Interoperability and Information System Replacement in the Health Sector

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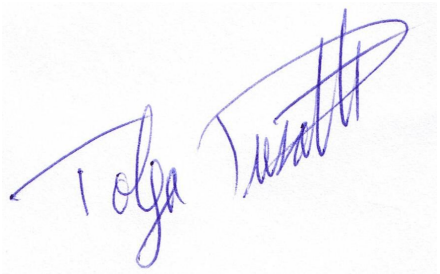
Certificate of Originality

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

(Signed):



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Abstract

It is difficult to decide when to replace (major components of) information systems (IS) used in large organisations. Obstacles include not only the cost and the technical complexities but also the fact that the workplace is dependent on the current IS and the users have familiarity with their functionalities. The problems become more complicated with increasing need for IS interconnectivity within and between organisations. Formal guidelines to assist in making replacement decisions are not commonly used.

This thesis aims to develop a model of key factors involved in the IS replacement decision and to investigate the role of interoperability in this decision. It concentrates on the healthcare domain in NSW, Australia, which represents a complex distributed multilevel organisation, which has identified interoperability as a problem and has started initiatives to improve it.

Research in IS and software engineering has shed light on many of the issues associated with the replacement decision. For example, studies in technology acceptance have explained why organisations delay in moving to new technologies, and modelled the effect of increasing popularity of such technologies. IS success models have explored the factors that contribute to success and failure of deployed systems, providing checklists to assess the appropriateness of current systems from the point of view of the users and other organisational stakeholders. Research into the value of user feedback has helped managers to align user expectations with workplace IS. In terms of software function, metrics have been developed to measure a range of factors including performance, usability, efficiency and reliability that help determine how well the systems are performing from a technical perspective. Additional research has identified important points to consider when comparing custom made systems versus buying off-the-shelf systems, such as skill availability and after sale support. Maturity models and life cycle analyses consider the effect of age on IS, and Lehman's laws of software evolution highlight the need for maintenance if an IS is to survive.

Improvements in interoperability at the information level have been achieved through domain specific standards for data integrity, and modular approaches for partial changes in IS. In particular, the healthcare domain has developed a number of standardised terminological systems such as SNOMED, LOINC, ICD and messaging standards such as HL7. Template high level data models have also been trialled as a way to ensure new IS remain compatible with existing systems.

While this literature partially covers and contributes to the understanding of when and how to replace IS and/or components, to our knowledge there has been no attempt to provide an integrated model identifying factors to be considered in the replacement decision.

The thesis adopts a multi method approach to build a model of IS replacement and to explore aspects of interoperability. Preliminary factors and their potential interactions were first identified from the literature. In depth interviews were conducted with 10 experts and 2 IS users to investigate the validity and importance of the factors and interactions and to elicit further potential items. The analysis of the transcripts guided review of further literature and contemporary data, which led to the development of a final model and insights into the role of interoperability. A member check was used to validate both the model and the researcher's conclusions on interoperability.

The final model is centred about the change request, that is, any request made by or on behalf of an executive officer in order to maintain or replace part or all of an IS. The change request is informed by user feedback but our research distinguishes the two factors because the change request factor filters and manages requests for change from multiple sources. Other factors that have an important direct or indirect effect on generating change requests include: the extent of system specialisation, that is, how the system is tailored to satisfy organisational requirements; popularity, the degree to which an IS or a component is liked or supported by its user community; the prevalence and severity of errors and failures in the systems; the usability and performance of the systems; and the adequacy of support, including training, documentation, and so on. The dependent factors are maintenance and replacement, determined through the change requests.

The validation through member checking showed that IS practitioners found our model useful in explaining the replacement process. The model provided an interpretation of the change requests. By exposing and clustering reasons behind the change requests, the complexity of deciding whether to maintain or replace system components can be reduced. Individual factors can be addressed more specifically. Formal guidelines on whether to maintain or replace components or entire IS can be drawn up using this understanding. The factors and their interactions as explained in the model could be the basis of a decision tree, which would be customised for organisational jargon and priorities.

The requirement for interoperability is an aspect of system specialisation. An important finding from the research was that one of the most significant reasons to change a

system is when problems are encountered in exchanging data and information. Conversely, as long as systems can exchange data, there is less pressure to replace them. Organisations benefit more from systems that provide more support for interoperability. Findings on interoperability in the health domain were that existing messaging standards (mostly HL7) used in the information exchange between subsystems including legacy databases are useful and are used. Also, ambiguities are diminished with vocabularies (mostly SNOMED, LOINC and ICD are used in NSW health domain). However, a methodology known as Interoperability Framework supported by government funding bodies for comparing data models has not been adopted and is not given any significant credit by the users. Likewise, a government proposal to use an overarching high level data model has not been adopted, in part because it is too complex. To guide use of such a data model requires a methodology for comparing data models: an example of such a methodology is developed in this thesis.

The thesis research found that replacement decisions in the healthcare domain are affected by the existing quasi-monopoly of large vendors which tend to use proprietary standards that limit interoperability. The research concludes that interoperability should be achieved by increased use of vendor-independent messaging and terminological standards. In order to get the co-operation of individual health institutions within the domain, initial investments should be concentrated on simple and easy to adopt standards.

A primary limitation of this thesis is the extent of testing of the findings. Data from a broader range of organisations, in different sectors and different countries, is needed to validate the model and to guide development of decision making tools that are based on it. Particularly valuable would be case studies of IS replacement decision making and the process which executives use in determining change requests. The priorities of the factors and their attributes as well as the strengths of the relationships in the model need to be tested empirically using tailored survey instruments. Another interesting research avenue which was only touched on in the thesis was the effect of policies and legislation on interoperability and on replacement decisions.