A Multidimensional Decision Making Model for Information Technology Investments in Universities

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Abstract—Justifying an Information Technology (IT) investment solely on the financial gain or lost has been proven to be difficult due to its intangible benefits. This study examines how non-financial measures can be incorporated to improve the decision on IT investment, particularly the Learning Management System (LMS) in universities. Design Research (DR) was adopted to develop a LMS decision making model which consists of six multidimensional perspectives which are both financial and non-financial measures. The six multidimensional perspectives were derived from the integration of two models; the IT Balanced Scorecard model and Murphy's "five pillars of benefit realization" model. The model is refined through a series of evaluation by practitioners in Malaysian universities. The final model is then translated into a decision support tool which is tested in the field. The findings show that the use of non-financial measures did improve the decision on choice of LMS. Specifically, IT managers in universities believe that the model helped them to make a well informed decision and provide support for a multi-dimensional model for evaluation of IT investment.

Index Terms—E-learning decision, Information Technology/Information System investment decision, Information Technology investments value, Learning Management System decisions in universities.

I. INTRODUCTION

The use of Learning Management Systems (LMS) has been a necessity for higher learning institutions worldwide. LMS is defined as "software designed to provide a range of administrative and pedagogic services related to formal education settings e.g. enrolment data, access to electronic data materials, faculty/student interaction, assessment, etc." defined LMS as "an information system that facilitates e-(OECD, 2005, p. 124). Klobas and McGill (2010) however learning by supporting teaching and learning activities and the administration and communication associated with them"(p. 115). Their definition however describes LMS from a managerial point of view and viewing LMS as having functions that are important in supporting and managing teaching and learning processes.

Researchers have questioned the benefits realised from IT investments in higher education (Mott & Granata, 2006; Terlizzi & Albertin, 2017) including the LMS. Some studies emphasized the importance of evaluating the LMS success to identify whether the benefits from the implementation has been realised. Mohan, Ahlemann, and Braun (2016) revealed that the difficulty in understanding the benefit realization from the system can be rooted by the fact that end-user could have been resistant to learn cutting edge technologies subject to cultural aspects and local values (Khan, Amin, & Lambrou, 2010; Macfadyen & Dawson, 2012). While many studies focus on the realisation of LMS success at the post-implementation phase, few studies examine what should be included in LMS decision-making processes prior the implementation.

Another crucial issue discussed by researchers is on how IT investment decisions are made, and their efficacy, are critical in achieving strategic business goals (Bacon, 1992). More recently, Khallaf, Omran, & Zakaria (2017) contended that IT investments are not generally correlated with financial performance measures therefore the reliance on financial measures in evaluating IT benefits realisation is insufficient and misleading.

In this study, a model was designed and then implemented as a tool to support evaluation of IT alternatives, taking into account multi-dimensional perspectives that incorporate financial and non-financial measures. The main research question that was developed to guide this study is:

> *Will non-financial measures, if included in decision making models, be able to improve LMS decision making processes?*

II. LITERATURE REVIEW

It is crucial for an organisation that desires to implement IT/IS into its organisation to understand the value from the technology implemented as well as to analyse the returns that are realised from the implementation (Murphy, 2002). Issues surrounding the effective ways to evaluate and realise the returns from an IT implementation have been discussed by researchers with the goal to establish the most appropriate method in justifying and evaluating IT value from an IT investment.

A. IT Investments Decision Making

Bacon (1992) described IT investments as "any acquisition of computer hardware, network facilities, or pre-developed software, or any "in-house" systems development project that is expected to add or to enhance an organization's information systems capabilities and produce benefits beyond the short term"(p. 355). More recently, authors have included the role of human capital and system processes in the IT investments components. This is specifically related to the IT investments in education where involvement of the users who utilise and manage the system has been considered as important in determining

the success of the systems implementation. (Schniederjans, Hamaker, & Schniederjans, 2010).

IT decision making decision is considered as a complex and multi-stage process which involves a sequence of actions that begin with the identification of IS-related problems or IS opportunities, and ends with the approval of an investment in a technology solution or IT related project (Boonstra, 2003; Xue, Liang, & Boulton, 2008). Despite the importance of IT evaluation processes in a decision making, researchers have reported that there have been issues with regard to a lack of robustness in the use of effective IT investment evaluation methods in organizations (Irani, Love, Elliman, Jones, & Themistocleous, 2005). Many authors suggested that the process of evaluation of IT investments should include the intangible benefits realized from IT investments which generally are not correlated with financial performance measures (Khallaf et al., 2017; Lingens, Winterhalter, Krieg, & Gassmann, 2016).

B. Issues in IT Investments

The problems in justifying value from IT investments made in organisation have been discussed by researchers in the 1990s. Among the critical issue raised is that there was very little convincing evidence that IT investments had generated positive financial returns and that many did not show any measurable benefit at all (Coleman & Jamieson, 1994). The problem in justifying the value from IT investments is mainly due to the lack of information (Bennett & Lemoine, 2014; Lingens et al., 2016) or also referred as the IT paradox which "describe the lack of information technology's ability to improve economic productivity" (Brynjolfsson, 1993, p. 19). There are also empirical evidences that show IT investments have no significant correlation with a firm's performance (Brynjolfsson, 1993; Weill, 1992). Some researchers suggested that the low returns and financial losses from IT investments are the result of the lack of an appropriate appraisal technique for IT investments and that organizations are unable to make effective IT investments because they fail to quantify and evaluate the intangible outcomes from those investments which are difficult to measure in

financial terms (Abdel-Kader & Dugdale, 2001; Irani & Love, 2001). In addition to this, Lin and Shao (2006) suggested that the business value of IT as measured by technical efficiency tends to decline as IT investments increase.

C.   The use of Non-Financial Criteria in IT Investment Evaluation

Researchers have been calling for a more sophisticated approach which can capture non-financial measures in IT investments evaluation (Lefley & Sarkis, 1997; Sarkis & Sundarraj, 2000). Some of the enhanced approaches include measures such as benefits of quality, organizational learning, training and process improvement and innovation (Abdel-Kader & Dugdale, 2001; Ivantysynova, Klafft, Ziekow, Günther, & Kara, 2009). Nonetheless, only few studies have discussed adoption of multi-dimensional model in real decision making processes. Some examples of such methods namely the Value Analysis Method (Strassmann, Berger, Swanson, Kriebel, & Kauffman, 1988), the CSF (Crescenzi & Reck, 1985) and Benefit Management Approach (Ward & Daniel, 2006) and the Balanced scorecards (BSC), which is perhaps the most well-known investment evaluation approach using non-financial measures (Kaplan & Norton, 1993; Kaplan & Norton, 2007). Another approach used by renown practitioners is the "Five pillars of benefit realization" developed by Murphy (2002) with the objective to assess the indirect and external factors that impact IT initiatives.

III. THEORETICAL FRAMEWORK

In this study, the BSC and Murphy's "Five pillars of benefit realization" framework are used to develop a comprehensive tool that considers multi-dimensional approaches to improve the IT decision making processes in universities, LMS in particular.

A.   ITBSC

ITBSC (Van Grembergen, 2000; Van Grembergen, Saull, & Haes, 2003) is an extension of the BSC that considered the use of BSC in the IS performance evaluation. The four perspectives in

ITBSC are financial perspective, business process perspective, user perspective and learning and growth perspective. In the ITBSC framework, Van Grembergen (2000) proposed that the "user orientation" is more appropriate for the IS environment rather than "customer perspective" in the BSC. While ITBSC comprehensively serves as a comprehensive multi-dimensional perspectives performance measures approach, the approach is seem to be lacking certain non-financial measures, particularly in terms of the IT technical infrastructure aspects and risk factors in IT investments.

B.   Murphy's "Five Pillars of Benefit Realization"

Murphy (2002) developed the "Five pillars of benefit realization", a framework that defines the relationship between the business context and IT investment management. In this framework, five important areas that impact the IT investments benefit realisation are specified, including the impact on the compatibility of IT infrastructure, and the risks and uncertainty factors related to IT investments. The five pillars of benefit realization areas are direct payback, strategic alignment, business process impact, IT infrastructure and risks.

C.   Framework of the LMS Decision Making Model

In this study, ITBSC and Murphy's "Five pillars of benefit realization" were integrated to develop the LMS decision making model. The mapping of both frameworks to the LMS decision making model is depicted in Figure 1.
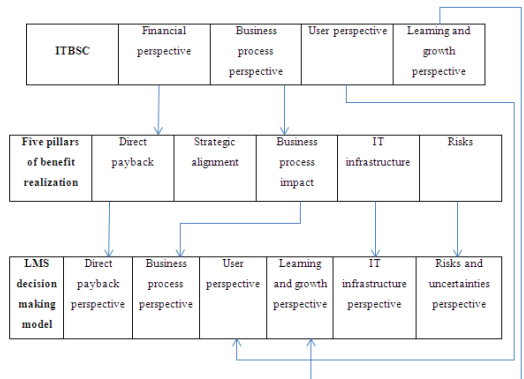

Fig. 1. Mapping of ITBSC and Murphy's "Five pillars of benefit realization" frameworks

- *Direct Payback perspective* includes the elements that contribute towards the direct financial benefits derived from an investment, as well as other benefits in terms of performance measures of the quality of teaching and learning.
- *Impact on a University's Processes perspective* considers the factors that contribute to better processes in administration of teaching and learning activities.
- *Users perspective* considers the impact of LMS adoption on the user which consists of students, academic staff and administration staff.
- *Learning and Growth perspective* considers how the sustainability and growth of the system can be maintained.
- *IT Infrastructure perspective* considers how effective is the management of IT infrastructure in the effort to realise value from the LMS implementation.
- *Risks and Uncertainties perspective* considers the estimation of risks and uncertainties from the LMS implementation especially in the effort to reduce the possibility of failures and disappointment in the LMS implementation.

IV. METHODOLOGY

This study adopted the Design Research (DR) approach which according to Collins, Joseph, and Bielaczyc (2004), involves "putting a first version of design into the world and seeing how it works, then the design is constantly revised until all the bugs are worked out" (p. 18). A strong motive of the DR approach is to improve the relevance of research (Van Den Akker, Gravemeijer, McKenney, & Nieveen, 2006). The present study is designed based on the DR research model developed by Vaishnavi and Kuechler (2004).

The study is designed with four phases. The first phase aims to obtain better understanding about theories and practices of LMS decision making in universities as well as exploring the feasibility of integrating non-financial measures into the process. Five IT managers from two universities were interviewed and data were analyzed inductively. The theme that emerges from the interview was then mapped into the initial LMS decision making model. The mapping process involves modification of the initial model to incorporate themes that did not match the six perspectives proposed.

The second phase aims to identify the criteria and indicators used in LMS decision making and consequently develop a conceptual design of the LMS decision making model. For this stage, 15 LMS decision makers from 11 universities in Malaysia were interviewed. The participants were selected based on 5 criteriaS which are i) level of LMS adoption, ii) location (i.e. rural or urban), iii) Multimedia Super Corridor (MSC) status, iv) year established, and v) type of university (i.e. public or private). As with the first phase, the data was analyzed inductively and the LMS decision making model are modified accordingly to come out with a conceptual design.

The third phase of the study is used to evaluate the criteria and indicators in the conceptual design of the model for their importance of feasibility in order to come out with a detailed design of the LMS decision making model. Six LMS decision makers from phase 1 answered a questionnaire that requires them to evaluate the model based on the importance (0 to 10) and feasibility (0 to 10) of each indicator. They were also asked to suggest any new criteria not listed in the model. Subsequently, an interview was conducted with the participants to gain deeper insight on their feedbacks. The quantitative data was dichotomized into two groups based on their score for importance and feasibility. Dichotomization was achieved by ranking each set of items based on their mean score and fixing the separation points where the largest drop in the mean occurred. The separation points were 7 for importance and 6 for feasibility. Only indicators which are considered important (i.e. scored ≥ 7 by at least 50% of participants) and feasible (i.e. scored ≥ 6 by at least 50% of participants) were retain in the model.

The final stage of the study tests on the detailed design and finalized the LMS decision

making model. Ten LMS decision makers from ten Malaysian universities evaluate the model using questionnaire consists of three sections. The first sections detailed out a scenario that simulate the LMS decision making situation in which the decision makers are required to choose between two alternatives. In the second section, the decision makers are required to use the LMS decision making tools to score the two alternatives based on the criteria identified in the model. In the third section, the decision makers answer a series of close and open-ended questions about their perception of the model. The data for this phase are analyzed using descriptive statistics and thematic analysis.

V. FINDINGS AND DISCUSSION

The LMS decision making model in this study is developed through a series of evaluation and validation process. The novelty of the model is in the inclusion of non-financial measures which resulted in a comprehensive tool that improves the decision on LMS investment in universities. Almost all participants agree that the model and tool developed in this study helped them to make an informed decision on which LMS to adopt. The final LMS decision making model was developed from this study which consists of six major perspectives.

A. Direct Payback

The direct payback perspective in the LMS decision making model corresponds to the returns on the investment in the form of monetary value. The majority of participants agreed that one of the most important features of a LMS is the re-usability of the content across multiple courses. Availability of the feature will allow lecturers to store and use teaching materials over and over again as well as shared them with their colleagues who teach the same course which contribute to time and costs saving on copying or reproducing content. The findings are in line with previous studies. Although the time saved from re-using the content in the LMS fits better as a non-monetary benefit, Collis and Strijker (2002) asserted that it can easily be converted to monetary gain. Another

concern is related to the costs associated with the LMS licensing. This is the main reason for the growing interest on the open source LMSs (Lakhan & Jhunjhunwala, 2008) which allow universities to reduce the cost to obtain the system while enjoying the available features and support.

The finding indicates that Malaysian universities still operate within financial constraints in their decision to invest in a particular system. The majority of universities involved in this study have adopted the open-source LMS as a way to reduce the costs associated with the system. In addition, the IT managers involved in this study mentioned that the decision on the choice of LMS was also made based on the features of the LMS and the strategy outlined by the university, as well as the Ministry of Higher Education (MOHE). In short, the present study confirmed that the decision on which LMS to invest also incorporate non-financial measures as proposed by researchers such as Ivantysynova, et al.(2009) and Mott and Granata (2006).

B. Impact on University's Process

Adoption of LMS have significant impacts on the university's process. These include the ability of academic staff to meet students' expectations (Lawrence & Sharma, 2002) and allowing students to take a more active role in the learning process (Coates, 2006). It also contributed to the students' completion time, graduation rate (Mott & Granata, 2006) as well as improve administrative process (Reigeluth et al., 2008).

Participants in this study mentioned that their decision to invest and choice of LMS is mainly affected by the ability of the system to improve the academic and administrative process. One of the most important considerations was the ability to integrate the LMS with the existing systems in the university in order to reduce data redundancies as well as reduce errors or inconsistencies of data in different information systems. This finding is parallel with Levy (2000) and Lenzerini (2002).

Additionally, the availability of tools that automate the teaching and learning as well

as administrative tasks was also considered as critical in the choice of LMS. These include features that allow evaluation of students' work as well as monitoring students attendance to class to be carried out automatically. According to Leidner and Jarvenpaa (1995), such automation technologies contribute to operational savings apart from allowing structured, routine and operational task to be carried out more efficiently.

Finally, flexibility in teaching and learning which include the ability to record a lecture, upload different types of teaching materials, conduct on-line quizzes as well as on-line discussions is also another important consideration. These technologies have been suggested to have a positive pedagogical impacts especially in enhancing the students' learning process (Mott, 2010; Ullrich et al., 2008), encouraging innovation and cater to the different needs of both lecturers and students (Lewis, MacEntee, & Youngs-Maher, 2002; Lonn & Teasley, 2009).

C. Human Capital

The human capital perspective of the LMS decision making model is concern on how the use of a particular LMS add value to all parties involved. For the academic staffs, the skills and knowledge demanded to fully utilize the potential of a particular LMS is the key criteria in determining their choice. Hence, the amount of training needed and level of support provided for lecturers to become accustomed to the LMS was considered as the precursor to the choice of LMS. This is consistent with Shannon and Doube (2003) who argued that the effectiveness of an online course delivery will be determined by the level of lecturers' knowledge and skills of the technology.

In addition, knowledge and skills of technical staff is another important consideration. This is crucial since this group is responsible for providing support for the users and involved in future enhancement and maintenance of the system. This finding amplified previous studies which found that staffs' IT skills play a key role in determining the successful adoption of a system (Keyes, 2005; Wainwright, Osterman, Finnerman, & Hill, 2007).

From the students' perspective, the benefits include better participation and engagement with the course, enhanced academic integrity through the use of anti-plagiarism tool integrated with the system. The availability for tools to allow students to communicate and collaborate more effectively with the lecturers and their fellow classmates such as real time chat or online forum is also another desirable feature. This finding support Venter, Jansen van Rensburg and Davis (2012).

D. IT Infrastructure

The most prominent perspective in the LMS decision making model with the highest number of criteria is IT infrastructure. The main concerns revolves around content sharing and migration. The main issue raised by the participants is whether the learning contents in their current LMS are reusable in the new LMS with the emerging technologies. In line with the finding from Chu et al. (2004), participants in this study contended that it is mandatory for a LMS to comply with the standards such as Sharable Content Object Reference Model (SCORM) to ensure interoperability, accessibility and reusability of the content across different platforms. Other important criteria include the level of security, customizability, durability and support offered by the LMS as well as the user-friendliness, learnability, testability, inter-operability with third party software and the storage and bandwidth requirements of the new system.

E. Risks and Uncertainties

In this study, the major risks raised by the participants are mainly associated with underutilization of the system. According to Embi (2011), the main challenges in adoption of LMS are related to resistance and lack of drivers to change. The advanced functionalities offered by the LMS also introduce the risk of being misused for non-academic purpose by the users. A number of participants suggested the use of monitoring software and other security mechanisms to control and ensure that the LMS is being use accordingly.

Another problem related to the risks and uncertainties of LMS adoption is related to updating and upgrading the system. This is

mainly the concern of universities which plan on using the open-source system and customize it based on their needs using third party software. Wainwright et al., (2007) asserted that LMS which are highly customize with the third party software are open to risks of losing functionalities due to the additional tools not being supported when the core code were upgraded.

F.   Strategic Alignment Perspective

In Malaysian universities, the Ministry of Higher Education (MOHE) plays a significant role in LMS adoption. Thus, strategies adopted by the universities usually follow the strategies set by the ministry. A committee known as Majlis e-Pembelajaran IPTA Malaysia (MEIPTA) was established with the objective to administer and spread knowledge and best practices regarding the LMS implementation among Malaysian universities. Additionally, the MOHE also require any LMS implementation in universities to comply with the item regarding e-learning and lifelong learning set by the ministry to lift the standard of Malaysian education on the international level. In short, the adoption of LMS among the Malaysian universities is directed towards transforming the education system into a world class standard. Since this finding is highly contextual, it is expected that different criteria may appear for different countries.

VI. CONCLUSION

This study presents a comprehensive model and a tool to evaluate LMS for adoption. Compare to the traditional evaluation models that focuses on financial measures, the findings shows that the non-financial measures incorporated in the model did improve the decision on LMS selection. The decision makers who took part in the study believed that the tools developed from the model did help them to make a well-informed decision as well as justify the investment.

Overall, the study contributes to the literature in IT decision making particularly on the value of non-financial measures. In addition, the findings also add support to the use of multi-dimensional perspective of IT evaluation model. From the practitioners' perspective, the study also provides a better insight on IT decision making process in universities. Since the study is mainly conducted in Malaysian universities, further study should be conducted to test the model in different setting as well as other forms of IT investments in universities.

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