Finnish Journal of eHealth and eWelfare

SCIENTIFIC PAPERS

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Decision making process for clinical it investments in a public health care organization – contingency approach to support the investment decision process

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Abstract

Purpose Health care organizations are lacking a clear decision-making framework in IT investment decisions. This study aims at finding a practical tool able to take the different financial and non-financial factors into account. The usefulness of one possible tool, the Contingency Theory, is evaluated.

The Contingency Theory seeks to understand which external factors in particular have an impact on the organization's operations or which internal factors must be taken into account to make the optimal investment. In the public health care context the internal variables such as organization's culture and condition of existing technology, and external variables such as legislation and politics play an important role.

Methods The Contingency Theory is applied to a complex real-world investment case a posteriori, and the variables thus obtained are compared with the actual acquisition process which took place. The relevant information has been gathered from the accounting systems, and by interviews.

Results The Contingency Theory finds a relevant set of variables to consider in the decision-making process, and the set of variables mostly coincides with the actual parameters considered in the decision-making process. The actual acquisition process placed more weight on cost factors than the Contingency Theory approach would have done.

Conclusions The application of contingency theory suggests that in this case the expected value of costs was overemphasized. It is likely that a contingency-based approach would have given a more balanced view of the different parameters. Further research is required to establish its usefulness in different types of public health care acquisitions.

Keywords: costs and cost analysis, economics, health information management, case management, signal processing, computer-assisted software

Introduction

The complex environment in the health care sector makes the investment decision-making process when investing in Information and Communication Technology (ICT) often more complicated and thus slows down the investments [1,2,3,4,5]. There are several relatively straight-forward cost factors—such as costs associated with hardware and software, availability of broadband and mobile networks, and ongoing maintenance costs—evident in the ICT investment decision-making process [6] but there are other financial factors whose value is difficult to evaluate during the decision-making, e.g., ongoing development of technology, present level of standardization, and interconnectivity between IT systems [7-9]. While even these factors can theoretically be assigned a financial value, there are also non-financial factors associated with the clinical IT systems. These could be related to the health care outcome (e.g. patient comfort, equality of care) or organizational factors, such as willingness to adopt new technology. These non-financial values may carry a strong emphasis in the public health care sector where the aim is often to produce as good health care as possible within the given budget instead of producing profit.

The growth in ICT spending and a broadening menu of technological investment choices have lead health care organizations to critically evaluate potential investments for the value they deliver [5,10,11]. Allocating resources among competing investment projects is one of the most critical elements of the whole process [12,13]; while capital budgeting is used to vet the competing investment projects [12,14,15]. Empirical evidence suggests that financial analyses beyond cost analyses are still rarely used in clinical IT investment decisions in health care organisations [16,17]. Health care organizations are lacking a clear decision-making framework which would aid in structuring IT investment decisions [18]. The objective of this study is to apply the contingency theory to see if it can be used in a clinical IT investment decision-making and to develop more information related to management practices. And also if the variables found could be expressed in form of a tool which is both able to take the different financial and non-financial factors into account and simple enough to be applicable in practice.

The case examined in this study is a large-scale ECG measurement, analysis, and storage system acquired by a public health care organization (see Case description). The investment decision was primarily driven by project finance and economics, but those core variables had to fit within a specific regulatory and political context in order to be successful owing to the public sector-nature of the investment.

The investment also illustrates the fact that while it seems to be an intodiagnostic equipment investment, the core of the investment is information. The instruments produce information which has to be stored, communicated and accessed. Thus such a system can and should be viewed as an IT system.

This study belongs to a series of studies which aim at charting the useful application fields of the contingency theory. [19-31].

Contingency theory and clinical IT investment decision-making process

According to contingency theory the optimal way of leading a company is contingent upon the internal and external situation at hand [32-36). The underlying premise in contingency theory is that organizational performance is the result of a match or fit among salient factors [37,38).

Central to the contingency approach is the notion of contingent fit among relationships between strategic priorities, organizational configurations, and management accounting systems. This approach asserts that neither the type of strategy, nor the organizational configuration will directly affect performance. Rather, contingency theory suggests that the most important determinant of performance is the contingent fit between the chosen strategy and its contextual variables [39].

Contingency theory explains the design of management accounting systems, in which the organizational context

and structure must be in line in order for an organization to perform well [24]. Using the contingency approach researchers have attempted to explain the effectiveness of management accounting systems by examining designs that suit the nature of the environment, size, structure, technology, strategy, national culture and international competition [36,40-43). There are many variables that might have a role designing a management accounting system to support an investment decision-making process. Internal variables cover the organization's strategy, culture, technology, structure and size, and external variables cover the organization's operating environment.

According to contingency theory, the effectiveness of decision- depends upon a number of aspects within a specific situation including the amount of relevant information and decision quality and acceptance [44]. The contingency approach is not commonly applied into the study of decision-making, but it is chosen to be evaluated in this study due to its main proposition that structure and process of an organization must fit its context in order to be effective [37]. Contingency approach analyzes the organization's internal and external factors that are expected to affect the investment decision-making.

While the emphasis in investment theories is in dealing with quantitative appraisals of project focus and costs, there is no self-evident methodology for contextual analysis of IT systems beyond financial considerations. Taking the broader context into account would potentially aid health care organizations evaluate the suitability of their IT investments [45] in terms of indirect costs and benefits [46].

Based on such a theoretical understanding of contingency theory and authors' previous empirical studies on cost-analysis in telemedicine and clinical IT investment studies in public health care organizations [47-55) this study adopts the following hypothesis:

The investment decision-making process for a clinical IT system in a public health care organization is positively correlated to the concept of contingency fit which is comprised of three independent variables:

- Strategic priorities :external variables including health care legislation, politics,
- Organizational configuration: internal variables including organizational culture, the role of public organization, the state of existing technology at the time of the final investment decision,
- Internal management accounting systems: non-profit organization, cost-benefit analysis

Material and methods

Applying the theory to a real-world investment case which has already been carried out provides an opportunity to use more than one method of data collection (questionnaires, interviews, informal conversations, meetings, material provided by the organization such as business plans, strategies, survey data and other observations) thus enabling perceptual triangulation, which ensures that a more accurate interpretation of the situation is made [56-59] by answering questions "how" and "why" [60] in addition to creating theoretical constructs and propositions from empirical evidence [61].

Written documents

The documents used in case evaluation included

- organization's strategy papers,
- IT strategy,
- materials related to the vendor selection process,
- investment analysis and selection criteria,
- results from the selection process,
- standard agreement templates for acquiring the system, maintenance and support service,
- material presented for the board of directors related to the purchase, and
- publicly available minutes of the Board of Directors of Hospital District of Helsinki and Uusimaa (HUS)

The material including information from the organization's accounting system follows the case from 2005 until the final investment decision was made by the board of directors in May 2008.

Interviews

To gain a comprehensive understanding of the case the administrative chief physician was interviewed in six semistructured interviews. Before each interview and during the analysis of the interview data, the researcher studied organizational documents mentioned above. Interviews were documented and several follow up questions were submitted by e-mail for clarification and additional information was provided also by other experts in the project.

The interview questions were related to the purpose of the investment and the overall procurement process in order to best reflect HUS' overall decision-making strategy, the contributing environmental contingency factors and criteria selected for the vendor selection process. In addition, during the interviews supplementary data was collected and analysed regarding the overall strategy of the organisation. This way of gaining more information was very important in order to understand the decision-making and how different decisions were linked each other.

Accounting data

Also, the financial data from the accounting system related to the volumes, costs and prices was analysed in detail. The degree of rigor applied in this study was meant not only to improve the reliability of the analysis based on interviews but also to enhance the understanding of specific details related to the investment calculations. While this analysis provided detailed information on the case, the main aim of this study is to evaluate if the contingency theory can be successfully applied in analysing this type of investment decision.

Results

The case was analysed from two points of view. The first viewpoint is the contingency approach ("what should have been taken into account"), and the second viewpoint is an analysis on the actual acquisition process.

Contingency approach and contingency variables

According to the contingency theory the effectiveness of the decision-making process can be explained by examining designs that suit the culture of the organization, nature of the environment and technology. This requires identifying contingency variables. As stated in section 2, the hypothesis emphasizes that the contingency variables can be divided into three categories: externalities, organizational culture, and technology. Figure 1 depicts the variables used in this case. The following section describes the contingency variables which – according to the contingency theory and our hypothesis – should have been taken into account in the acquisition process.

Organization's culture

HUSLAB is the leading provider of clinical laboratory services in Finland. HUSLAB's main area of operation is the Hospital District of Helsinki and Uusimaa (HUS) – a joint authority formed by 24 municipalities. HUSLAB has over 70 sampling points around the Helsinki and Uusimaa area, where nearly 20 million tests are carried out annually. HUSLAB is a public utility able to set its own prices but selling 90 % of its services to the HUS municipalities.

HUSLAB started operations in 2004. One of the objectives for separating laboratory activities from the hospital district was that the costs can be better identified. At the time of the investment decision the entity was also able to make profits and the positive cash flows were used for financing investments. Today HUSLAB makes "zero" results and investments, i.e. financing, are separately decided at the Hospital District level.

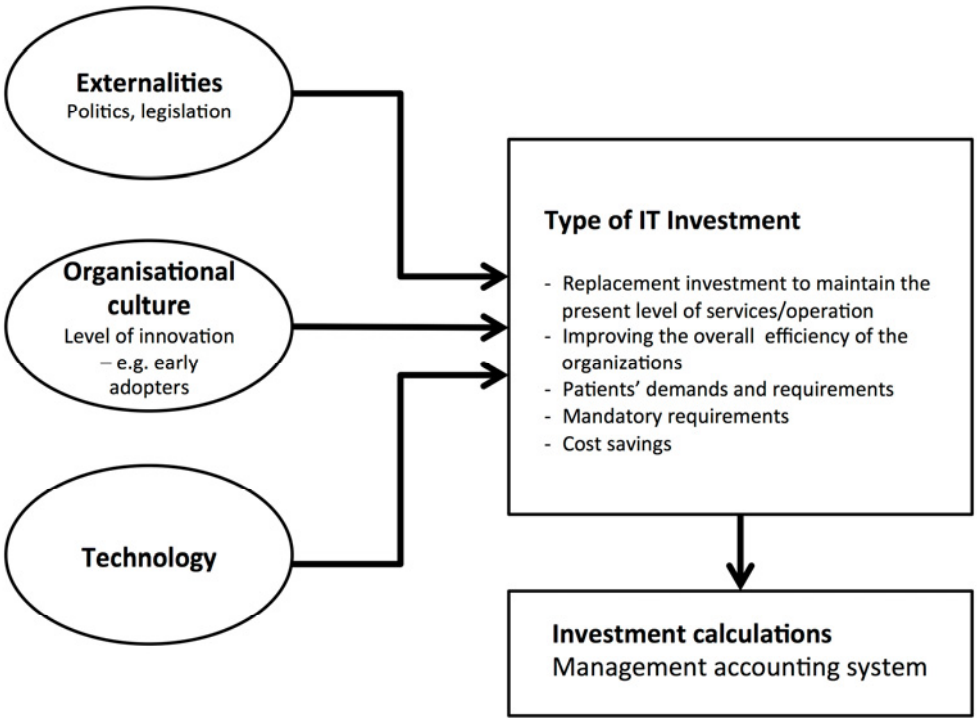

Figure 1. The contingency variables which should be driving the investment decision-making process when investing in clinical IT systems.

Externalities

During the preparation of the IT system investment a law related to the electronic data processing in health care services passed the Finnish Parliament. The law required health care entities to ensure the ability to store patient records electronically in the national archives not later than April 1st 2011, which increased the strategic importance of the investment in question within a wider institutional context.

Technology

The goal of the investment was to provide paperless ECG operations with the ability to view ECG records at remote workstations. The intention was also to create a system with similar equipment and procedures that could be used in the Hospital District and by the health care professionals in HUS's member municipalities.

The driving forces behind the ECG system investment were the need to harmonize the process within the hospital district and to create cost savings. There was also a demand to provide interfaces to integrate the laboratory system in the existing ordering and laboratory result delivery system. Standardization was an important parameter during the decision-making process. Before the purchase of the new digital ECG recording, analysis, and storage system there was a long discussion between HUSLAB and the Ministry of Social Affairs and Health about the relevant standards. At that time there were no uniform standards for digital ECG activities neither in Finland nor in the EU.

Acquisition process

The actual acquisition was carried out by using a few financial calculations and according to the existing legislation. The legislation had a significant influence on the

acquisition process; according to the Public Procurement Act § 29, the financial value of the purchase should be the most relevant factor in decision-making. Financial performance was analysed by estimating three vendors' tenders overall financial benefits. Table 1 presents the criteria and the importance of them in the selection process.

The most important criterion was the overall price with a total weight of 40% and the second most important criterion was the quality of support and maintenance services including the annual fees for the services. Previously, hospitals paid all licences and equipment in cash and booked investments on their balance sheet. In contrast, the new system was acquired as a service and the selected criteria (overall price, maintenance costs and support services) covered the total annual cost for the system.

After testing each system offered by the qualifying vendors the evaluation group evaluated the functional benefits and usability of each system. The analysis on usability was mostly based on subjective assessments. The interoperability of the systems was evaluated and analysed by the answers given by each system vendor.

Cash flow, scorecard or pay-back type of investment calculations and analyses were not presented in the case material. Management account reporting which was established in the new entity did not follow the financial performance of the investment itself, as it was created more to support the Enterprise's (HUSLAB) overall results. HUSLAB introduced a balanced scorecard model for cost accounting and the first pilots were already running in 2005, but it was not applied to this project.

In addition to the financial criteria, there was one important technological criterion; while there were no standards in place, only some EU level discussion, only the systems that had been used in other organizations were selected for the evaluation.

Table 1. The selection criteria for the competing systems.

Criterion	Weight
Price of the licence and modification work	**40 %**
Quality including technical merits of the systems, as well as maintenance and support services	**30 %**
Functional benefits including the user-friendliness of the system	**10 %**
Interoperability, the possibility to integrate the system into the present IT environment	**20 %**

Table 2. The number of ECG test and ECG devices between 2008 and 2012.

Year	Number of tests	Number of devices
2008 (prior to digital ECG)	240 000*	470**
2009	195 905	229
2010	390 737	297
2011	422 353	314
2012	403 709	334

*Estimate, of which some 130 000 were carried out by HUSLAB
**The number of devices in registry, of which some 200 were in active use.

Outcome of the system acquisition

The new system was fully implemented in 2011 and Table 2 illustrates the number of ECG tests and number of devices in use during the years 2008-2012. The number of devices in active use and tests performed increased during 2008 – 2011 until the system was fully implemented in. The decrease in the number of tests after 2011 is explained by a decline in unnecessary re-examinations for the same patient due to the availability of patients' data in a digital format.

Even though HUSLAB operates as a non-profit entity, the organization has to keep its costs down to manage end consumer prices. HUSLAB's ability to provide ECG services at a relatively low cost supports the view that the IT investment was financially beneficial for the organization. Table 3 illustrates the development of the prices during 2008 – 2013. The reference price (base price is the price during the normal working hours) of conventional paper ECG in 2007 was 10.00 euro and the on-call price in 2007 was 14.50 euro.

The ECG prices for HUSLAB's clients have increased 3.7 % per annum (table 3) while at the same the overall costs in health care sector have been increasing 5.4 % [62]. The increase in the prices is mostly explained by the increase in real prices (inflation, labor costs). The increasing prices in 2012 and 2013 are explained by the fact that the total cost of the system is allocated into test prices, and as the number of tests has fallen, the cost for a single test has risen. However, the data of 2011 and 2012 shows that the total cost has decreased, i.e. the same result can be obtained with less money.

Evaluation of the contingency theory application

When evaluating the applicability of the contingency theory approach, the question is whether applying it to this specific case would have given optimal outcome. Would there have been some variables which could have been better accounted for, or would it have missed something. This question has also a very strong subjective side in whether the application of the contingency theory would have felt natural and been simple enough to be useful in the decision-making process.

The outcome of the IT system investment was according to HUSLAB's initial expectations: processes improved with harmonisation of digital ECG recording, analysis, and storage while the cost level has been kept at the same or even lower level. Clearly, the test case was a successful one, and the actual course of the process can even be thought as a benchmark.

The investment decision-making process showed that the hypothesized contingency variable groups yielded relevant variables while analysing the investment decision:

Table 3. Price trend (in euros) of the ECG examinations between 2008 and 2013.

Year	Base Price	On-Call Price
2008	10.00	14.50
2009	11.00	13.50
2010	11.50	15.00
2011	11.90	15.00
2012	12.25	15.45
2013	12.60	15.90

Externalities

There was observable legislative pressure which enabled the organization to renew its present system with a new digital ECG system. According to the interviews, the acquisition of the new system also resulted to a redesign of the HUSLAB's processes.

Organizational culture

Even though in the HUSLAB case the external, environmental factors–both political and legislative–drove the need for the investment, the organization itself had a major impact on the decision as well. In the case the management team comprised of professionals with diverse backgrounds who looked for new and innovative ways to implement services. In addition, an organization's culture has a palpable influence over the degree of innovation for providing health care services. While in the case organization, the final investment decision will be made by politicians, it is very important that the organization brings to decision-makers well-founded and prepared presentations, such as this case was.

Technology

Technology itself played a key role in the investment decision – the new open application interface was better integrated into the present IT environment which subsequently enabled further process improvements. When discussing the clinical IT system, standards play an important role. Since there were no uniform standards for digital ECG activities, in the HUSLABS case the system was selected because it was already in use in a few other hospitals.

It seems that the factors identified by the contingency theory were relevant factors. They were to some extent taken into account in the case without the contingency context, but using contingency theory and examining the fit between the most important variables would possibly have helped HUSLAB to have more structural decision-making process.

The most notable difference is in handling the cost as a factor. The actual acquisition process set a very strong emphasis on the cost, but at closer inspection the most important factor variable was technology, i.e. standards and integration, as only systems having open interfaces and prior installations were accepted.

There were also legislative changes which impacted the decision-making process; the change in legislation helped the management to get the needed resources from the decision-makers (politicians). This is an example of another contingency factor which was in reality taken into account, but does not show in the process.

Discussion

During the study it was found that the original contingency model goes quite far to demonstrate how management accounting systems, external strategic priorities and organizational configurations contribute to explaining clinical IT decisions-making in the case studied.

Intuition vs. Contingency theory

The lack of a structured method to take the complex environment into account seems to lead to a situation where decisions are often based on intuition and recommendation by trusted parties. While this more intuitive line of work may produce good results, it has its obvious risks. This problem becomes more acute, as today's IT systems are becoming complex and intertwined, and an increasing amount of specialist knowledge is needed to understand the essential details.

One of the main challenges is the integration between different systems. There are numerous different systems from different vendors in today's health care environment, and if these systems do not interact fluently, it will introduce unnecessary friction into operational processes.

The contingency theory is about strategic fit. A practical example of this is that some organizations–such as

HUSLAB in our case–want to use new technology, whereas some other organizations may want to adopt new technology much later in order to benefit from acquiring mature and cost-effective technology. Neither of these strategies is worse than another *per se*, but the optimal investment type and investment schedule is probably quite different with this kind of strategic differences.

The Contingency Theory seeks to understand which external factors in particular have an impact on the organization's operations and, correspondingly, which internal factors must be taken into account so that the organization is making the optimal investment decision in terms of process performance. The application of contingency theory to this case study suggests that in the decision-making process, the internal variables such as organization's culture and condition of existing technology are supported by the externalities such as legislation and politics, which are important variables in a public health care organization's decision-making.

Even though the case we used to test the contingency theory in this context was a highly successful one, the application of contingency theory shows that in this case the expected value of costs was over-emphasized. Had there not been any external pressure, no investment decision would have taken place. In this case the contingency theory would have given a more balanced view of the different parameters. The investment decision was made due to the strong views and intuition of the leaders instead of a structured process.

Using the contingency approach in financial calculations

We are optimistic about the opportunities opened by applying the contingency theory into complex health care IT investments. However, we talk about investment projects, and in addition to qualitatively identifying the contingency factor we will need to be able to integrate them into the financial calculations. In order to do that we suggest a modified version of the commonly used Net Present Value (NPV) formula [63]:

$$\mathrm{NPV} = -I\frac{1-\delta}{1+\alpha+\beta} + \sum_{t=0}^{N}\frac{R_t}{(1+i)^t} \quad (1)$$

where
I is the actual cost of the required investment,
α the possibility for the system to be integrated into the present and future environments ($\alpha \geq 0$),
β is a factor which describes the level of IT technology ($\beta \geq 0$),
δ is the strategic fit of the required investment ($0<\delta\leq 1$)
N number of years to take into account,
R_t net cash flow on year t (excluding initial investment), and
i discount rate

This is essentially the same as the standard NPV value apart from the coefficient of the investment. If the strategic fit would be excellent, the effect of the investment can be regarded to be zero. Also, if the level of IT technology (in the organization) or the future integration prospects of the system are very good, the cost of the investment diminishes from the organization's point of view.

This modification of the NPV method should enable one to factor in the total effect of the contingency variables. Admittedly, determining the values of α, β, and δ have a great variability, but the formula still provides a way towards quantifying the complex and contingency factors which tend to be qualitative in nature.

Next steps

Naturally, as this study is based on testing a theory on a single case, its results may not be valid when generalized to other cases. This study does not give a complete recipe on how and when to apply the Contingency theory into clinical IT investments, but it may provide a starting point for practical application and further research. Our earlier personal experience with clinical IT investments suggests that there are many common factors which are quite independent from the actual system which is being purchased.

As such, contingency theory should be further tested on cases in which the independent variables are not aligned symmetrically, thus providing more insight into how the variables interact with one another under less than optimal conditions and creating the opportunity to scrutinize the role of individual agency more closely.

Acknowledgements

To the contributors: Dr. Petri Haapalahti and Ms. Eveliina Forsvik.

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Case: HUSLAB's digital ECG recording system investment

HUSLAB is a large publicly owned provider of laboratory services in Helsinki, Finland. HUSLAB purchased in 2008 an information system for digital ECG recording, analysis, and storage. The system was intended to replace all existing earlier generation systems, and to give, e.g., savings and paperless operation. At the time of the purchase time HUSLAB carried out some 240 000 ECG examinations a year and over 200 ECG recording devices were in use.

The purchase was performed in accordance with the Public Procurement Act § 29 (competitive dialogue), because it was not possible to determine in advance the legal and economic conditions, or exact technical specifications of the system. A short list of referenced vendors was created so that only vendors who were able to provide interfaces with existing systems were chosen. During negotiations, vendors were able to present the Hospital District with systems meeting the requirements set by the project management. One of these systems was chosen to be the new ECG system.