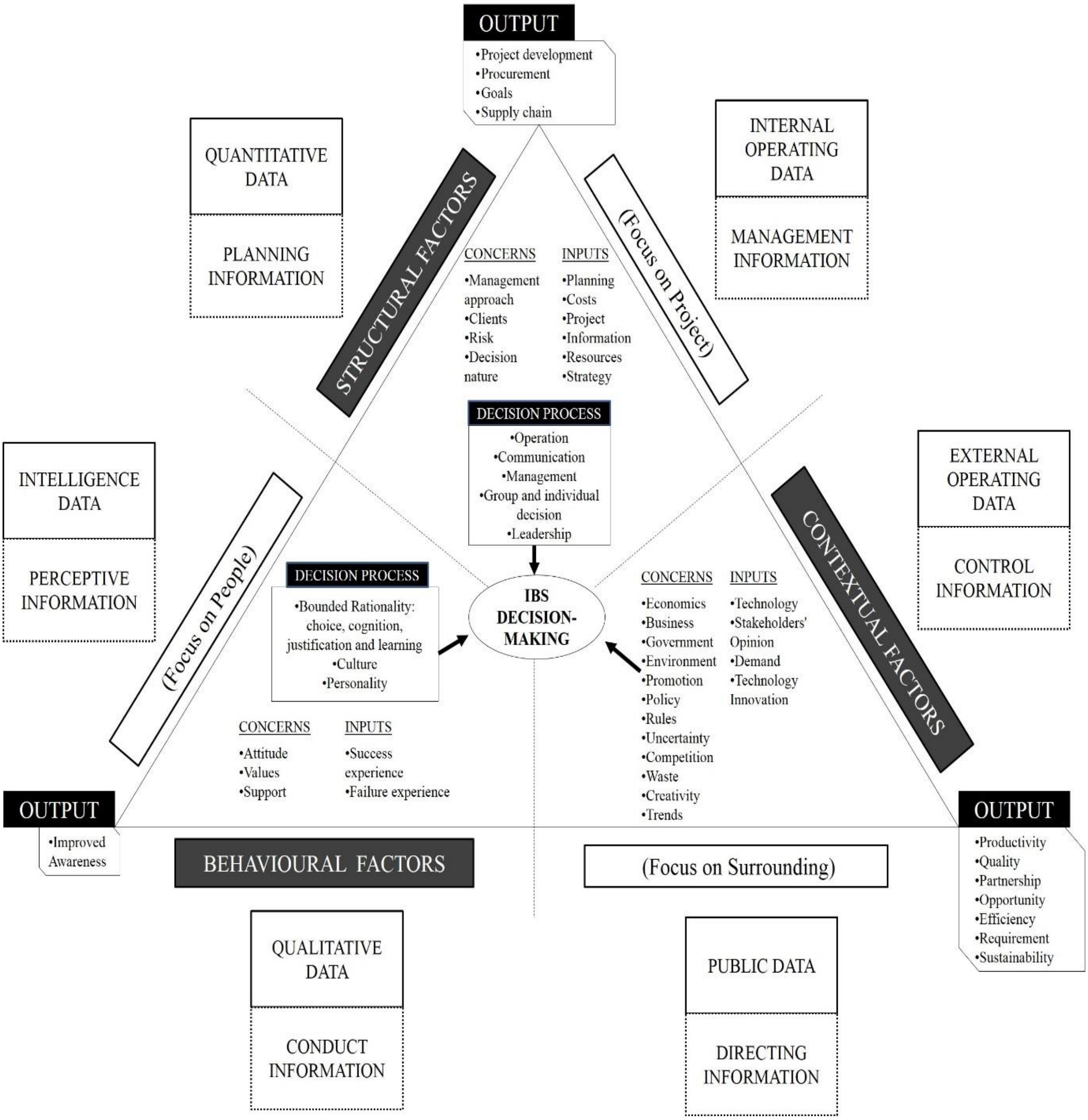

Figure 7.13 Representation of IBS Decision-making with Information Processing

The major rationale, then, is to support and facilitate IBS decision-making and the technique is based on various data types, as careful consideration should always be applied to deciding which elements of information to use in IBS decision-making if availability and accessibility are not to be a prohibitive factor. Therefore, the specific types of IBS decisions that will be made will apparently determine the information needs.

In addition, in terms of the categorisation of information, this classification into understood representation forms provides the basis for the higher levels of IBS decision-making. Long-term decisions or future IBS decision-making plays a significant role in classifying perceived information into known categories. This situation is illustrated in Figure 7.14 which is developed based on Figure 7.12.

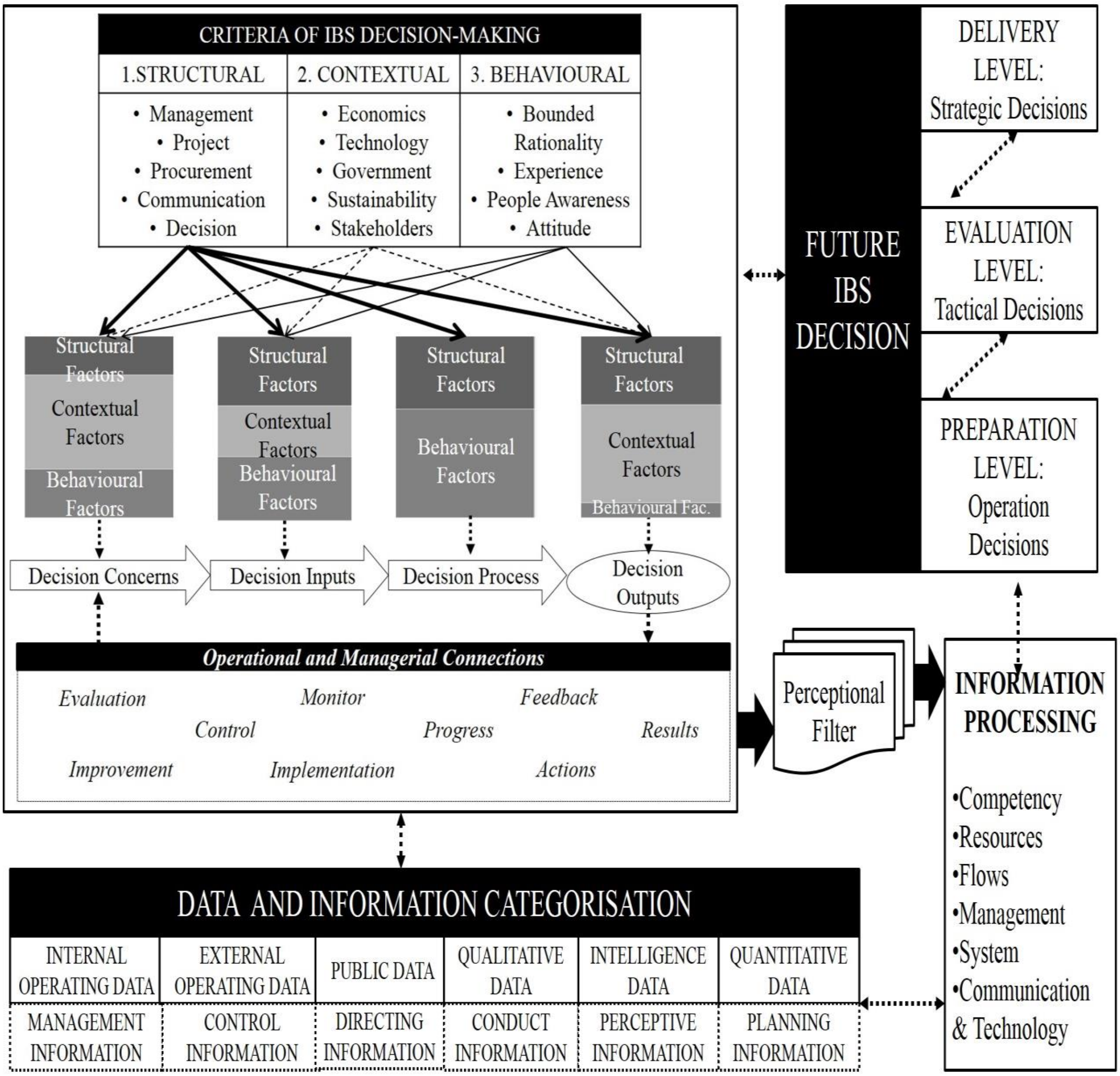

Figure 7.14 Future IBS Decision-making with Operational, Managerial and Information Connections

As illustrated in Figure 7.14, the dotted arrows represent validating mechanisms in the decision-making of IBS technology adoption. Decision-makers have to re-evaluate decision-making outputs and the implementation of IBS technology adoption due to changing conditions. In the process of information and data categorisation and utilisation, contextual and structural features are driven and processed in parallel, and these elements form the basis for the preparation level of IBS decision-making. In addition, decision-makers can progress in a goal-driven manner (Kenrick et al., 2010). Situation awareness is impacted by a person's goals and expectations (Veksler et al., 2013), which influence how attention is directed, how information is perceived and how it is interpreted.

This model, as presented in Figure 7.14, is based on a qualitative research and, as such, does not give a full and rigorous validation of qualitative data. Therefore, it is wise to experiment with, test the model and publish the resulting data using quantitative survey. This test is to help validate the model with a much larger sample size. In the case of this model that contain elements of human decision-making, validation becomes a matter of establishing credibility to ensure the effectiveness (in reaching the right decisions), efficiency, robustness and reliability of the model itself. Model verification and validation are essential parts of the model development process if this model to be accepted and used to support decision-making. Thus, it is also vital to establish a validation or further test the model qualitatively using a larger sample size so that the model produces sound insights and sound data based on a wide range of tests. The ultimate goal of model validation is to make the model useful in the sense that the model addresses the right problem, provides accurate information about the process of IBS decision-making being modelled and to make the model actually used as a valid one for assisting a wide range of IBS decision-making.

In a top-down decision process, the building-projects' goals and plans are directed along the aspects of projects' evaluation (Endsley and Jones, 2013). That information is then interpreted in light of these goals and integrated into the delivery level of IBS decision-making. The adequacy of this information setting as a basis of IBS decision-making is highlighted by the inclusion of:

a) IBS and building-project information about the future.

b) data expressed in qualitative data, quantitative data, internal operating data, external operating data, intelligence data and public data.

c) information dealing with strategic, tactical and operational decision level as it might bear on project conditions in a particular building project, concerning IBS technology adoption.

On an ongoing basis, trade-offs between top-down and bottom-up processing will occur in dynamic construction environments. While goal-directed processing is occurring in IBS decision-making, patterns in the dynamic construction environment may be recognised, indicating that new plans are necessary to meet active project goals or that different goals should be activated. In this way, a project's current goals and plans may change to be responsive to events in the construction surroundings.

Alternating top-down and bottom-up processing allows a decision-maker to process information effectively in a dynamic construction environment. In the process of IBS decision-making, both information categorisation and information processing have an important role. Information diversification is frequently used to avoid attention limits, following a pattern dictated by IBS decision objective, nature and process concerning relative priorities of information and the validity or reliability of information. The rationales underlying this view are that the decision-making of IBS technology adoption in building projects is viewed as:

a) A holistic concept that has to deal with project and non-project concerns.

b) Informative where a basic function of decision-making is to utilise decision mechanisms that facilitate IBS decision-making.

c) Integrative with clusters of managerial or structural activities that are interdependent.

Consequently, information processing also plays an important role, allowing decision-makers to focus on, and analyse, information on the basis of available project goals or other information perceived. A decision-maker's perceptions about information can affect the speed and accuracy of information processing (Galdi et al., 2008). Therefore, the categorisation of data and information into components that map to the mental or organisational model in IBS decision-making is important, but according to Lurie and Swaminathan (2009), perceived data and information should be filtered. Important aspects are then selected by the decision-maker that will bring the perceived surroundings into line with the project's plan and goals throughout information processing. A building-project's goals, selected as the most important among competing goals, will act to direct the preparation level of IBS decision-making.

It is emphasised throughout this discussion that a decision-maker needs information to assist him or her in the decision-making of IBS technology adoption, to indicate building-project performance and to assist in developing project plans, setting IBS standards and controlling outcomes to achieve optimised and improved IBS decision-making.

In this regard, the key to developing a productive and highly functional project- and management information system, is to shift beyond the limits of current IBS decision-making and to consider information as it relates to the two vital elements of the project-management process that are, planning and control. Similarly to other technology decisions, Hall et al. (2011) stated that investment analyses are believed to be psychological in nature with human capabilities for integrating information into a judgment or decision in their natural working environment.

Restating this concept for the interpretative phenomenological analysis of IBS decision-making among building projects in the construction industry, when the processes of IBS decision-making are tailored to the type of building project, with the anticipation of structural, contextual and behavioural factors, optimised IBS decision-making will result, as illustrated in Figure 7.15. In other words, higher levels of information compatibility, process or procedures, based on appropriate data type and information role, with suitable and supportive mechanisms, create improved IBS decision-making and promote better IBS decision outcomes.

CURRENT IBS DECISION MAKING			OPTIMISED IBS DECISION MAKING	
DATA TYPE:	INFORMATION ROLE:	MECHANISM:	INFORMATION NEEDS FOR IBS DECISION MAKING	INFORMATION NEEDS FOR ACTIONS AND IMPLEMENTATION
EXTERNAL OPERATING DATA	CONTROL INFORMATION	•DECISION SUPPORT SYSTEM •BUILDING SOLUTIONS •BENCH-MARKING	INFORMATION COMMUNICATION AND TECHNOLOGY	Information as analysis and visualization tool.
QUANTITATIVE DATA	PLANNING INFORMATION		INFORMATION SYSTEM	The need for stakeholders access to information.
INTERNAL OPERATING DATA	MANAGEMENT INFORMATION		INFORMATION MANAGEMENT	Public participation in information gathering.
QUALITATIVE DATA	CONDUCT INFORMATION		INFORMATION FLOWS	Internal and external information categorization.
PUBLIC DATA	DIRECTING INFORMATION		INFORMATION RESOURCES	The role and contribution of information.
INTELLIGENCE DATA	PERCEPTIVE INFORMATION		INFORMATION COMPETENCY	The importance of information.

IMPROVED IBS DECISION MAKING

Figure 7.15 Current, Optimised and Improved IBS Decision-making

In the decision-making of IBS technology adoption, the utilisation of good data and information on an unsuited type of building project will inevitably lead to ineffectiveness, whereas use of the same data and information on the appropriate context of building project may result in the higher chance of success or outstanding project performance. It can also be stated that if data and information are matched with an appropriate context and type of building project, better IBS decisions result.

Therefore, a well-developed data- and information collection with fine categorisations may be promising for IBS decision-making and for further actions and implementations. A highly detailed classification provides decision-makers with access to detailed knowledge from an existing project portfolio and is also based on a vast amount of information from the environment or industry. The indications used to achieve these classifications are very important to IBS decision-making, deriving from the criteria of IBS decisions. With higher levels of expertise, decision-makers in building projects appear to develop knowledge of critical indicators in the construction industry that allow them to make very fine information classifications, analysis and interpretation for optimised IBS decision-making.

In summary, this information composition provides a guiding principle within which IBS decision-makers can effectively integrate the various external inputs of the project and then synergise them with the internal elements of several building projects. Additionally, this integration should lead to an improved IBS decision-making in terms of:

a) A more intensive focus on the information role and its mechanisms.

b) A better system of project information management to provide decision-makers with a clearer perspective and a superior foundation for IBS decision-making based on various information needs.

c) A better understanding of IBS decision-making influences as an adjustment mechanism that is able to utilise project resources to meet changing industry conditions successfully, based on an adequate amount of information.

7.8 Testing the Developed Models of IBS Decision-making

Based on the decision-making models built using the theoretical propositions, established through the qualitative approach with interview and case study methods, future research using quantitative methods is proposed to validate the models. Although the findings from this research have extended knowledge and provide insights into IBS decision-making and its influencing factors in the context of Malaysian construction industry, it is essential to confirm them using quantitative methods and to test the models of IBS decision-making presented in this chapter. Hypotheses will be established based on the theoretical propositions underpinning the decision-making model.

It would also be valuable for quantitative research to be conducted particularly on the influencing factors on IBS decision-making, as this would allow proposing the relationships of various influencing factors, which can be tested through correlation analysis or regression between the factor groupings and decision frame. In addition, the purpose of conducting a large scale statistical study would be to further test the validity of IBS decision-making model as presented in Figure 7.12 (IBS Decision-making with

Operational and Managerial Connections) and to determine how comprehensive it is to a larger sample of construction professionals. Specifically, construct and propositions underpinning Figure 7.12 will give be used as a guide to design the quantitative hypotheses, which is presented in Figure 7.16.

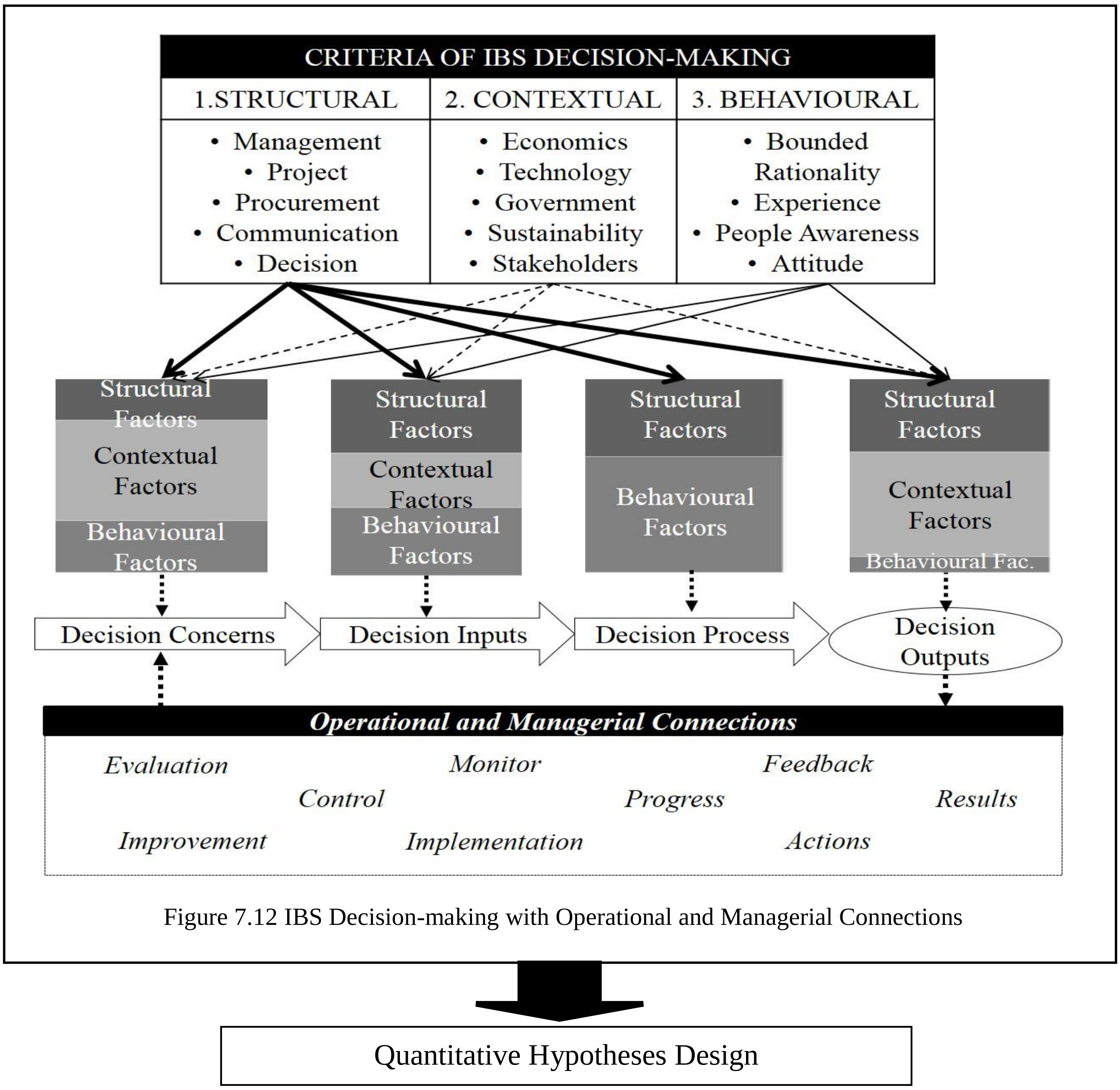

Figure 7.16 Quantitative Hypotheses Design Underpinning Decision-making Model

Further, the test will be undertaken as a four-stage program with the results of each of being incorporated into the following stages. The overall program is outlined in Figure 7.17. Figure 7.17 shows the overall procedure that will be adopted in the quantitative method of model testing and each stage is described in more detail below.

STEP 1 (S-1) *Quantitative Instrument Development*	The constructs (factors) from this qualitative study will be transformed into variables (face validity is established through this research outputs)
	Attributes and measures will be developed for each construct (statistical validity)
	A questionnaire survey instrument will be developed

↓

STEP 2 (S-2) *Sampling Design, Ethics Approval and Survey Execution*	Sample size and survey administration will be designed
	Ethics clearance will be obtained

↓

STEP 3 (S-3) *Data Coding and Entry*	Data entering and coding (SPSS protocols) will be conducted
	Data screening for anomalies will be performed

↓

STEP 4 (S-4) *Data Analysis*	**STEP 4 - Part I** *Descriptive Analysis*	**STEP 4 – Part II** *Inferential Analysis*
	Purpose is to describe the : • Sample characteristics • Study variables	• Purpose is to test the model variables (factors) • Establish association between the factors and a factor structure • Link the factors to Decision-making frame
	Descriptive Statistical Techniques: • Frequency distribution for nominal scale data (e.g respondent details) • Percentile analysis and median analysis for interval scale data	Inferential Statistical Techniques: • Kruskal-Wallis Test to test the homogeneity of the population • Data screening – box and whisker plots and stem and leaf diagrams to identify extreme values (statistical validity) • Test for normality through skewness & kurtosis (statistical validity) • Reliability analysis though Cronbach's Alpha (convergent validity)
		Perform one sample *t*-test (test value of 3) to establish significance of the decision-making factors (structural, contextual and behavioural)
		• Factor analysis to establish the factor structure to confirm the decision-making factor grouping • Multiple-regression analysis to establish the relationship between the factors grouping on each decision-making frame components

↓

To Confirm Decision Making Model

Figure 7.17 Quantitative Methodology Framework for IBS Decision-making

As shown in Figure 7.17, the proposed quantitative study will be designed in 4 stages namely: S-1: Instrument Development, S-2: Survey Execution, S-3: Data Coding and Entry and S-4: Data Analysis.

a) S-1 is focused on designing the survey instrument using theoretical constructs established in this research – that provide the face validity, as they have been sourced from literature and then reinforced through qualitative primary data. Each of these constructs will then be allocated with a measurement scale (Kumar, 2005; Nardi, 2003). Most constructs will be measured using a 5-point Likert scale (that may use for e.g. Strongly Disagree to Strongly Agree scales or Very Satisfied to Very dissatisfied) (Likert, 1961; 1967).
b) S-2 will focus on sample design stage and ethics protocols and operational execution of the survey. Population of construction-profession stakeholders and supply-chain members will be established to work out appropriate sample sizes, followed by the distribution of survey. Depending on the stakeholder online engagement, questionnaires will be distributed through online or paper based.
c) S-3 will focus on data coding, entering and screening using statistical software (e.g. SPSS).
d) During S-4, data will be analysed using descriptive and inferential statistical techniques.
    i) In Part 1 analysis, nominal and ordinal data will be grouped and frequency analysis will be performed to provide information of the sampling frame. All Likert scale data will be analysed with means, medians etc.
    ii) Part 2 analysis will consist of inferential statistical analyses to project the sample findings to the population with set confidence limits. One sample *t*-test will be conducted on each factor to identify statistically significant factors impacting IBS decision-making. Factor analysis will be performed to confirm the grouping of the factors impacting IBS decision-making. Multiple regression analysis will be performed to establish the impact of factors on components on the decision-making frame (e.g. decision concern, input, process, and output).

Based on the findings of inferential statistics, hypotheses underpinning the components of the IBS decision-making model will be accepted or rejected. Further, the development of IBS decision-making model can be performed in such as a way as to be as generic as possible. Therefore, it is suggested that a study can be conducted to determine its generalizability using quantitative methods before it can be applicable to other types of decision-making or other problems with similar issues in the construction industry.

As the invention of such model has been developed, further improvement and tests can also be focused towards determining its robustness. This aim might be achieved by spreading the research with different decision-making scenarios such as other construction technologies or other project management settings or more building projects. Finding a quantitative mechanism to verify the various perspectives of IBS influencing factors might be useful in accommodating IBS decision-making model. Thus, Figure 7.17 provides a broad quantitative research framework for confirming the qualitative theoretical proposition established in this research.

7.9 Emerging Progression in IBS Decision-making

The answer to the research question must therefore be that contextual and behavioural factors, in this study, impacted the decision-making of IBS technology adoption according to the degree of influence of each factor. Specifically, IBS decision-making was also affected directly by the structural factors of building projects through conceptual and practical perception. Fundamentally, this study is a first step to explore decision-making in the realistic setting of IBS technology adoption, to discover IBS decision processes based on the perceptions, or the interpretative phenomenology analysis, of the construction stakeholders and IBS supply-chain members, that are interrelated to those predicted by other decision theory (Driscoll et al., 2010; Rostek, 2010).

The purpose of this clarification is not to provide a definite answer to how structural, contextual and behavioural approach should be implemented, but rather to raise understanding of the diminished nature of qualitative behavioural economics in the decision-making of IBS technology adoption. This study has shown that the research is highly relevant as many of the findings on the decision-making of IBS technology adoption were based on the interpretative phenomenological analysis, besides being supported by the literature. Therefore, it is important to acknowledge that the results obtained from this study are noted within two different, but very complimentary perspectives:

a) A conceptual perception whose objective lies in the elaboration and the validation of an explanatory approach stemming from behavioural economics- and project-management viewpoints.

b) A practical perception that is a foundation in determining a number of structural, contextual and behavioural influences upon the decision-making of IBS technology adoption.

However, both perspectives can be synthesised to the improvement of the use of IBS decision-making criteria in times of IBS technology adoption in the Malaysian construction industry. Further details on both perceptions are discussed below:

7.9.1 Conceptual Perception

The thesis has revealed that the perception of structural, contextual and behavioural factors and their impacts have a significant effect on IBS decision-making, based on their priority aspects or relevancy. This is in combination with how these factors are perceived, whether these factors are highly, or moderately, or less influencing on IBS decision-making. Without considering multiple-perspectives in IBS decision-making with the deeper understanding that it can bring to both applications and research, there is a possibility that IBS decision-making will fall short of its potential and aspirations, in the adoption of IBS technology.

In the view of the present study on IBS decision-making, the future holds a number of challenges for the synthesis of structural, contextual and behavioural factors in IBS decision-making, not the least of which is regarding its own call for a more intensive effort toward theory building. It was also discussed that in many of these factors, particularly on establishing an ongoing awareness and understanding of important situational and behavioural components poses the major task of the decision-maker driven by highly interactive aspects and perspectives that are governed by bounded rationality. Thus, situational and behavioural awareness provide the primary inputs to the decision process of IBS technology adoption.

Therefore, this study of IBS decision-making and the relevant conceptual construct, in greater detail, is of value for at least two reasons:

a) This knowledge is likely to provide an insight into the nature of unmediated effects or influences discovered by structural, contextual and behavioural factors, for instance, an understanding of the specific mechanisms through which these factors influence the decision-making of IBS technology adoption.

b) Second, and importantly, such a study would also enable the development of a behavioural economic in terms of a theoretical and practical description of the IBS decision-making process, applicable to a variety of decision-making domains and the technology management domain; it would further bridge the gap between IBS decision-making and the implementation of IBS technology collectively with contextual and structural factors.

According to Luo et al. (2010), social trust is an important dimension in attitudes towards technologies, based on some aspects of human endeavour using different technology perceptions. Therefore much has been, and will continue to be, learned from decision-making-process studies on IBS technology adoption based on the influence of structural, contextual and behavioural factors. However, there are reasons to question their ultimate effectiveness for understanding and improving the adoption of IBS technology in building projects.

Finally, IBS decisions vary in generality, some being rare or one-of-a-kind, whereas others occur so frequently as to be generic. Good solutions to IBS decision-making are not developed or improved by themselves, but they require the exploration of various perspectives, disciplines, factors and aspects. The invention of outputs from this thesis such as the STUCONBECH© Model, IBS decision-making criteria and IBS decision-making models can provide important mechanisms for overcoming the limitation of information processing and availability, when making IBS decisions in complex and dynamic construction environments.

7.9.2 Practical Perception

With the increasing level of infrastructure development and the increasing use of building technology, this type of study can be of benefit. Moreover, the unique characteristics of IBS decision-making are not yet defined. This thesis has argued that IBS decision-making is dynamic and complex but through a rather counter-productive and uncertain contrast with the common traditional theory of decision-making, its unique contribution to the decision world has so far been mostly in applications based on a fairly limited set of theoretical concepts and paradigms.

While much work on decision-making study involve a relatively abstract or conceptual composition which underpin technology decision (Gallego et al., 2008; Schiavone, 2011; Van Riel et al., 2011), only relatively little has sought to examine the ways in which decisions are made in IBS technology adoption. There are, however, good reasons for examining the ways in which IBS technology is adopted. This is particularly true as not only is it important to learn something more of the structural, contextual and behavioural context in which psychological thought is embedded, but it is also crucial to explore the decision-making scenario in the interpretative phenomenology analysis of IBS technology adoption to better understand the links between more hypothetical technology decisions and actions. Furthermore, the interactions between decision-makers and their environment allow different collective IBS decisions to appear under different conditions. This study also highlighted the complexity of IBS decision-making and the need for appropriate information coordination in the decision-making process of IBS technology adoption.

Furthermore, through the mechanisms of IBS decision-making, a decision-maker can also exploit the characteristics of a building project situation. Then, decision-makers can also identify and take advantage of a project's key characteristics. This can happen in either of two ways. First, by recalling similar project situations from the past, a decision-maker can recall what did or did not work before. Unless the current project situation is insightfully characterised, recall efforts will either be unproductive or will yield volumes of inter-relevancies. Second, by characterising the process of IBS decision-making in structural, contextual and behavioural terms, specific decision- and problem analysis can assist in more efficient and effective IBS decision-making.

These reasons are obtained from the two principles of IBS decision-making process. First, the variability derives, in part, from individuals and groups in a building project or organisation, but primarily from different project types. Second, there is no standard decision-making process, nor even a manageable set of process variations. Consequently, traditional functional models of decision-making cannot accommodate, for instance, the fact that a combination of structural, contextual and behavioural factors are applicable in some project situations while being absent in others (Davila et al., 2012).

This thesis has discovered IBS decision-making in the phenomenological context of building construction which involve project elements as each project is a situation comprised of certain requirements, goals, constraints, causes, skill and other conceptual and physical entities in a complex set of relationships. Additionally, IBS decision-making processes are also of varying depth with behavioural elements that are relatively deep and hidden.

Additionally, these holistic concepts and multiple perspectives in exploring IBS decision-making involve various anticipations in external and internal surroundings in order to be more responsive to new stimuli in the construction industry. This is similar to the findings of Chan et al. (2004); as there are many variables involved in the timescale of a project, it is important to assess which risks are likely to have the greatest impact, so that sufficient energies can be invested in establishing what they are, and how to protect against them.

7.10 Summary

This discussion was organised around the interpretative phenomenological analysis suggested by Smith et al. (2009) for gaining an insight into how an individual perceives a phenomenon, as it focuses on the uniqueness of an individual's thoughts and perception. This was used in the current study and seen to be associated with the decision-making of IBS technology adoption. From the data findings and literature, there is clear evidence that the decision-making of IBS technology adoption in the construction industry, particularly in building projects is influenced mainly by the project features or structural factors, besides contextual and behavioural factors. The key elements that have been identified through the research instruments and literature have been extensively considered and methodically discussed to further reinforce the conclusions.

This chapter has discussed the findings obtained from the qualitative study and incorporated these findings to develop IBS decision-making models. The research contributes to enhancing the body of knowledge in the arena of building technology, decision-making and the adoption of IBS technology in building projects, both in terms of literature and qualitative data investigated. This research also delivers a holistic concept in knowledge and understanding on various factors that impact on IBS decision-making. This establishes the foundation for extending research in decision-making of building technology adoption, in terms of intensifying the methodology of the research and expanding the scope to address a wider application for creating guiding principles underpinning technology adoptions in the construction industry. The next chapter presents the conclusions of the study and notes the implications of the research findings for the provision of the construction industry as well as identifying issues for further research.

CHAPTER 8 - CONCLUSION

8.1 Introduction

This chapter summarises and presents the final conclusions of the research. It illustrates the answer to the research question: how do contextual, structural and behavioural factors impact on the decision-making of IBS technology adoption in the Malaysian construction industry?

The chapter begins with an overview of the study and briefly mentions why the study was initiated and how it was developed. Then it summaries the key findings and highlights important issues relevant to IBS decision-making, its influencing factors and the way these factors have impacted on the decision-making of IBS technology adoption. This chapter also identifies the limitations of the study and includes recommendations for future research into IBS decision-making. On the basis of the research findings emerging from the current study, the chapter concludes with suggestions about the way an understanding of the decision-making of IBS technology adoption can be used by construction professionals and project decision-makers, as an aiding tool in deciding on building technology adoption.

The chapter is presented in ten sections. First, an overview of the research background is outlined (section 8.2). Section 8.3 presents the summary of the literature review and is followed by the summary of the theoretical research framework (section 8.4). Consequently, the summary of the research methodological approach is presented in section 8.5. The summary of results, findings and IBS decision-making models is explained in section 8.6. The two major contributions of this research, namely to the literature and to the research methodology, are then presented in section 8.7. Section 8.8 describes the limitations of this research and is followed by recommendations for future research (section 8.9). The concluding remarks of this chapter are presented in section 8.10.

8.2 An Overview of the Research Background

This research uses a qualitative research approach to explore the IBS decision-making in building projects. Using a holistic concept through a multiple-perspectives approach based on a phenomenology lens, this research focuses on factors that influence IBS decision-making, by identifying these factors through extensive literature review and further, exploring them from the inter-project and intra-project perspectives with three selected IBS building projects. This phenomenological method is employed by the chosen research instruments of interview and case studies, with data analysed constructively and contextually, using NVivo software.

This research reveals that the complex, multi-faceted and far-reaching impacts of structural, contextual and behavioural factors are based on the degree of influence of each factor on IBS decision-making. As with most decision-making research, this research sets out to help improve the understanding of decision-making of IBS technology adoption in the construction industry. Therefore, this thesis contributes to the literature by exploring the nature of IBS decision-making in the context of the influences of structural, contextual and behavioural factors.

The conceptual underpinning of IBS decision-making in this thesis, shifts away from the view that IBS decision-making is a typical, linear process, implying rather that it is complex and multifaceted and can be best explored through the perspective of phenomenological context. The methodology is based on the perception of the construction-profession stakeholders (in exploring inter-project perspective), and the supply-chain members of IBS projects (in exploring the intra-project perspective. In order to examine this, the group of construction-profession stakeholders was studied and three IBS building projects were adopted as the multiple case studies. Lastly, this research raises the issue of the potentially important role of Building Information Modelling in IBS decision-making. Further details on the research conclusion are presented in the following sections.

8.2.1 Research Gap, Questions and Objectives

Chapter 1 establishes the background to the research, the research question and the significance of the research. The importance of this research was established and the background to this research was addressed. The research problems were also identified.

The literature review identified that much of the past research captured a narrow view of IBS technology adoption and IBS decision-making. Consequently, a research gap emerged, as the literature failed to relate various influencing factors to the decision-making of IBS technology adoption. The research gaps are based on an understanding identified in the literature review. They are expressed as a research question and used as a guideline in the data analysis and conclusions of the thesis. Based on the literature, the following research question was developed and this thesis was primarily designed to address the research problem:

> ***How do contextual, structural and behavioural influences impact on the decision-making of IBS technology adoption?***

The objectives of the thesis were:

a) First, to review literature from multiple disciplines, primarily from mainstream management and construction management, on decision-making and the factors influencing the decision-making of IBS technology for the purpose of developing a theoretical framework.

b) Second, to develop a theoretical research framework to explore the decision-making phenomenon focused in the context of IBS adoption in building projects.

c) Third, to develop a research methodology in exploring the decision-making of IBS technology adoption and its influencing factors, using a holistic concept from the multiple-perspective of decision makers based on an interpretative phenomenological analysis.

d) Fourth, to explore the influencing factors that impacted IBS decision-making, using primary data collected from the group of construction- profession stakeholders and the group of supply-chain members in IBS projects.

e) Fifth, to verify how various influences have impacted the decision-making of IBS technology adoption based on an integrated data analysis and results.

f) Sixth, to generate a more integrated framework or models of IBS decision-making in terms of key decision criteria with the integration of IBS technology adoption, focusing on IBS requirements and current practice in project and non-project environments and other problems of consequence in IBS implementation.

g) Lastly, to integrate the overall research and draw its components together in order to present the conclusions, research significance, contributions and recommendations.

8.2.2 Significance of the Study

With the empirical evidence and the significance of the consideration mentioned above, this research fills the gap that exists between the theory, as it stands, and its application in circumstances involving IBS building projects in the Malaysian construction industry. This study should benefit decision-makers in the construction industry in terms of improving decision-making within a building project, by considering various influencing factors more intuitively. This research extracts and integrates existing theories from the literature and then considers the applicability of these theories to the discussions and developments of IBS decision-making models, by researching their characteristics and identifying their presence or absence.

This study has thus demonstrated the importance of decision-making models to better understand the decision-making frame of IBS technology adoption and to aid the realisation of the interconnectedness of various factors that influence IBS decision-making. The proposed models of IBS decision-making act as common theoretical frameworks for understanding IBS decision-making in building projects. Understanding this phenomenon has come from both an “interpretative phenomenology analysis” as well as a theoretical perspective. As with most decision-making research, this study sets out to support or assist IBS decision-making, particularly in building projects. Using an “interpretative phenomenology analysis” in IBS decision-making, however, is currently suboptimal.

Many of the conclusions made in this research are based on perception studies and observations, through semi-structured face-to-face interviews and case analysis of IBS decision-making in building projects, as perceived and practised in the phenomenological context of the construction-profession stakeholders and the supply-chain members of IBS projects. This is optimistic because they address the argument that most research into decision-making in the construction industry relies on quantitative methods and technical perspectives (Ahmed et al., 2004; Turskis 2008; Yang et al., 2003; Zeng et al., 2007).

The research focuses on discovering answers to the research questions developed from the gaps in the current literature. Findings of this study contribute to the decision-making of IBS technology adoption under its influencing factors, the construction industry literature, as well as practical guides for professionals, particularly decision- and policy makers in the construction industry. Looking at each research objective individually, a summary of the results is made and the resulting conclusions are presented in the following sections.

8.3 Summary of Literature Review

Chapter 2 has provided an overview of IBS technology adoption in the Malaysian construction industry and identified the contextual, structural and behavioural factors that influence IBS decision-making from both management and construction mainstreams, in reference to the construction industry. Decision-makers in building projects consist of construction professionals or project members with different knowledge backgrounds and possessing different skills.

In Chapter 2, the extensive literature was reviewed and gaps in the current theories and practices pertaining to IBS decision-making and its influencing factors were identified. The chapter began with a review of decision-making as a conceptual position with its frame and significance. The construct of IBS decision-making consists of four sections. The first involved a description of the concept of decision-making in the construction industry, the second involved the specific nature of IBS technology adoption and the third involved the nature of the technology decision. This was followed by a specific section on the nature and issues of IBS decision-making. The next section described the decision-makers in the context of IBS technology adoption, including construction-profession stakeholders and the supply-chain members of IBS building projects. Finally, the literature review then proceeded with a discussion on factors influencing IBS decision-making. This discipline was discussed in three sections namely contextual, structural and behavioural factors. The literature review concluded with an identification of the research issues to be addressed and a discussion of the research gaps relating to IBS decision-making and its influencing factors.

The literature reviewed in Chapter 2 confirmed that IBS decision-making is vital for today's building projects, in order to improve their performance. Many authors in the literature have defined the concept of decision-making and IBS technology adoption. In order to develop an appropriate theoretical research framework and decision-making model for IBS technology adoption, the evidence from the literature was used to develop an integrated conceptual framework for this research. According to the immediate discipline described in section 2.9, the literature suggested that the development of an appropriate decision-making criterion for IBS technology adoption should have concern for contextual, structural and behavioural factors that influence decision-making.

8.4 Summary of Theoretical Research Framework

This thesis took note of this progress and developed a theoretical research framework in Chapter 3, based on the literature that links contextual, structural and behavioural factors with their impacts on IBS decision-making, resulting in IBS decision-making criteria and models.

The theoretical model of IBS decision-making is developed through the related literature review as presented in Chapters 2 and 3. The integrated conceptual framework, depicted in Figure 3.1 consists of:

a) Contextual, structural and behavioural factors that influence the decision-making of IBS technology adoption as a construct of IBS decision-making.
b) The decision-making frame of IBS technology adoption which consists of decision concern, input, process and output as a construct of IBS decision-making.
c) The inter-project- and intra-project perspectives of IBS decision-makers.

The research proposes that the consideration of influencing factors on IBS decision-making, as perceived from the multiple perspectives of decision-makers, should be optimised through an integrated framework of IBS decision-making. It also concludes that the key to IBS decision-making lies in adhering to a defined decision-making process which is related to the multiple perspectives of decision-makers, with the influence of structural, contextual and behavioural factors.

Considering the decision with its influencing factors makes it possible to focus on the decision-making process of IBS technology adoption. The dependability between IBS decision-making and its influencing factors is factual and the concept indicates that IBS technology adoption in building projects is based on the projects' portfolios.

8.5 Summary of Research Methodological Approach

Chapter 4 was formed to establish the methodology that was used to conduct this research. This section outlined the characteristics of qualitative approaches, including the predominant methodology in this thesis, being exploratory research. The chapter moved into a justification for the paradigm of "interpretative phenomenological analysis" using a holistic concept in exploring IBS decision-making and its influencing factors from a multiple-perspective approach. This paradigm, with its phenomenology lens, has provided underpinning reasons why the proposed research methodology was appropriate for this research to conduct face-to-face interviews and develop multiple case studies. This was followed by a discussion of why the construction-profession stakeholders and the supply-chain members of IBS projects were chosen in exploring inter-project and intra-project perspectives respectively, as the focus of this research. This flowed into a discussion of the foremost processes for collecting optimal data and a discussion of the analytical techniques used to ensure data integrity in the research, besides the progression of data analysis. The chapter concluded with reflections on the justifications of research methods encountered in this exploratory research and the ethical considerations factored into the thesis.

Chapter 4 has provided an overview of the research design, methods and analysis which were used to carry out the current study. The research design for the current study needed to be able to address the central research questions, which were to investigate the way contextual, structural and behavioural factors impact on IBS decision-making from the inter-project perspective of a group of construction-profession stakeholders and from the intra-project perspective of the group of supply-chain members in IBS building projects, to provide a better understanding on IBS decision-making. In investigating the research questions, a qualitative exploratory method was used to identify factors associated with IBS decision-making.

Based on a qualitative approach, the research uses multiple-case-study methodology, as this was found to be appropriate since no particular theory had been developed to attempt the research question: "How do contextual, structural and behavioural factors impact on IBS decision-making?" Data collection is based on multiple sources of evidence. These sources can be summarised as documentation, archival records and semi-structured face-to-face interviews. Therefore, a holistic concept was adopted in this research in exploring factors influencing on IBS decision-making, from multiple perspectives. This thesis has investigated the impacts of structural, contextual and behavioural factors on the decision-making of IBS technology adoption in the Malaysian construction industry, using multiple perspectives (Hardman, 2009; Miyapuram and Pammi, 2013; Oliveira et al., 2012; Xiao et al., 2005) as a foundation through which to view the research problem, and using an interpretative phenomenological analysis (Smith et al, 2009a).

8.6 Summary of Results and Findings

In Chapter 5, the data collected from the construction professionals in Malaysia was analysed and the profile of all participants was explained. Also, the analysis of the data from the 54 face-to-face semi-structured interviews was presented, revealing two groups including 27 construction-profession stakeholders (to explore inter-project perspective) and 27 supply-chain members of IBS building projects (to explore intra-project perspective). The participants were chosen from a wide range of construction professionals. Primary data was gathered from the perceptions of the participants towards IBS decision-making and its influencing factors. Quotations, descriptions, tables and figures were used to illustrate the results, using a holistic concept and ensuring a multi-perspective approach. Specifically, Chapter 5 consists of the analysis of intra-project and inter-project perspectives, Chapter 6 presents an integrated data analysis and results; and Chapter 7 discusses the research findings and reveals IBS decision-making models.

8.6.1 Results of Inter-project and Intra-project Perspective

The analysis of face-to-face semi-structured interviews and multiple case studies, documented in Chapter 5, shows that the decision-making frame of IBS technology adoption in the construction industry does vary and change depending on the type of building project and the nature of IBS decision-making. During the interviews for the data collection of this research, the construction-profession stakeholders and the supply-chain members of IBS projects have also provided their opinions in terms of both hypothetical and real IBS decisions.

According to the data collected in Chapter 5, the participants believed that there were various factors that impacted on IBS decision-making. It can be concluded that in exploring the inter-project perspective, the structural factor of project condition was perceived as highly relevant with its highest degree of influence on IBS decision-making. Meanwhile, among the IBS building projects studied in exploring the intra-project perspective, they perceived that the structural factors of procurement set up, project condition and management approach were highly relevant in IBS decision-making. However, in terms of contextual factors, both perspectives perceived that the aspects of economic conditions and technology development were very relevant in IBS decision-making. In terms of behavioural factors, it can be concluded that from the inter-project perspective, the aspects of bounded rationality and experience were highly relevant to IBS decision-making, while from the intra-project perspective, the aspect of experience was more relevant to IBS decision-making than bounded rationality.

In some instances, the decision-making of IBS technology adoption is unique to the building project type, whereas in other instances, influencing factors on IBS decision-making are varied. Accordingly, the decision-making process of IBS technology adoption is adapted depending on the characteristics, requirements and specifications of a given building project. Consistent with the findings across a variety of cases, the influence of behavioural factors is seen to exist within the decision-making process, after structural and contextual factors. These factors are pronounced at the beginning phase of the process but also noted in the overall process and frame of IBS decision-making.

8.6.2 Synthesised Results

Overall, it can be concluded that the way structural, contextual and behavioural factors impacted on the decision-making of IBS technology adoption was based on the degree of influence of each factor. In terms of the impact of project management factors, the study found that the participants are more focused on project-related matters when deciding on IBS technology adoption because they have to make sure that IBS decision-making is highly related to the performance of building projects. This finding, therefore, highlighted that construction professionals tended to make IBS decisions based on project features, and the way they perceived the interactions of different factors impacted on IBS decision-making, hence the project performance.

Based on the cross construct analysis of the impact of influencing factors on IBS decision-making frame in Chapter 6, it also concludes that the key to improving IBS decision-making outcomes lies in adhering to decision concerns and inputs with a defined decision-making process from the perspectives of contextual, structural and behavioural factors. Separating the decisions concerns and inputs from the outcomes in IBS decision-making makes it possible to focus on the decision-making process. Therefore, outcomes or outputs with time horizons that allow for observations of long run probabilities in IBS decision-making can be considered as an indicator of whether the decision is effective. The variance between process and output in IBS decision-making is real and it is indicated that the best hope for a good outcome is to give primary importance to process within a group, organisational or project context.

In Chapter 6, there are three major factors that impacted on IBS decision-making. Several important aspects, related to the three major factors that influence the decision-making of IBS technology adoption, are also uncovered and justified. It can be concluded that the structural factors are more influencing than the contextual and behavioural factors in the decision-making of IBS technology adoption. These are discussed as individual case studies, documented in Chapter 5, and reveal differences and similarities in what decision-makers went through and what decision-makers actually did to make IBS decisions. The major difference is that the priority of influencing factors on the decision-making of IBS technology adoption, is left out. When it is included, the new construct of the framework is more integrated to make sure that it categorically reflects the true nature of IBS technology adoption in building projects, based on the influencing synergy of structural, contextual and behavioural factors on the process of IBS decision-making.

In essence, in such an uncertain construction environment, it is observed that the use of key decision criteria in IBS decision-making should be used in building projects to determine the justifications for, and types of, IBS technology adoption in fulfilling certain project specifications or requirements. Indeed, this is undertaken by very few building projects and organisations and no participant mentioned about key decision criteria in IBS decision-making, its specific analysis and the integration of structural, contextual and behavioural factors.

8.6.3 The Models of IBS Decision-making

Chapter 7 presented the development of IBS decision-making models together with decision criteria that facilitate the decision-making process of IBS technology adoption, based on the consideration of relevant influencing factors. These models provide an improved framework in IBS decision-making within which to assist the decision-making of IBS technology adoption.

The models were developed based on the established knowledge and opinions of the construction-profession stakeholders and the supply-chain members of IBS building projects, with the classification of three major influencing factors that are structural, contextual and behavioural aspects. Each aspect of the factors is a continuum, hence the constructed models allow for the consideration of various structural, contextual and behavioural influences on the decision-making process of IBS technology adoption based on their relevancy, and in a hierarchical way according to the degree of influence of each factor.

Essentially, for the structural element, there are five major factors with eighteen priority aspects, whereas for the contextual element, there are also five major factors with nineteen priority aspects. Meanwhile, for the behavioural element, there are four major factors with twelve priority aspects. These aspects occur when only the essential or significant influencing features of structural, contextual and behavioural elements on IBS decision-making are acquainted in the characterisation. The priority aspects of IBS influencing factors are also explained.

The IBS decision-making models of interpretative phenomenology analysis developed in Chapter 7 address the research objective. The major model, STUCONBECH©, shown in Figure 7.6, is refined from information and data obtained in qualitative and semi-structured interviews. The STUCONBECH© model comprises of various major dimensions or elements in a nested structure which is very similar to the theoretical IBS decision-making model with the integration of structural, contextual and behavioural factors that assimilate a practical-, thinking- and holistic concept in IBS decision-making.

As a new model of IBS decision-making, Figure 7.14 demonstrates that the influence of structural, contextual and behavioural factors is linked to various concerns regarding: the sphere of construction dynamics, decision inputs as project-success criteria, the process of IBS decision-making and decision inputs as project-success performance. In IBS decision-making, another consideration deals with the need for a process of information and data categorisation and its utilisation in a balanced way. That is, the need for relevant structural and contextual information to flow in both directions at the organisational or project level namely, operation decisions at the preparation level, tactical decisions at the evaluation level and strategic decisions at the delivery level.

Through analysis of the data collected in Chapter 5, it is discovered that the development of an appropriate and effective decision-making model will not be too easy to apply in the context of IBS technology adoption. This is due to the key factors that currently influence its decision-making frame. However, IBS decision-making models can be used as a guiding principle in IBS decision-making, as well as to understand the phenomenon of the decision-making of IBS technology adoption and its influencing factors.

In summary, decision-makers will need to contemplate the impact of three main factors, namely structural, contextual and behavioural when deciding on IBS technology adoption. Consequently, the major aspects or characteristics of each factor have a substantial impact, and if considered in the right way, the transition to the new decision-making paradigm is possible. These factors need to be considered, as they are potential stumbling blocks in the adoption of IBS technology in Malaysia. However, effective management and planning should be able to override the impact of these factors.

8.7 Research Contribution

The research results and conclusions have provided key contributions in terms of:

a) Enhancement of knowledge and understanding pertaining to the concepts of IBS decision-making in construction.

b) Development of a conceptual framework relating to the determination of factors influencing on IBS decision-making.

c) Customisation of various perspectives on IBS decision-making namely construction-profession stakeholders and group of supply-chain members in IBS projects.

d) Establishment of groundwork for research on IBS technology adoption based on the data findings of IBS decision-making.

e) Provision of additional knowledge through phenomenological method in the field of construction, specifically decision-making and IBS technology adoption in building projects.

Specifically, this thesis also offers a significant number of contributions. First, the conclusions derived from the research were used as IBS decision-making criteria and they helped to develop the models of IBS decision-making. As the final product of this thesis, these models should benefit building projects directly in terms of improving their project decisions. Second, building projects in Malaysia that are commonly involve in various types of decision-making activities should also benefit from this research. These projects could embrace the suggested changes to improve their project decision-making.

Developing decision-making based on these models is a powerful option for building projects wanting to improve their decision-making. Finally, based on an interpretative phenomenological analysis, this investigation has refuted the arguments presented in the literature reviews (Abdul-Rahman et al., 2012; Abidin et al., 2013; Ern and Kasim, 2012; Hassim et al., 2009; Kamar et al., 201; Majid et al., 2011; Nawi et al., 2011). In particular, IBS decision-making in a building project involves Malaysian societal or behavioural characteristics, besides the structural factors and the anticipation of various contextual influences. The following subsections describe details of these contributions in detail.

8.7.1 Contribution to the Literature

This thesis provides a literature review that offers an alternative framework for decision-making in the construction industry. First, the integrated analysis of inter-project and intra-project perspectives confirms that IBS decision-making in building projects should employ a more integrative decision-making process, with the consideration of not only project- and socio-economic factors but also human-related aspects or behavioural factors, to make effective and efficient IBS decisions. The thesis has provided evidence, and arrived at conclusions based on the findings, to ensure that the suggested approach and IBS decision-making models are suitable for building projects. Furthermore, an investigation using a holistic concept from a phenomenology lens provides an opportunity for building-project teams to alter their present decision-making style by employing a more holistic and integrative decision-making process thereby making them effective decision-makers.

Second, this thesis has provided an opportunity for project members at all levels in the construction industry to explain their thoughts about the current IBS decision-making process. They have come to realise that decisions made, based on the consideration of a single factor, are not sufficient or efficient for building projects. This response can inspire the projects' personnel to reconsider current IBS decision-making and help them determine that it is not appropriate and requires insights into the integration of socio-economic-, project management- and human- related factors. However, as indicated by the research findings, the influence of each factor on IBS decision-making is based on a hierarchical manner, and it is also important to determine the relevancy of each factor to the nature of the project and its decision-making styles. This redevelopment in IBS decision-making should foster societal consideration in the construction industry, to provide the considerable foundations required to facilitate the development of effective IBS decision-making in building projects.

Finally, this thesis has offered an alternative in the field of IBS decision-making in building projects. Based on this thesis's findings, as perceived by project members who were involved in decision-making tasks at all levels in building projects, this study reveals that, although final IBS decisions are made at a high level by top management or even by a single individual within the building project, the decision-making process can also involve other individuals in middle- and lower management who are also aware of various factors that impact on IBS decision-making.

8.7.2 Contribution to Research Methodology

This research involves the exploration of intra-project perspective of the supply-chain members of IBS projects who are mandated to adopt IBS and engaged in IBS decision-making across the building projects. In addition, this research is also based on the exploration of inter-project perspectives of the construction-profession stakeholders who are contemplated to adopt IBS across the construction industry. Therefore, this research can have several benefits for other building projects that involve in various decision-making tasks.

The decision-making style using a holistic concept with the consideration of various factors, can be used in many other business projects, including road and highway projects, manufacturing projects and also non-project-based decision-making. These projects and non-project entities may have many common characteristics, such as possessing a number of objectives, goals, performance criteria, communication process and decision-making style. Furthermore, the change to project decision-making requires a positive management strategy to develop decision-making. The strategic tool for sustaining the holistic decision-making models is likely to be applicable to any complex decision-making. What decision-makers may have to do through the use of the new models is to identify the change-management strategy and strategic tools that are suitable for their unique organisational background, culture and style.

8.8 Limitations

The findings of this study are subject to some limitations and they are as follows:

a) At the industry level, this research only covered a partial geographical area. Accordingly, with a limited industrial coverage, it was not possible to compare the results with other building projects from a broader geographical area. Therefore, a broader geographic area should be considered in future related research, to acquire greater meaning from a wider coverage of the construction industry.

b) At the research level, there is also a limitation in terms of the validation of IBS decision-making model that were developed using qualitative research. Unlike quantitative research, this research cannot use sampling or statistical methods for validity purposes. Moreover, this research involves the identification and analysis of cases that cannot be accounted for by a particular interpretation. Since the current approach is acknowledged as 'sub-optimal', integrating quantitative and qualitative approaches to generating new knowledge which will provide greater breadth of perspectives around IBS decision-making.

c) At the project level, the case studies are limited to office-, school- and commercial-building projects. Moreover, only building projects using traditional procurement methods are selected for the case study of this research. There is also limited access to some significant IBS information regarding the specific mechanisms of IBS decision-making in the multiple case studies. This is due to the unwillingness of the participants to fully disclose the actual procedures of IBS decision-making processes in their building projects.

d) At the organisational level, the information gathered from the organisational representatives regarding the IBS decision-making process is based on the organisational members' perception and interpretations of IBS decision-making. It was only possible to obtain data on the generalised decision-making process and mechanism of IBS technology adoption rather than specific procedures for IBS decision-making. However, efforts were made to overcome this matter by cross-checking of information with additional sources such as companies' guidelines and reports, as publically available data.

e) At the individual level, the nature of the study and the issues covered concerning the decision-making of IBS technology adoption are limited to the willingness of some construction-profession stakeholders and the supply-chain members of IBS projects to discuss the IBS decision-making process and IBS technology adoption issues from personal perspectives. The scope limits the interviews to the construction industry players of only these two groups, which generates its own limitation in any attempt at generalisation to the whole industry at large. Addressing this issue involves further research work in extending the study to explore IBS decision-making further than personal perspectives with more construction players across the industry. Large sample will give the optimal information on the decision-making of IBS technology adoption besides to cross-validate the small number of samplings.

8.9 Recommendations for Future Research

There are several aspects of this research that provide suggestions for future research. Follow-up studies using similar methodology may be valuable. As multiple case studies were used as a qualitative methodology in this research, using a holistic concept and multiple-perspective approach based on an interpretative phenomenological analysis, future research could use this method to survey a larger sample. Future research may be expanded to take into account other than building projects such as road and highway projects. Future research could investigate several related organisations which engage in technology decision-making.

In contributing to the theoretical and practical improvements, specifying changes of dynamics in the way building projects make or perceive IBS decisions and developing an IBS decision-making framework, various perspectives are now documented to facilitate the improvement of future research projects. Eight main features have emerged during this study that could form the basis for future research.

a) In the light of improving IBS decision-making, the latest evolution in the construction industry should be included into the IBS decision-making models to improve their relevance. The thesis has shown the importance of a multiple-perspective approach and holistic concept to gain further understanding of the IBS decision-making process in building projects. The models presented in this thesis illustrate the impacts of structural, contextual and behavioural influences on IBS decision-making.

The concept of 'green' building which has received considerable attention in recent times, was mentioned during interviews although not originally considered in this study. However, green building concepts can be incorporated into the role of a green-technology initiative, such as green labelling mechanisms, green building-evaluation systems and green assessment systems in IBS decision-making that can be explored in more detail. The mapping of green building concepts related to IBS technology adoption, with its major and significant elements, can be a proper tool to investigate green technology initiatives in IBS decision-making.

b) Further research to test the model with hypotheses in terms of the way one influencing factor on IBS decision-making and link or relate to other influencing factors. Such a study would complement previous research within the field of IBS decision-making.

As a complement to the studies of IBS decision-making, it may be helpful to extend the understanding of other project dynamics pertaining to IBS technology adoption by adopting varied theoretical and practical perspectives in analysing these systems. Therefore, it is also encouraged that the external validity of this research is tested across different construction projects, other than building projects, such as bridge projects, within the construction industry.

Further, the external validity of this research can also be tested across other industries that operate in dynamic and uncertain environments and which involve complex technology decisions such as the information technology (IT), agriculture, mining, manufacturing, transportation, finance and other services industries.

The findings of this study can be a starting point for a number of comparative studies. One of these comparisons relates to the comparative IBS decision aspects among different types of building projects in a more detailed manner. As mentioned earlier, the cases in this study were based on three different types of building projects (office buildings, school buildings and commercial buildings) and in different locations. There were noticeable differences between the cases with regard to these structural, contextual and behavioural influencing factors towards IBS decision-making that can be explored and tested on a more detailed comparisons using a quantitative method.

Another area of interest that requires further consideration in a more detailed study is related to the dominance of the board of directors or the top management team in the organisations of a building project, and it would be interesting to explore and examine potential implications that this may have on IBS decision-making.

c) Consequently, there are also aspects which were disregarded in this study that may be of interest to investigate. In addition to those, many other interesting explorations of the decision-making process of IBS technology adoption could follow this study. That includes further studies of the subjects that were briefly investigated upon here, as part of a whole, but each of which can form a feasible topic of its own. For example, this study did not examine the relationships between the IBS decision-making process on the one hand, and the consensus of top management or other structural factors (e.g. management approach, procurement setup, communication process and decision-making style) in a wider project- or organisational setting on the other hand.

Further, the relationship between IBS decision-making and its influencing factors can be further investigated using decision-making theories, to increase the understanding and appreciation of IBS decision-making. It is proposed that the relevancy and applicability of decision-making theories are further explored particularly in the research of the IBS decision-making process and generally in the extensive field of construction or project management.

d) One area that is universally associated with decision-making is risk in a dynamic environment. Risk, crisis and uncertainty now need to be incorporated into a broader understanding of how decision-makers respond, make judgements and deal with governance issues, in unexpected circumstances, particularly in the area of disaster management.

Therefore, current horizons in IBS decision-making and related studies need to be broadened to incorporate a disaster management perspective of risk, crisis and uncertainty. Based on a broader decision typology, it is proposed that prevailing insight within IBS decision-making can be reviewed and adapted for the purpose of redevelopment activities in disaster management. Within the framework of IBS decision-making, it would be advantageous to perhaps consider extending its use to coordinate and control the strategies of decision-making for disaster management.

e) In this study, the structural factors of a building project or organisation and its information requirements are inextricably linked and also connected to contextual and behavioural factors. Unfortunately, it could happen that a decision-maker may not know precisely what information he or she requires, or alternatively, what information is available in the decision-making of IBS technology adoption.

Hence, further studies could also be conducted to examine the various uses of information for the decision-making of IBS technology adoption in a building project and its related organisations. Information use within construction projects has been studied widely and extensively for example, decision situations (Dikmen et al., 2007); design decisions (Schlueter and Thesseling, 2009); decision coordination (Sacks et al., 2010b); decision support system (Shen et al., 2010b); decision basis (Teng et al., 2012) and investment decisions (Li et al., 2013). Consequently, an alternative view would be to further examine the role of information processing within organisations or building projects, relating to IBS decision-making.

f) Further work is also needed to help understand the impact of bounded rationality on the decision-making process of IBS technology adoption. Most research is focused on individuals and performing research of this kind from group perspectives in the construction industry is certainly recommended. It is also suggested that such research investigate the impact of bounded rationality on the types and category of decisions, based on project stages.

g) The practice of exploring the influences and impacts of structural, contextual and behavioural factors on the decision-making of IBS technology adoption based on the concept of a holistic and multiple-perspective approach could be extended through a longitudinal study of interpretative phenomenological analysis in various building projects, in terms of specific public or private project clusters, project size and building functions.

h) Lastly, although project or IBS consultants can help by observing the types and contents of IBS decisions made, investigating the adequacy and accuracy of existing information, suggesting alternative solutions, proposing information sources and indicating all costs involved, as a project client or owner for instance, it is wiser to recognise and verify the right information, in the right quantity, at the right time at minimum cost.

Based on the comparison of IBS decision-making in its phenomenological context as presented in Chapters 4 and 5, with the integrated conceptual framework of IBS decision-making as presented in Chapter 3, several prescriptions for change are recommended to facilitate decision-makers in the construction industry, moving from the currently sub-optimal- to an optimised decision-making of IBS technology adoption. Consequently, to facilitate the practical use of an optimised IBS decision-making by the construction industry, these prescriptions are summarised in a figure style in Figure 8.1.

The use of information technology such as Building Information Modelling (BIM), can help decision-makers to understand the use of analytical and technical techniques as well as other non-analytical and non-technical aspects, to ensure the quality of information used for IBS decision-making. This transition, achieved by incorporating a Building Information System in IBS decision-making, is illustrated in Figure 8.1.

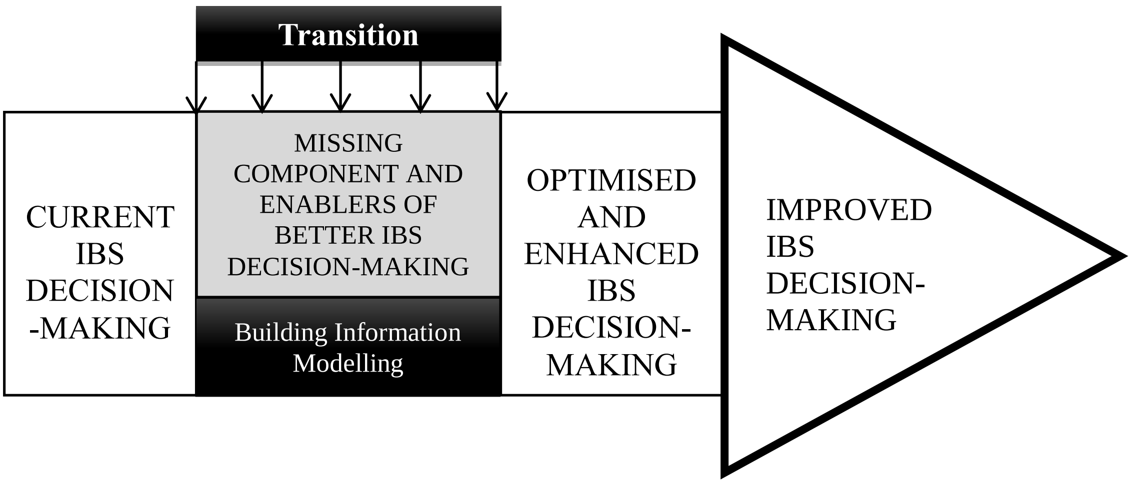

Figure 8.1 Incorporation of Building Information System in IBS Decision-making

Therefore the use of BIM with the incorporation of structural, contextual and organisational factors is proposed to facilitate IBS decision-making for routine or non-routine purposes in building projects and to overcome insufficient, inaccurate or delayed information. Moreover, the need to react quickly and promptly to a changing contextual element demands fast and accurate retrieval, as project- or non-project facts that take too long to obtain, compile, analyse and interpret, are often ineffective when the focus on real time is of the essence.

8.10 Concluding Remarks

This chapter drew together the research gap, research question and research objectives as presented in Chapter 1 and the summary of literature review which was presented in Chapter 2, theoretical framework in Chapter 3, the research methodology in Chapter 4, the analysis of intra- and inter-project perspectives in Chapter 5, an integrated data analysis and results in Chapter 6 and the discussion in Chapter 7.

From the literature and analytical data findings, there is clear evidence that the decision-making of IBS technology adoption in the construction industry is influenced by three major, or core, factors in a hierarchical way, namely structural, contextual and behavioural factors. Although it was discovered from the literature that contextual factors seemed to be dominant in IBS decision-making, the result of this research reveals that IBS decision-making is more influenced by structural or project organisation factors. The key elements that have been identified through the literature and the research instruments have been extensively investigated and methodically discussed to further reinforce the conclusions. This research contributes to enhancing the body of knowledge in the field of building technology on the adoption of IBS technology in the construction industry, both in terms of literature and the analytical data investigated.

Finally, findings arising from the research work, including the models developed from IBS decision-making criteria, have established a number of potential areas for further research that could assist in the efficiency and effectiveness of IBS decision-making. This established the groundwork for further research into the adoption of construction technologies, expanding the methodology and scope of the research, extending IBS decision-making models to address broader application, and recommendations for research enrichments for the construction industry concerning building- or other construction technologies.

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Appendix 1

THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA

Decision-making of Technology Adoption: The Case of Industrialised Building System (IBS) in the Malaysian Construction Industry

SEMI-STRUCTURED INTERVIEW SCRIPT

PURPOSE:

The purpose of the interview is to obtain an in-depth understanding of the decision-making involved in the adoption (and non-adoption) of Industrialised Building Systems (IBS) in building projects.

PROCEDURE: The interview will proceed in 3 main stages:

1. The pre-interview stage with greetings, establishing rapport, verbally explaining the interview process and obtaining informed consent.
2. Completion of the semi-structured interview.
3. The post-interview stage and formal close of the interview.

INTERVIEW QUESTIONS:

A. I'd like to understand the scope of your normal duties, during normal day-to-day work.

1. What is the nature of the decisions that you routinely have to make, in terms of their scope, their influence on design and construction processes?

2. What are the internal influences on these decisions i.e. influences from within your organisation?

3. What are the external influences on these decisions i.e. from stakeholders within projects on which you’re working?

4. What is the degree of formality you employ when communicating them i.e. written justification for decisions taken?

B. Now I would like to understand the nature of your involvement in decision-making related to IBS.

1. Would you describe yourself or your organisation as enthusiast supporters/adopters of IBS?

2. Why you believe this is the case?

3. What is your understanding of the benefits associated with IBS?

C. Now I would like to understand the business influences on the decision whether to use IBS or not in your organisation.

1. What are the business considerations that lead you to decide whether to use IBS or not e.g. financial, technical knowledge, availability of skilled labour, availability of IBS products, risk?

2. To what extent do you consider government directives to be an influence on the use of IBS?

3. To what extent do you consider the project procurement mechanisms to be an influence on the use of IBS on that project?

D. Lastly I would like to understand IBS adoption from your personal perspective.

1. What influence does past experience play in your IBS decision-making?

2. What influence does the experience of others play in your decision-making?

3. To what extent does the opinion of other stakeholders in a project influence your decision in relation to IBS adoption?

4. To what extent do you consider the use of IBS in a project to be a decision that increases risk?

Inter-project Perspective – Stakeholder, Project Manager

INTERVIEW TRANSCRIPT: SH/PM/18

Q1

R18: Decisions that I make in my routine work are more related to project integration management to ensure that the various project elements are well coordinated. It is not really with the design, but more on project implementation. Even most of them are part of project scope to ensure that all the work required and only the required work is included. This means, what are the required works for a project that need to be done. Here, I also use project management software in deciding certain matters, if not for all project related tasks. We have to make sure all are done precisely because of timing factor as time management is essential in order to provide a good project schedule. Yes, it sounds like everything has to be exact, besides to make sure project cost in terms of to also help to determine needed project resources so that we can maintain budget control. From this, we can move further to make sure that the quality aspects of a project can be handled so that later, it is easier to ensure functional requirements are met. Another aspect is about workforce, ranging from HR management to development and I have to make sure the project has a required staffs and also skilled labour too.

Q2

R18: In principle, as a project manager, I should be aware of the position of my own firm and the other firms involved in the project. My staffs and I, sometimes have to face the difficult task of trying to align the goals and strategies of these various firms and agencies to accomplish the project goals. For example, the owner of an industrial project may define a goal as being first to market with new products, the buildings. In this case, facilities development must be oriented to fast-track, rapid construction. As another example, a contracting firm may see their advantage in new technologies and emphasize profit opportunities from the new technology. So in many cases, we have to negotiate all resources for the project from the existing firm framework. On the other hand, the firm may consist of a small central functional staff for the exclusive purpose of supporting various projects, each of which has its functional division. When comes to decisions, this decentralized set-up is referred to as the project oriented firm as each project manager has autonomy in managing the project, so the same goes to any decisions that have to be taken. In many decisions, there are many variations of management style between these two extremes, depending on the objectives of the firm and the nature of the construction project. For example, a large company with in-house staff for planning, design and construction of facilities for new projects will naturally adopt the matrix organization. On the other hand, a construction company whose existence depends entirely on the management of certain types of construction projects may find the project-oriented organization particularly attractive. While firms may differ, the same basic principles of management structure are applicable to most situations in decision-making.

Q3

R18: Dealing with projects, we have to also deal with its surroundings. What I have to keep up is on the overall company's approach for the project. Many things will change as the project advances. We have to make sure whatever changes are being handled, not only whether factors, but workers conditions too, site development and also the overall financial related matters. In fact, we have to admit that the function of our company may change to a matrix type as we have to deal with other parties in a project, which may also change to a project based company. What I mentioned just now is one of the way how we deal with external matters although it is not necessarily in this order. Another thing that I regard as quite important is the authority requirements that we have to fulfil, as they also to be considered in any decisions that we make. The reason is simple because at the end, those authorities are the one who will go through the project for official certification. All in all, they are part of us too. We have to consider this to make sure that the cost centre may have participants assigned from many different functional groups in a project, besides for decision-making only. In turn, these functional groups may have technical reporting responsibilities to several different tiers in the project. So, the composition of all project members is another consideration in our decisions because the extent to which decision-making will be made in terms of it is centralized or not is crucial to the organization of the project especially for bigger scale projects.

Q4

R18: When comes to the overall project and also the company's operation, I have to ensure effective internal and external communications. This is important because simple things may get wrong if we do not get it communicated well. Meaning to say that, there are many divisions in a project and the same goes to the company. In the office we have an engineering division and an operations division. Under each division, there are several what we call as sub-division. Since the authorization of a project is usually initiated by the senior management, the planning and design functions are separated in order to facilitate operations. In this condition, we have to make sure every single matter is well communicated, and of course it has to be formal. Let me give one situation, since the authorization of the feasibility study of a project may come first before the authorization of the design by many years, each stage can best be handled by a different branch in the engineering division. It sounds like we have separate people in performing each task, but at the end, all construction matters have to be coordinated. If construction is ultimately authorized, the work may be handled by the construction division or by outside contractors. The operations division handles the operation of construction and other facilities which require routine attention and maintenance, also when come to decision-making. What we practice here is that when a project is authorized, a project manager is selected from the most appropriate branch to head the project, together with a group of staff drawn from various branches to form the project team. When the project is completed, all members of the team including the project manager will return to their regular posts in various branches and divisions until the next project assignment. It is just a matter of making all these clear to make sure my team members and I what is expected from us, and also our reporting channels too. So, in general, the project manager's authority must be clearly documented as well as defined, particularly in this company where the functional division managers often retain certain authority over the personnel temporarily assigned to a project. When we have to deal with this kind of team work, communication has to be made clear so that it creates less problems, I mean small petty things. When we have a kind of more or less formal style, the interface between the project manager and the functional division managers should be kept as simple as possible. Then, it is easier for me to control over those elements of the project which may overlap with functional division managers. By having this, it is easier for me to encourage problem solving rather than role playing of team members drawn from various divisions.

Q5

R18: Although I am not the only one to decide on this matter, I can bring some expertise in technical analysis, besides some managerial aspects too, and a lot of their decisions rest with that. A lot of the ones regarding building codes, for example. Anything that's generally technical in nature I have a background in that I can bring to the table. The discussion we had last week, for instance, about IBS use for building projects, reading their report I know exactly where they are coming from because we just did that for two building projects. To support, it is a yes but to decide, as I said, it has to be relied upon others too. So, that is an area I can judge, and the project can achieve those goals a lot faster and more cost-effectively if they had the expertise and experience on IBS. Only with these two, then you can gauge either we want to proceed with IBS or not. Another example would be the IBS application for the housing projects. It's getting to be where the city is common with high rise projects. Under many measures, I consider the most effective building method in the area is IBS. I have involved in four different projects and my odds are five in eight in something that's normally less than 10 percent, and I am four out of four in operation phase. Meaning to say, if you can see that there are less problems after the construction phase in an IBS project, then we have a bigger tendency to support it. These are the kinds of things I can say about IBS, especially with decisions that are facing them in the next two years in particular. Because I know they are going to spend a fair amount of time on IBS development and infrastructure improvements and these two are two major areas that are going to be tackled. The other area is the interaction between industry people and government authorities because IBS have started its application from the government projects. I have seen a lot of the problems created for projects trying to start business by the application of IBS and they have no intention of causing that level of problem. But it's largely because they don't understand how that's going to impact new projects more than bigger existing projects. But IBS affects both. They don't realize how easy it is to kill a start-up just by using IBS straight away.

Q6

R18: Yeah, exactly. That's going to be something which will be happening in many more years to come, and it was really for me a way of being able to make something very large without actually physically having to do it myself and also working alongside an architect that can make all the drawings and understand how this structure can go together and tell the builders what to do, but it will be working with many unexpectedly situation and making a kind of loop of where there was a gap rather than a sort of ladder to climb, so it will be an architectural space but it will be sort of unusable. You'll be able to go inside it and from the outside it will be very, very straightforward, very formal.

Q7

R18: In particular, IBS components are ease for construction and enhancing the ability to effectively speed up the duration of the building project. Similarly, the design in IBS construction and its components can be reconstructed in a relatively straightforward manner. Thus, the specific standard could be applied in between two different sectors of manufacturing and construction. It is just a matter of, sometimes, the practice is not the same with the theory as we should look at other factors too when installing IBS components at site either for commercial buildings or housing projects. May be we still need more advanced standards or work procedure, and while these standards are being discussed, in practice they are very much related to a single design approach for IBS which may support the both projects simultaneously. In fact, the ultimate goal of the IBS construction is to develop solutions that satisfy both of these sectors.

Q8

R18: The manpower, in the broadest sense of the term, is the most important thing for the success or failure of an IBS project. We can have the latest or the best technology but if the person who is working on it is not capable enough, then technology is nothing. For sure this has to be followed by the compatibility of IBS technology itself. Or else, IBS cannot go far in this industry, cannot sustain for a longer period of time. So, as project manager is responsible for planning, organizing and controlling the project, I also receive authority from the management of the company to organize the necessary resources to complete a project and this is the biggest challenge to me, indeed. Don’t only look at the supply of skilled labour, if we have the manpower, we can train them. If we don’t have them, we can go and search for them, but the issue here is to make sure that they are capable enough to deliver IBS projects. If there are cracks for example, some workers can simply overcome it by plastering, although it should not be the way when comes to IBS. So, when come to IBS decision, as a project manager, we must be able to exercise interpersonal influence in order to lead the project team. I mean, I need to make sure workers are really capable to deliver. Luckily, we often gain the support of my team through when we have a certain degree of formal authority resulting from an official capacity which is authorized to issue orders and possessing special knowledge or expertise for the job. Sounds like it is ridiculous, but we have to create a kind of management with influence because a project manager should have a personality or other characteristics to convince others. In a project for example, the members of the project may be used to a single reporting line but we have to coordinate the activities of the team members. It is not only about technical knowledge, manpower and expertise that we are concern about, but also we are also responsible for priorities, coordination, administration and final decisions pertaining to project implementation. Thus, there are potential conflicts between the company’s goals and project teams’ goals. Dealing with this, I have to make sure my responsibility and authority to resolve various conflicts such that the established project policy and quality standards will not be jeopardized. When contending issues of a more fundamental nature are developed, they must be brought to the attention of a high level in the management and be resolved professionally.

Q9

R18: Yes, infrastructure development in Malaysia is growing from time to time along with the overall country's growth, aimed to drive forward the momentum for innovation and demonstrate improvements in speed and efficiency. Then, for sure the government plays an important role in IBS. It is just like the housing features like apartments aimed at local people in Kuala Lumpur on moderate incomes and key workers, as well as other major cities in our country. These kinds of buildings are an extended experiment for the government into the potential for delivering high quality housing through IBS construction methods. As non housing project development, it followed on from KLCC, KLIA and hailed by the government and the construction industry as a breakthrough for innovative IBS building. Much of what was achieved with IBS was an industry first and it was the largest factory-assembled in the country at the time. From what we can see is that, the growth of non-housing building construction seemed to be able to pass through better than the housing building segment in terms of IBS projects, except for the high rise, as I said. Additionally, the growth trend of the non housing segment in recent years of economic instability reflects that it performed better than the housing building segment. I believe that it is expected that the overall building construction market would be important in growth with the 10th Malaysia Plan from 2011 to 2015. Moreover, the government has also expressed interest in more involvements from the private sector and investors to engage in public projects such as construction and management of schools, hospitals, and other community infrastructures to use IBS.

Q10

R18: This is another important factor in any kinds of construction projects as this mechanism is a basic to obtain necessary resources from external sources. We all know that clients considering a construction project are likely to want a solution which will meet their needs, at a cost they can afford, at an acceptable date in the future. So, that's why, IBS is not only for the sake of applying it in a project but IBS has to be based on the statement of needs in a project, look at its value proposition too. I mean, we must really know what is expected from IBS. It this is not in place, the industry is always comfortable with the conventional method. What I would like to stress here is that achieving a successful project solution depends upon verifying the need for a project. I mean, this process should come from the client's value proposition or business case for the project that is adopting IBS and should involve all stakeholders including those who will take the risks associated with the project and those who will be directly involved in using the completed facility of IBS. Not to overlook that the process will need to establish and prioritise the objectives to be met by the project and the financial and physical programme parameters.

Q11

R18: To a certain degree, it is true. In delivering a project, everything that I have to perform, I make a very sort of clear cut decision about it. It may be to do with sort of physically what it looks like, it may have come from a project that I'm familiar with, and it may. So the same goes with IBS. You know, there is all sorts of building technology that can inform each piece that I choose, but they are certainly not meaningless, and I think, you know I always see IBS, especially sort of technology that is a kind of people are not well open to it unlike the consumer technology products. That is almost like people, you know, there are just sort of how people can accept it from all angles. IBS has been there in the industry, it is not totally new to us, so I think, we can refer to the successful projects that have applied IBS. May be to a group of people, IBS has been liked and used, and then they have no objections anymore in using it again in their other projects. It is just a matter how they just placed IBS in the industry. It's something that we see in public projects, we know everywhere, it is just part of the sort, I would say accepted IBS projects because they are government projects, but other non government projects, or whatever, they are still the major part of the industry.

Q12

R18: We work in a team, deal with others in a project, definitely we deal with their experience as well, I mean; it can be directly or indirectly. Just take one scenario; it is common that architects who are creative in design are often innovative in planning and management since both types of activities involve problem solving. Architects work with engineers. In fact, they can reinforce each other as they both are included in the construction process, provided that creativity and innovation instead of routine practice are emphasized. In this industry, it is not your qualifications only that matters, but your experience line. A project member who is well educated in the fundamental principles of IBS design for example, can usefully apply such principles once he or she has acquired basic understanding of a new IBS application area. But when comes to IBS management, for sure this kind of member require other member to deliver the project. A project member who has been trained by specific learning for a specific type of project may only gain one year of experience repeated twenty times even if he or she has been in the field for twenty years. So, experience and learning has to be very broad that comes from various aspects. Let me put it this way, a broadly trained project member can reasonably hope to become a leader in a project but a narrowly trained project member is often refer to the role of his or her first job level permanently, not going any further.

Q13

R18: Deciding on IBS, the owners have much at stake in deciding a building technology and in providing her or him with the authority to assume responsibility at various stages of the project regardless of the types of contractual agreements for implementing the project. Of course, the project members must also possess the leadership quality, technical competency in IBS and the ability to handle effectively complicated interpersonal relationships within a project. I regard the ultimate test of the background and experience of stakeholders for construction lies in her or his ability to apply fundamental principles to solving problems in the new and unfamiliar situations like IBS which have become the characteristic of the changing environment in the construction industry. If we have to use IBS components, construction planning for instance should be a major concern in the development of facility designs, in the preparation of cost estimates and in forming bids by contractors. I can say that we really need those who have experience in these matters. Unfortunately, planning for the IBS construction of a project is sometimes often treated as an afterthought by design professionals. This contrasts with manufacturing practices in which the assembly of IBS components is a major concern in design. Design to insure ease of assembly or construction that should be a major concern of engineers and architects. IBS decision has to go hand in hand, although an individual has to take the principal action in this method. All too often chances to cut schedule time and costs are lost because construction operates as a production process separated by a gap from financial planning, scheduling and engineering or architectural design. We have to avoid this. Too many engineers, separated from field experience, are not up to date about how to build what they design, or how to design so structures and equipment can be erected most efficiently, what more with IBS.

Q14

R18: Whatever decision that we make, I make sure we conduct project risk first, because risk management is a prerequisite to analyse and lessen potential risks especially on building method like IBS. So, to minimise cost and environmental effects or whatever consequences in the future, it is common to source material for building from our familiar suppliers, then work on them on-site, where suitable. Of course it is necessary to seek permission for this from the authorities. For IBS, all these have to be more cautious, or what I shall say is to triple check with all project matters in IBS decision. The management of a project that involve IBS is a difficult and challenging task due to the many variables determining its final outcome. Yes, this is to mitigate risks. Let me put it this way, although typical project management practice addressing scope, cost and schedule requirements are proven approaches to managing a project in normal conditions, projects often run into trouble even when we employ well planned and sound control methods. The common reason is that threats to the projects are not clearly identified and actions to control these threats are not properly implemented. As a consequent, project managers and also project engineers must be consciously aware of potential threats to the success of their projects and take early, effective, and offensive actions against these threats, what more when dealing with IBS. An effective risk management approach will provide engineers, managers and all project team with a technique that will increase the probability of success for their projects by addressing these problems, which resulting in clear benefits to them and their customers.

Intra-project Perspective – Supply chain member of Project A, Design Architect

INTERVIEW TRANSCRIPT: A/DA/7

Q1

R7: Our company involves in the design of commercial projects and also government projects. So, I involve not only in individual decision-making but also in a team, most of them are in-team. Decisions that we make basically are based on our clients in terms of project but when comes to company internal operations, there are certain things that I have to decide on personal basis based on the company situation. For example when comes to projecting the future of the project design in which the building is located is not in a prime area, like risky areas which involves slopes and alike. So, before any decisions are made, we have to be based on analytical and market projections systems which can to be relied upon. It is not only design that matters. It is not only deciding based on the given specifications but also based on the examples of similar successful projects as well as marginal projects that we examined. In this case, often the future of a building's use and purpose relative to market conditions are not clearly identifiable. For us, we include all of those because upon the initial review of the market analysis our clients may perceive that there is no place for the building's design. I mean, as you said, IBS for example, people see it as not very suitable in a project. So, at this critical point in time, many clients will lose hope and come back to square, even if in reasonable condition, useless, outdated and subject to IBS. Then they have to follow, especially in government projects. At this point our design team must grab the opportunity to change a perceived negative into a positive.

Q2

R7: We take into account our professional conduct in all decisions. Another consideration for the designers is how to be based on reliable information throughout the design process in order to make decisions efficiently and effectively. We decide based on softwares, using simulations besides drawings too. So, we have to decide by several choices too. What I can say here is the choice is between a manual or automated system for design and simulation. We still based on a manual system relies on sketches, files, checklists and a traditional use of paper and pencil techniques. Our designs are also supported by an automated system incorporates computer hardware, architectural design and construction management software and an electronic approach to information processing. So when we decide on a certain thing, for the purposes of decisions, the designers are also encouraged to use a manual system, pencil and papers for creativity, unless they are working on government projects with proposed layout and guidelines. So, for a one-time use on a construction project, a considerable amount of time will be dedicated to training for and development of a software system geared toward building design. Rather than expend the time and effort, not to mention hardware and software costs, to develop a proficiency in the use of a software system, we also should concentrate on the primary goal of building design that is to create a project which meets the needs of clients, I mean with their requirements.

Q3

R7: Of course we are dealing with our stakeholders, especially our clients. It is not always easy to influence each other but we can make some suggestions by giving our opinions. Most clients are not aware of or are unwilling to explore the idea of creating their own market demand for their building. I go to the elements of added value which can be done through building design, using IBS for instance. The environment for housing, facilities, hospitality, office and leisure have never has been more dynamic. The project team sometimes may even follow the project design that do not even suitable with our current environment. Usually, at first, our suggestions are not being considered because many clients do not entertain this possibility of using new design or new technology, new materials. There are many examples of new building concepts that have created strength and a reappearance of traditional buildings. So, as an architect, I suggest that a lot of redevelopment strategy may call for the creation of a unique concept in the building use as it relates to the existing conditions of construction projects.

Q4

R7: I don't really practice a kind of very formal way of communication. It is a kind of open here. This is the best environment for designers and architects to work. Their piece of mind is important as there are developments and required reports on the projects that they are working on. So, a logical and practical use of communication practice has been our company's practice. Regularly as a company strategy the design will retain clients' wishes and we just improve from them with some particular detailed work. Sometimes the new clients were owners of even simple home buildings, so we have to communicate our design clearly to them. Now we have many communication tools, so communication becomes easier in our company. Meetings are essential too, no matter where we are working on a project. It is either we meet on weekly basis face-to-face or via telephone.

Q5

R7: Since the growth of building technologies in Malaysia and in other developed countries, precast are in very high demand for adaptive use. What I would like to stress here is the adaptive use of IBS. Some clients they even don't really notice that some of their projects are using IBS. So, the most important here is the suitability of IBS, for rounded shapes in building of course IBS is not always fit into that kind of design. Unless it is for wide open areas that are desirable for space planning requirements, definitely IBS like steel trusts are suitable. In fact when safety elements are required besides other major specifications, IBS is often left exposed and not even highlighted. This is a kind of the justification between an old and a new construction method. Another issue is the importance of project presentation to financing institutions cannot be underestimated too. For government projects, tendering in another consideration to comply with IBS, that's for sure. So to secure financing project owners must rely upon analytical and market projection systems too. It is not easy to simply change or switch to another. We have to also consider some degree of autonomy which is occasionally accounted in the interpretation of a design. In the design analysis for example, often there is the "feeling" or intuition of the project team whether a project will be successful. It is sometimes difficult to tell, but gut feelings sometimes play its role. While some other project team members rely heavily on the quantitative, the positive psychological aspect of the project can give a strong movement to even minor projects. For me, it is also essential to emphasize this issue which is often overlooked. IBS is not only about application, we have even to ask about all preparations. In this case, lack of preparation will limit chances for IBS success. The preparation should include the architect's drawings and other graphic materials that clearly define the theme of a project and must be delivered with an exciting and positive flair. I mean the collaboration with other factors and project members too. Sometimes, brief written testimonials from influential community leaders depicts that the project owner is not the only one who believes in the project. When a building using IBS is certified or testified, an image is created that there is a strong confidence in the future of the construction community.

Q6

R7: As I mentioned, typically other projects will follow giving priority to further IBS investment opportunities for the construction sector. Even some IBS investment can be influenced by the argument that project development opportunity as a sense of business. Whereas, construction community is also thinking of positive psychological benefit, I mean not only solely about financial returns. As an architect, taking part in the preservation of esthetical values in building designs will lead the clients to influence traditional methods in the construction projects. Even though this is not very obvious, there exists a sense of pride in most unique buildings unlike more modern IBS building designs. But sometimes, we have to comply what our clients require. So, in this matter, I think the building owner must pursue and exploit IBS as an element for project success.

Q7

R7: Since you mentioned about behaviour, let me put it this way. I started wondering whether there is a potential for IBS components to become more marketable to the architects if we were to introduce the concept of aesthetical feeling during an IBS component's development process. Aesthetical feeling is something that involve the process of psychological interaction between a designer and a manufactured product where the product has the ability to bring out aesthetical preferential. If we could, there is potential for the country to increase the utilisation of IBS components in a building project. So, for me, IBS benefits should be viewed from the perspectives of price, cost and value. Of course for me it is the value that we are looking at and for sure for other project team members, they will go for price and cost. Meaning that IBS is not only about the technology per se, not only about making all construction work faster, but also we should look at each of building or project in order to determine the common things and differences. This is important if a project is intended to preserve heritage and restoring community pride and identity. Then if these projects have a kind of serious political and budget related issues to overcome during a long period of time, then the decision is more complicated. Moreover if the successes of previous projects have had significant widespread economic impact that no modern building method like could have achieved. So, it is good to have our government providing the incentive to convince other projects in using IBS. Yet, it was strong community and construction industry support and activism that initially compelled the governmental decision-makers to act.

Q8

R7: Talking about the built environment, it really marks out a society's political, economic, cultural and sociological attributes. It is not only in traditional building methods that these characteristics are clearly expressed. I believe that in whatever kind of construction and building projects. If our government is already into IBS, somehow or rather, they have taken all these matters into account. But the question is the degree of these factors. Meaning that how well one factor is being taken into account compared to the others. All of these must come hand in hand. If architects can design IBS buildings, we have to also question the built process, skilled workers to do the installations and other expertise. If we look at the loss of traditional buildings method that might results in a shortcoming of cultural and historical identity. Is IBS can guarantee this aspect, I always believe that IBS can go far. If people are not influenced with IBS problems or some failures, then surely it will not have the confidence and ability to experience the future growth of this method. So, it is essential to grab each opportunity to conserve traditional buildings method to retain a clear understanding of a society's basic existence but at the same time it is also important to educate the public and building owners in particular, about the significance of IBS in buildings projects. So, again is essential for all stakeholders and IBS supply chain to maintain a belief in itself.

Q9

R7: In a way only, but in real, I think the government should look into more comprehensive approach. It is not only promotion. It is not only for the sake of having and using IBS. We should just follow the way others do it if we don't really doing it properly. It is not only by giving incentives to in order to get going. If you look at advertising, for consumer products, yes it can play us psychologically but to do the same with IBS is not relevant. So, what I intend to say here is to have a slightly concern from the government side whether the current policy and implementation of IBS in public building project that are sustainable and practical for the long run and can really reform our construction industry. As you mentioned about success stories of IBS, construction people want to know more about this. The uptake from private sector on IBS implementation is still non-traceable by the policy makers and does not reflect the true representation, thus measurement on its performance in terms of quality, time, cost and safety. In terms of design, administrative procedures by the local authorities can be another factor that might hinder IBS. Ranging from the safety requirements; from our fire department up to our local authorities. The procedures being legislated by the local authorities is important because any project development constructed must be approved so that the building can be safely occupied by residents. The developer and constructor are compulsory to obtain the Certificate of Fitness (CF) after a project development site is completed and if the construction implements

IBS and can have real profit however the failure to sell the building to the market of non utilization will cause severe loss to the developer. In our situation, the architect would automatically think about IBS construction without thinking much about it during design. The last reflective processing is related to the consumer's image or prestige when using certain products. It is the provision of an avenue for architects to show off to people the creative product they are hired for.

Q10

R7: If the traditional approach, of course it is a bit slow in terms if project implementation but mostly IBS projects are based on this approach because IBS mostly involve government projects. But for design and built, it is faster because it is a kind of tender free compared to the traditional approach. Whereas, PWD or government projects have to go through tendering process and the designs also has to be subjected to many changes. Then, what I shall say is that, changes in design will incur costs too. For this matter, a physical building itself does not have be an architectural value for it to contribute to the project success. It is not a matter of IBS or not, as traditional building method can represent a "sense of norms" that has developed over time is unique and cannot be simply replicated. It is different than IBS, as it consisted of numerous buildings components joined together in with less particular architectural composition. Even, throughout the next 25 years, I think the market will continue in its traditional methods if IBS is still in a position where everyone accepts it as a barrier of architectural development, besides cost factors and others.

Q11

R7: As the construction industry grow and mature around the market, the traditional building methods will continue to decrease but still operated in a smaller industry scale. But architects will provide advice on the best ways clients can achieve their plans within the constraints set by project requirements, building regulations and planning permission by taking the correct design brief and should be able to see the big picture. Basically, from the past projects, we look at the immediate requirements to design flexible buildings that will adapt with the changing needs of the project. We try to involve ourselves at the earliest project planning stage so that we can gain more opportunities to understand the project, develop creative solutions and propose ways to reduce costs. So looking at these situations, in terms of IBS, I definitely apply the same with our teammates. In the late 1980's, our government came out with a town development and this move was accountable for the buildings in metropolitan areas and there was no regard for a traditional building's historic, social or cultural value and some of the buildings that representing cultural ideals were destroyed. So now, construction people have to consider this by looking at the old style of building image conservation in the mission for modernization. So, we do not want this to be happened again. We do not want IBS to limit or destroy the building image. However, today we can see numerous construction people recognized this IBS as significant with the government support. If we look at the success of some IBS projects, this situation has increased the popularity of IBS and also has brought to the attention of many people the value of using new building method. If this situation is always made known to the public, definitely this project became the initial inspiration to save many foreign labours in the country.

Q12

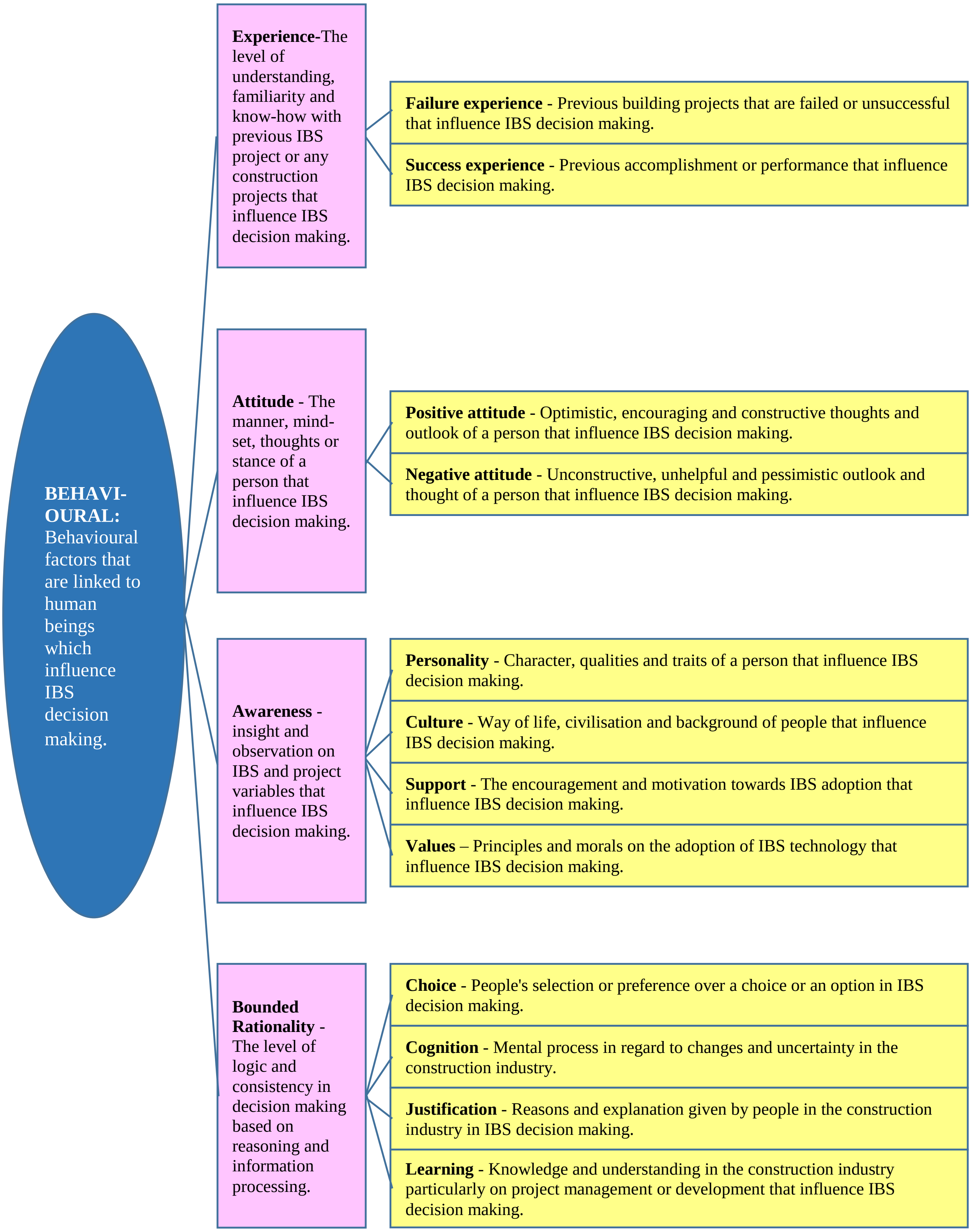
R7: For us, our main target is on the key design objectives of a building or a project. This might involve the client forming a view on the relative importance of matters such as the relationships between key activities, the required patterns or design itself and the need for flexibility. Besides that from previous projects, we give our also give the priorities of users, the quality of public and private spaces and the need for design innovation too. We can refer to other projects, but when come to the real decision, we have to look at a case by case situation. I mean like the potential for good design to provide added value in terms of the effects of the finished project on our staff, clients and the public. Recently, built environment has also going to embark on sustainability and green technology in building. So, I believe that all these things should start from the design itself. Meaning that the relationship between design and sustainability issues taking into account such matters as use of natural resources, transport issues, construction waste, emissions and how these contribute to the whole life environmental impact of a project and its surroundings. When comes to IBS, it is now for us to simply decide on it but architects shall use innovation and management of new technologies like IBS to offer client a benefit of project advancement. By doing so, we shall increase efficiency and productivity through continuous learning and training to keep pace with time and survive in competitive market or else we will be left behind. With the current uncertainty, changes in the world economy and also the uncertainty of labour condition, all of these are a kind of demanding issues that we must handle our others concern on quality, economy and speed in all aspects of building process ranging from the design to completion of building. As an architect, we shall be updated and keep pace with all the three aspects.

Q13

R7: I'm not quite to cal it influencing or not, but we do consult with any other construction professionals like surveyors, engineers etc regarding the design of the surroundings. So, when comes to IBS, we only have to prepare and present possibility design proposals and reports to the client and also advice the client in details about the feasibility of the project. If we need an IT expert in design, we also refer to those to get the help of IT in designing and in project management, especially by means of software packages. Our works are mostly done in a team, internally and also externally. With our project members we discuss the objectives, necessities and financial plan of a project besides some other things like to assist in selection of site and try to keep within the deadlines and financial budgets. When comes to the general public, it is not that easy to convince them about IBS. Their attitudes have been changing and are becoming important in the support of IBS use. A new building technology like IBS is planned and the old construction method would once again be the centre of attention with an important role. So, by looking at these two, there must be something that needs to be done. Meaning that, this new building method now serves as an image to anchor a new age of project development. It also seems that IBS is also serving as the foundation for the development of the entire government projects.

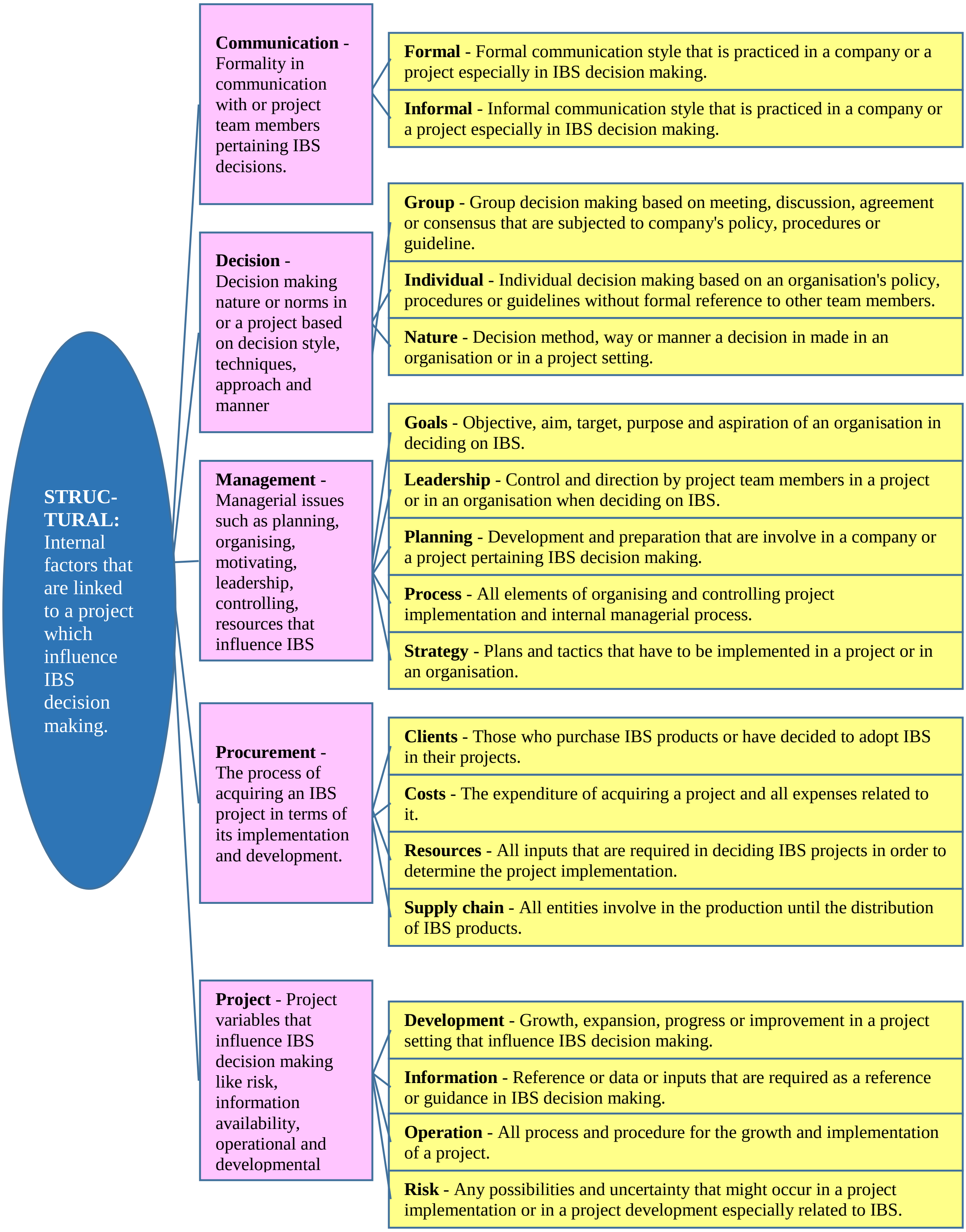
Q14

R7: Yes in a way. In one hand, as an architect what I can say is that Malaysian professionals are said to lack competency in advanced design and R&D while on the other hand we are said to be not as highly skilled as our counterparts in Germany or France or Japan. It is very unlikely that we can achieve both scientific strength and superior skills at the same time if other things in construction industry are not supporting each other towards IBS. Moreover, we also know that construction industry should be one more open to risk taking and innovation than one where capital is tight. I notice that this was not necessarily the case. I mean risk in IBS and risk taking must be qualified given the context within which IBS risks are interpreted, handled or rejected. It is already known that every IBS project is unique or even other projects, in its design due to the difference in design, physical setting and structure and the landscape too. So, it is still depends. For us, to determine risks whether in design or throughout construction process we have to based on the technical data that is required in the IBS design of a building project up to building completion, not only has to consider the economic factor, but also risk and safety, as well as environmental factors. Why I said so is due to the problems encountered in the design and also operation can be solved or at least minimized with proper management and a technical approach.


BEHAVIOURAL: Behavioural factors that are linked to human beings which influence IBS decision making.
Experience-The level of understanding, familiarity and know-how with previous IBS project or any construction projects that influence IBS decision making.
Failure experience - Previous building projects that are failed or unsuccessful that influence IBS decision making.
Success experience - Previous accomplishment or performance that influence IBS decision making.
Attitude - The manner, mind-set, thoughts or stance of a person that influence IBS decision making.
Positive attitude - Optimistic, encouraging and constructive thoughts and outlook of a person that influence IBS decision making.
Negative attitude - Unconstructive, unhelpful and pessimistic outlook and thought of a person that influence IBS decision making.
Awareness - insight and observation on IBS and project variables that influence IBS decision making.
Personality - Character, qualities and traits of a person that influence IBS decision making.
Culture - Way of life, civilisation and background of people that influence IBS decision making.
Support - The encouragement and motivation towards IBS adoption that influence IBS decision making.
Values – Principles and morals on the adoption of IBS technology that influence IBS decision making.
Bounded Rationality - The level of logic and consistency in decision making based on reasoning and information processing.
Choice - People's selection or preference over a choice or an option in IBS decision making.
Cognition - Mental process in regard to changes and uncertainty in the construction industry.
Justification - Reasons and explanation given by people in the construction industry in IBS decision making.
Learning - Knowledge and understanding in the construction industry particularly on project management or development that influence IBS decision making.

CONTEXTUAL: The contextual or external factors that influence IBS decision making.

- **Economics** - All elements related to price, costs, inflation, currency and other economic variables that influence IBS decision making.
  - **Competition** - All entities that compete and survive in the construction industry which influence IBS decision making.
  - **Business** - All elements related to trade and commerce in the construction industry that influence IBS decisions.
  - **Demand** - The level of orders for IBS products from clients or for the fulfillment of a project requirement that influence IBS decision making.
  - **Uncertainty** - Elements of doubts, unsecure and ambiguity in the business environment that affect IBS decision making.
  - **Opportunity** - Chance or prospect in the economy that are considered in IBS decision making.
- **Government** - Direction, control and administration in the development of IBS adoption in construction industry.
  - **Policy** - Guiding principle and procedure outlined by the government that influence IBS decision making.
  - **Promotion** - Promotional activities on IBS development by the government including encouragement, support, guidance and incentives that influence.
  - **Requirement** - Necessity, obligation and condition in a building project that influence IBS decision making.
  - **Rules** - Government regulation and system related to building development on IBS adoption.
- **Stakeholders** - All parties who have their interests in an organisation or a project like government, financial institutions and others.
  - **Opinion** - Outlook, view or beliefs of construction stakeholders that influence IBS decision making.
  - **Partnership** - Joint venture or affiliation that are formed or can be formed in the construction industry to develop IBS adoption which influence IBS adoption.
- **Sustainability** - The support and environmental concern for human well-being that influence IBS decision making.
  - **Efficient** - Well organised construction activities in terms of operations, resources management and faster completion time in a project
  - **Environment** – Surrounding, situation and setting of the construction, particularly on health issues and people concern that influence IBS decision
  - **Trends** - The tendency, movement and lifestyle of society members who are technology savvy, which influence IBS decision making.
  - **Waste** - Waste management issues that are related to clean construction site, less construction wastage and cost at construction site.
- **Technology** - Technology related factors that influence IBS decision making.
  - **Creativity** - Imagination for improvement in a product or a process that can be one of the competitive advantages.
  - **Innovation** - Any aspects of improvement or advancement that are considered in IBS decision making.
  - **Productivity** - The level of output, efficiency or yield that influence IBS decision making in implementing a building project.
  - **Quality** - The value, feature or specialty aspect of IBS that influence IBS decision making.


STRUC-TURAL: Internal factors that are linked to a project which influence IBS decision making.
Communication - Formality in communication with or project team members pertaining IBS decisions.
Formal - Formal communication style that is practiced in a company or a project especially in IBS decision making.
Informal - Informal communication style that is practiced in a company or a project especially in IBS decision making.
Decision - Decision making nature or norms in or a project based on decision style, techniques, approach and manner
Group - Group decision making based on meeting, discussion, agreement or consensus that are subjected to company's policy, procedures or guideline.
Individual - Individual decision making based on an organisation's policy, procedures or guidelines without formal reference to other team members.
Nature - Decision method, way or manner a decision in made in an organisation or in a project setting.
Management - Managerial issues such as planning, organising, motivating, leadership, controlling, resources that influence IBS
Goals - Objective, aim, target, purpose and aspiration of an organisation in deciding on IBS.
Leadership - Control and direction by project team members in a project or in an organisation when deciding on IBS.
Planning - Development and preparation that are involve in a company or a project pertaining IBS decision making.
Process - All elements of organising and controlling project implementation and internal managerial process.
Strategy - Plans and tactics that have to be implemented in a project or in an organisation.
Procurement - The process of acquiring an IBS project in terms of its implementation and development.
Clients - Those who purchase IBS products or have decided to adopt IBS in their projects.
Costs - The expenditure of acquiring a project and all expenses related to it.
Resources - All inputs that are required in deciding IBS projects in order to determine the project implementation.
Supply chain - All entities involve in the production until the distribution of IBS products.
Project - Project variables that influence IBS decision making like risk, information availability, operational and developmental
Development - Growth, expansion, progress or improvement in a project setting that influence IBS decision making.
Information - Reference or data or inputs that are required as a reference or guidance in IBS decision making.
Operation - All process and procedure for the growth and implementation of a project.
Risk - Any possibilities and uncertainty that might occur in a project implementation or in a project development especially related to IBS.

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Sharifah Akmam Syed Zakaria
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Faculty of Engineering and Built Environment
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Email: sharifahakmam.syedzakaria@uon.edu.au

INFORMATION SHEET- INTERVIEW FIRM

[Delete before distribution: This is used for both inter-project and intra-project perspectives recruitment]
Document Version 2; dated [12/05/11]

Address

Date

Dear …..

Re: **DECISION-MAKING OF TECHNOLOGY ADOPTION: THE CASE OF INDUSTRIALISED BUILDING SYSTEM (IBS) IN THE MALAYSIAN CONSTRUCTION INDUSTRY**

This research is part of Sharifah Akmam Syed Zakaria's, Doctoral Studies at the University of Newcastle, supervised by Dr. Thayaparan Gajendran and Associate Professor Graham Brewer from the School of Architecture and Built Environment. {**Delete Appropriately: For Inter-project perceptive**: We would now like to invite you to participate in the study. **For Intra-project Perspective**: We would now like to invite you as the [Design architect, Quantity surveyor, Developer, Consultant, Contractor, Project Manager, Supplier, Client] of [Project A] to participate in the case study of [Project A].} This sheet contains information about the research.

Why is the research being done?
The purpose of this research is to develop an in-depth understanding of the processes involved in the decision-making process associated to (non) adoption of Industrialised Building Systems (IBS) in building projects. It primarily focuses on various dimensions of (non) IBS technology adoption in the construction industry.

Who can participate in the research?
Participants in this research should have knowledge of IBS systems and engaged in the decision-making process of IBS adoption in building projects.

What choice do you have?
Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the project. Whether or not you decide to participate, your decision will not disadvantage you. If you do decide to participate, you may withdraw from the project at any time without giving a reason and have the option of withdrawing any data, which identifies you.

What would you be asked to do and how much time will it take?

If you agree to participate, you will be asked to:

1. Participate in an interview that could take approximately 50 minutes.
2. Provide any documentation in relation IBS adoption decision-making that is not commercially sensitive.

Please find attached the semi-structured interview schedule for your information. It is estimated that the interview will take approximately 50 minutes. It will be conducted at your convenience, in a location of your choice. The interview questions seek your opinion - there are no right or wrong answers.

What are the risks and benefits of participating?

By participating in this research you will be contributing to the development of an in-depth understanding on how decisions to (not) adopt Industrialised Building Systems (IBS) are made. This will assist the management of IBS technology in the Malaysian construction industry. It is not anticipated that participation in the project would present any appreciable risks to you. There are no identifiable direct benefits to individual participants. However, the finding of this research could benefit the building industry to develop a better understanding of the various issues faced in IBS adoption decision-making process.

How will your privacy be protected?

All data gathered through the interview will be treated with the strictest confidence. All identifiable features (i.e. names of individuals and projects) will be removed and codes will be assigned. You will be provided the opportunity, upon request to review, edit, or erase the recordings or transcripts of the interviews. You reserve the right to remove or edit any commercially sensitive information used in the analysis/report.

Only the research team will have access to personally identifiable data collected. All information will be stored in password protected computer files. Once the project is complete the information will be stored for five years in the Principal Investigator's office in a locked cabinet and then destroyed according to University of Newcastle procedures.

How will the information collected be used?

The data will be used within a range of publications such as scientific journals, international conference and in the PhD thesis to be submitted by Sharifah. Participants will not be identified in any reports arising from the project. The participants will be offered a summary of the results. If you would like to receive a summary of the results of the research, please register your request in the 'Consent Form' or by contacting Dr. Thayaparan Gajendran on the phone number or email address below.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact the researchers. Should you choose to participate in this study, please complete the attached 'Consent Form' and e-mail or post it to Sharifah Akmam Syed Zakaria. The research team will then contact you to arrange a time convenient to you for the interview. Please keep this Information Sheet.

Yours sincerely,

Sharifah Akmam Syed Zakaria	Principal Investigator:	Co-Investigator:
Doctoral Candidate	Dr. Thayaparan Gajendran	Dr. Graham Brewer
University of Newcastle	Senior Lecturer	Associate Professor
University of Newcastle	University of Newcastle	University of Newcastle
	Principal Supervisor	Co-Supervisor

Research Team Contact Details

Any enquiries about the study may be directed to:
Sharifah Akmam Syed Zakaria
Telephone: (04) 5115 5065 or
E-mail: sharifahakmam.syedzakaria@uon.edu.au

Dr. Thayaparan Gajendran
Telephone: +61-2-49215781
Email: Thayaparan.gajendran@newcastle.edu.au

Complaints about this research

This project has been approved by the University's Human Research Ethics Committee, Approval No. H- 2011-0117.

Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au.

Sharifah Akmam Syed Zakaria
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Faculty of Engineering and Built Environment
The University of Newcastle
University Drive, Callaghan, NSW 2308, Australia

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Email: sharifahakmam.syedzakaria@uon.edu.au

CASE STUDY INFORMATION SHEET - LEAD FIRM IN PROJECT

Document Version 2; dated [12/05/11]

Address

Date

Dear …..

Re: **DECISION-MAKING OF TECHNOLOGY ADOPTION: THE CASE OF INDUSTRIALISED BUILDING SYSTEM (IBS) IN THE MALAYSIAN CONSTRUCTION INDUSTRY**

This research is part of Sharifah Akmam Syed Zakaria's, Doctoral Studies at the University of Newcastle, supervised by Dr. Thayaparan Gajendran and Associate Professor Graham Brewer from the School of Architecture and Built Environment. We would now like to invite you as the [Design architect, Quantity surveyor, Developer, Consultant, Contractor, Project Manager, Supplier, Client] of [Project A] to participate in the case study of [Project A]. This sheet contains information about the research.

Why is the research being done?

The purpose of this research is to develop an in-depth understanding of the processes involved in the decision-making process associated to (non) adoption of Industrialised Building Systems (IBS) in building projects. It primarily focuses on various dimensions of (non) IBS technology adoption in the construction industry.

<u>Who can participate in the research?</u>
Participants in this research should have knowledge of IBS systems and engaged in the decision-making process of IBS adoption in building projects.

<u>What choice do you have?</u>
Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the project. Whether or not you decide to participate, your decision will not disadvantage you. If you do decide to participate, you may withdraw from the project at any time without giving a reason and have the option of withdrawing any data, which identifies you.

<u>What would you be asked to do and how much time will it take?</u>

This study will involve a number of other members from the [Project A] supply chain. This includes the [**Delete Appropriately:** design architect, quantity surveyor, developer, consultant, contractor, civil engineer, project manager, suppliers and clients]. You have been identified as the lead contact for the [Project A].

If you agree to participate, you will be asked to:

1. Distribute Information Statements to other project supply chain members, [***Delete Appropriately:*** design architect, quantity surveyor, developer, consultant, contractor, civil engineer, project manager, suppliers and clients] to be interviewed by the researchers.
2. Participate in an interview (approximately 50 minutes)
3. Provide any documentation in relation to IBS adoption decision-making that is not commercially sensitive

Please find attached the semi-structured interview schedule for your information. It is estimated that the interview will take approximately 50 minutes. It will be conducted at your convenience, in a location of your choice. The interview questions seek your opinion - there are no right or wrong answers.

<u>What are the risks and benefits of participating?</u>

By participating in this research you will be contributing to the development of an in-depth understanding on how decisions to (not) adopt Industrialised Building Systems (IBS) are made. This will assist the management of IBS technology in the Malaysian construction industry. It is not anticipated that participation in the project would present any appreciable risks to you. There are no identifiable direct benefits to individual participants. However, the finding of this research could benefit the building industry to develop a better understanding of the behavioural issue faced in IBS adoption decision-making process.

<u>How will your privacy be protected?</u>

All data gathered through the interview will be treated with the strictest confidence. All identifiable features (i.e. names of individuals and projects) will be removed and codes will be assigned. You will be provided the opportunity, upon request to review, edit, or erase the recordings or transcripts of the interviews. You reserve the right to remove or edit any commercially sensitive information used in the analysis/report.

Only the research team will have access to personally identifiable data collected. All information will be stored in password protected computer files. Once the project is complete the information will be stored for five years in the Principal Investigator’s office in a locked cabinet and then destroyed according to University of Newcastle procedures.

How will the information collected be used?

The data will be used within a range of publications such as scientific journals, international conference and in the PhD thesis to be submitted by Sharifah Akmam Syed Zakaria. Participants will not be identified in any reports arising from the project. The participants will be offered a summary of the results. If you would like to receive a summary of the results of the research, please register your request in the 'Consent Form' or by contacting Dr. Thayaparan Gajendran on the phone number or email address below.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact the researchers. Should you choose to participate in this study, please complete the attached 'Consent Form' and e-mail or post it to Sharifah Akmam Syed Zakaria. The research team will then contact you to arrange a time convenient to you for the interview. Please keep this Information Sheet.

Yours sincerely,

Sharifah Akmam Syed Zakaria
Doctoral Candidate
University of Newcastle
University of Newcastle

Principal Investigator:
Dr. Thayaparan Gajendran
Senior Lecturer
University of Newcastle
Principal Supervisor

Co-Investigator:
Dr. Graham Brewer
Associate Professor
University of Newcastle
Co-Supervisor

Research Team Contact Details

Any enquiries about the study may be directed to:

Sharifah Akmam Syed Zakaria
Telephone: (04) 5115 5065 or
E-mail: sharifahakmam.syedzakaria@uon.edu.au

Dr. Thayaparan Gajendran
Telephone: +61-2-49215781
Email: Thayaparan.gajendran@newcastle.edu.au

Complaints about this research

This project has been approved by the University's Human Research Ethics Committee, Approval No. H- 2011-0117.

Should you have concerns about your rights as a participant in this research, or you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au.

Appendix 9

Sharifah Akmam Syed Zakaria
School of Architecture and Built Environment
Faculty of Engineering and Built Environment
The University of Newcastle

University Drive, Callaghan, NSW 2308, Australia
Telephone: (04) 5115 5065
Email: sharifahakmam.syedzakaria@uon.edu.au

Consent Form for the Research Project:
Decision-making of Technology Adoption: The Case of Industrialised Building System (IBS) in the Malaysian Construction Industry

Research Team:

Sharifah Akmam Syed Zakaria	Principal Investigator:	Co-Investigator:
Doctoral Candidate	Dr. Thayaparan Gajendran	Dr. Graham Brewer
University of Newcastle	Senior Lecturer	Associate Professor
	University of Newcastle	University of Newcastle
	Principal Supervisor	Co-Supervisor

Document Version 2; dated [12/05/11] **[Participating Firm]**

I agree to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand that I can withdraw from the project at any time and do not have to give any reason for withdrawing.

I understand that I can review and edit my interview recording

Appendix 9

I consent to:

• completing a questionnaire;	Yes / No
• participating in an interview and having it recorded;	Yes / No
• provide any documentation that is not commercially sensitive	Yes / No

I understand that my personal information will remain confidential to the researchers.

I have had the opportunity to have questions answered to my satisfaction.

I like to receive a copy of the research findings. (Yes /No)

Print Name: ____

Contact Details: ____
(for interview arrangement and receiving the results)

Signature: ____________________________ **Date:** ____________________

Appendix 10

Sharifah Akmam Syed Zakaria
School of Architecture and Built Environment
Faculty of Engineering and Built Environment
The University of Newcastle

University Drive, Callaghan, NSW 2308, Australia
Telephone: (04) 5115 5065
Email: sharifahakmam.syedzakaria@uon.edu.au

Consent Form for the Research Project:
Decision-making of Technology Adoption: The Case of Industrialised Building System (IBS) in the Malaysian Construction Industry

Research Team:

Sharifah Akmam Syed Zakaria Doctoral Candidate University of Newcastle	Principal Investigator: Dr. Thayaparan Gajendran Senior Lecturer University of Newcastle Principal Supervisor	Co-Investigator: Dr. Graham Brewer Associate Professor University of Newcastle Co-Supervisor

Document Version 2; dated [12/05/11] **[Lead Firm]**

I agree to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand that I can withdraw from the project at any time and do not have to give any reason for withdrawing.

I understand that I can review and edit my interview recording

I consent to:

• distribute Information Statements to other project supply chain members.	Yes / No
• completing a questionnaire;	Yes / No
• participating in an interview and having it recorded;	Yes / No
• provide any documentation that is not commercially sensitive	Yes / No

I understand that my personal information will remain confidential to the researchers

I have had the opportunity to have questions answered to my satisfaction.

I like to receive a copy of the research findings. (Yes /No)

Print Name: ____

Contact Details: ____
(for interview arrangement and receiving the results)

Signature: ____________________________ **Date:** ____________________

Codes for the participants – Inter-project Perspective
(the construction professions stakeholders)

CONSTRUCTION PROFESSIONS STAKEHOLDERS INTER-PROJECT PERSPECTIVE (STAKE HOLDERS - SH)							**Total Professions**
Method: Semi-structured interview							
Stake-holders of construction industry	**Transcript and Code of participants**						
	Transcript	**Code**	**Transcript**	**Code**	**Transcript**	**Code**	
Design architect	R 4.doc	SH/DA/4	R 6.doc	SH/DA/6	R 19.doc	SH/DA/19	3
Quantity surveyor	R 10.doc	SH/QS/10	R 14.doc	SH/QS/14	R 20.doc	SH/QS/20	3
Developer	R 11.doc	SH/DR/11	R 15.doc	SH/DR/15	R 21.doc	SH/DR/21	3
Consultant	R 12.doc	SH/CT/12	R 16.doc	SH/CT/16	R 22.doc	SH/CT/22	3
Contractor	R 8.doc	SH/CR/8	R 9.doc	SH/CR/9	R 23.doc	SH/CR/23	3
Civil Engineer	R 13.doc	SH/CE/13	R 17.doc	SH/CE/17	R 24.doc	SH/CE/24	3
Project Manager	R 1.doc	SH/PM/1	R 18.doc	SH/PM/18	R 25.doc	SH/PM/25	3
Manufacturer	R 26.doc	SH/MR/26	R 27.doc	SH/MR/27	R 28.doc	SH/MR/28	3
Clients	R 49.doc	SH/CL/49	R 50.doc	SH/CL/50	R 51.doc	SH/CL/51	3
						Total Participants	**27**

Level of Involvement in IBS Decision-making for Project A, Project B and Project C

(Intra-project Perspective)

PROJECT	**IBS SUPPLY CHAIN MEMBERS**	***Types of Decision:*** **R=Routine, NR=Non-routine, B=Both**	***Category of Decision:*** **G=Group I=Individual B=Both**	***Decision-making at Project Stages:*** **D=Design, P=Planning, F=Feasibility, C=Construction, O=Operation**			
A	ARCHITECT 1	B	G	D	P	F	
A	QUANTITY S 1	B	B	D	P		
A	CONTRACTOR 1	B	G	C			
A	CIVIL ENGINEER 1	N	G	D			
A	CONSULTANT 1	N	G	D	P		
A	CLIENT 1	B	B	D	P	F	C
A	DEVELOPER 1	B	B	D	P	F	
A	PROJECT MGR 1	N	B	O			
A	MANUFACTURER 1	B	B	D	P	C	O
B	ARCHITECT 2	N	B	D	P		
B	QUANTITY S 2	R	G	D	P	F	
B	CONTRACTOR 2	B	B	P	O		
B	CIVIL ENGINEER 2	B	G	P	C		
B	CONSULTANT 2	N	G	P	F	C	
B	CLIENT 2	N	B	D	P		
B	DEVELOPER 2	B	B	D	P		
B	PROJECT MGR 2	R	B	C	O		
B	MANUFACTURER 2	B	G	D	F	C	O
C	ARCHIRECT 3	B	G	D	P	F	
C	QUANTITY S 3	B	G	D	P	F	
C	CONTRACTOR 3	B	B	C			
C	CIVIL ENGINEER 3	B	B	C	O		
C	CONSULTANT 3	B	B	D	P	F	
C	CLIENT 3	N	G	P			
C	DEVELOPER 3	B	G	C			
C	PROJECT MGR 3	B	B	C	O		
C	MANUFACTURER 3	B	G	D	F		

Codes for the participants – Intra-project Perspective
(the supply chain members of IBS projects)

IBS PROJECTS INTRA-PROJECT PERSPECTIVE (SUPPLY CHAIN –SC)							**Total Professions**
Method: Semi-structured interview							
Supply chain members of IBS projects	**Transcript and Code of participants**						
	Project A		**Project B**		**Project C**		
	Transcript	**Code**	**Transcript**	**Code**	**Transcript**	**Code**	
Design architect	R 7.doc	A/DA/7	R 36.doc	B/DA/36	R 42.doc	C/DA/42	3
Quantity surveyor	R 29.doc	A/QS/29	R 37.doc	B/QS/37	R 43.doc	C/QS/43	3
Developer	R 32.doc	A/DR/32	R 38.doc	B/DR/38	R 44.doc	C/DR/44	3
Consultant	R 31.doc	A/CT/31	R 39.doc	B/CT/39	R 45.doc	C/CT/45	3
Contractor	R 5.doc	A/CR/5	R 40.doc	B/CR/40	R 46.doc	C/CR/46	3
Civil Engineer	R 2.doc	A/CE/2	R 35.doc	B/CE/35	R 47.doc	C/CE/47	3
Project Manager	R 34.doc	A/PM/34	R 41.doc	B/PM/41	R 48.doc	C/PM/48	3
Manufacturer	R 30.doc	A/MR/30	R 3.doc	B/MR/3	R 33.doc	C/MR/33	3
Clients	R 53.doc	A/CL/53	R 52.doc	B/CL/52	R 54.doc	C/CL/54	3
Total Participants							**27**

Results of the input-output analysis on the decision-making of IBS technology adoption:

DECISION	SOURCE	REFERENCES	ASPECTS:	FACTORS:	SOURCE	REFERENCES
CONCERN	54	6017	Economics	C*	54	800
			Attitude	B	54	719
			Management process	S	54	694
			Business	C	53	638
			Clients	S	52	437
			Risk	S	51	389
			Government	C	54	310
			Values	B	50	298
			Environment	C	50	264
			Promotion	C	50	236
			Support	B	50	233
			Policy	C	49	171
			Rules	C	41	131
			Uncertainty	C	37	116
			Competition	C	42	112
			Waste	C	32	85
			Creativity	C	31	75
			Trends	C	36	73
			Decision Nature	S	32	61
Number of concern:			20 aspects (12 contextual factors, 4 structural factors and 3 behavioural factors) *[B = Behavioural, C = Contextual and S = Structural]			
INPUT	54	4380	Success experience	B*	54	571
			Failure experience	B	54	536
			Planning	S	52	519
			Costs	S	54	471
			Technology	C	53	371
			Stakeholders' Opinion	C	53	359
			Project Information	S	50	352
			Demand	C	52	296
			Resources	S	48	254
			Strategy	S	49	188
			Technology Innovation	C	49	187
Number of inputs:			11 aspects (5 structural factors, 4 contextual factors and 2 behavioural factors) *[B = Behavioural, C = Contextual and S = Structural]			
PROCESS	54	3797	Bounded Rationality-choice, cognition,	B*	54	1525

			justification and learning			
			Operation	S	53	575
			Communication	S	49	333
			Management	S	47	272
			Group and individual decision	S	51	248
			Culture	B	44	146
			Leadership	S	38	126
			Other behavioural aspects	B	42	116
			Personality	B	41	100
Number of processes:			9 aspects (5 structural factors and 4 behavioural factors) *[B = Behavioural, C = Contextual and S = Structural]			
OUTPUT	54	3337	Project development	S*	53	642
			Productivity	C	53	379
			Quality	C	53	329
			Procurement	S	52	272
			Partnership	C	49	247
			Awareness	B	48	195
			Goals	S	47	169
			Supply chain	S	45	169
			Opportunity	C	48	165
			Efficiency	C	48	164
			Requirement	C	46	138
			Sustainability	C	38	97
Number of outputs:			12 aspects (7 contextual factors, 4 structural factors and 1 behavioural factor) *[B = Behavioural, C = Contextual and S = Structural]			