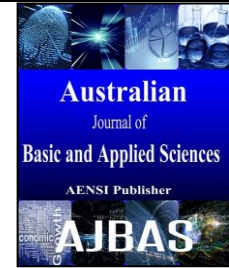




ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com



Measuring Framework for Information System Evaluation

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ARTICLE INFO

Article history:

Received 12 March 2015

Accepted 28 April 2015

Available online 6 June 2015

Keywords:

Information system, criteria, performance, SME, Malaysia.

ABSTRACT

Background: Information Systems (ISs) have been developed to assist human to create, store, share and utilise information across businesses for quick and accurate data and information for wise decision making. However, from a big pool of existing ISs, selecting the best IS as business solution for an organisation is based on personal judgments that are usually from very subjective personal feeling. Clear criteria for measuring IS performance is hence critically importance especially for some low budget organisations such as small and medium enterprises (SMEs). **Objective:** This study aims to propose a new measuring model to evaluate information system (IS) performance. Different types of IS were empirically tested using the developed six domains as criteria of measurement. **Results:** Six domains such as “System Quality”, “Information Quality”, “Service Quality”, “System Use”, “User Satisfaction” and “Net Benefits” were confirmed to be the measurement criteria. Six ISs such as “Executive Support System” (ESS), “Management Information System” (MIS), “Decision Support System” (DSS), “Knowledge Work System” (KWS), “Office System” (OS) and “Transaction Processing System” (TPS) were adopted as the six types of ISs for SMEs. **Conclusion:** This study proposes a research model that is important for SME to improve IS performance. Apart from contributing to the literature of IS, this study would assist in developing appropriate criteria to adopt IS for domestic companies. This research is one of the limited studies in Asia and Malaysia that examines how to evaluate IS to improve organisational performance in Malaysian SMEs.

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To Cite This Article: Lew Sook Ling, Measuring Framework for IS Evaluation. *Aust. J. Basic & Appl. Sci.*, 9(22): 56-62, 2015

INTRODUCTION

Dynamic business operations, strategies and policies require quick and accurate data and information for wise decision making. The importance of this organisational information highlights the needs for a better understanding of data and information management. However, data and information management is sometimes complex due to its huge size that beyond human's data management capability. Therefore, Information Systems (ISs) have been developed to assist human to create, store, share and utilise information across businesses. However, selecting the best IS as business solution for an organisation is critically important; arising from the selection from a big pool of existing ISs particularly for some low budget organisations such as small and medium enterprises (SMEs). The IS selection will be based on personal judgments that are usually from very subjective personal feeling. This personal feeling is from how the person uses the IS to process his/her tasks and does not represent the actual quality of IS system.

A key objective of this research, therefore, is to identify a set of unified measurement criteria from a pool of techniques to access the performance of IS systematically. For example, an IS performance was assessed based on the identified set of measurement criteria before an IS is adopted for organisation. A measurement framework that comprises the identified techniques and criteria of measurement was tested as a tool to measure IS performance systematically. This measurement framework can provide the level of performance result of an IS to users based on different measurement criteria.

The research outputs of this study can provide a framework of measuring an IS for organisations to improve decision making, product and service delivery. The findings from this study will serve as a frame of reference for future research in measuring IS performance domains and capitalising on information and knowledge for improving organisational performance.

2.0 Literature Review:

2.1 Information System Frameworks:

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There are different frameworks to evaluate and classify Information System (IS) based on classifying and compare IS planning and methodologies (Kandjani *et al.*, 2014). Past researches (Shannon and Weaver, 1949; Mason, 1978) classified IS into three categories; (1) Technical level presents the accuracy and efficiency of IS while using them to transport information, (2) Semantic level presents if the IS had successfully conveyed the information into intended meaning and (3) Effectiveness level presents if the receiver had successfully received the information. These three categories were further expanded by DeLone and McLean (2003) as DeLone and McLean Success Model (DMSM). DMSM was focused on several measurement dimensions; (1) system quality used to measure technical success, (2) information quality used to measure semantic success and (3) other dimensions were used to measure effectiveness success. Many past studies have used DMSM to investigate the influences of IS qualities and satisfaction with IS (Chen and Cheng, 2009; Meng-Hsiang *et al.*, 2014; Teo *et al.*, 2009). IS qualities and user's satisfaction with IS have positive effects on future purchase intention (Meng-Hsiang *et al.*, 2014).

Palmius (2007) continued and restructured the concept of DMSM into a more measureable model. He has developed a set of domains to be measured using weight. A set of calculation methods for marking approach has also been developed for assessing the quality of IS performance (Akoka and Wattiau, 2010).

Diverse types of IS due to its increasing demand for different purposes. These various frameworks and standards were proposed to measure the quality of these different types of IS. One unified framework and standard which is suitable to measure the quality of a common IS which enable a floating set of variable conditions is proposed in this research from a number of measurement principles.

Numerous Information system (IS) studies were carried out on different research dimensions. The coverage of IS is normally huge as defined in previous scholars (Laudon, K. and Laudon, J., 2006; Nowduri and Al-Dossary, 2012; O'Brien and Marakas, 2007; Patterson, 2005). Relevant IS definitions to the present study are defined as follows:

"An IS can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making, coordination and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products" by Laudon, K. and Laudon, J., 2006

"IS can be any organised combination of people, hardware, software, communications networks, data resources, and policies and procedures that stores, retrieves, transforms and disseminates information in an organization" by O'Brien and Marakas, 2007

In this era, IS is required by all businesses especially small and medium enterprise (SME) to keep track of all levels of business processes, not limited to operations, but also from planning, product manufacturing, quality and delivery activities (Nowduri and Al-Dossary, 2012).

2.2 Information System Domains:

Previous researches proposed the nature of information system (IS) into three levels; technical, semantic and effectiveness (Mason, 1978; Shannon and Weaver, 1949). These three IS levels presents user perception based on system features. For instance, technical level presents the accuracy and efficiency of IS when using the IS to transport information; semantic level presents if the IS can successfully convey the information into intended meaning and effectiveness level presents if the receiver had successfully received the information.

In 90's, DeLone and McLean information system success model (DMSM) (DeLone and McLean, 1992) has become a prominent measurement framework for IS. DMSM has provided a clear guidance to future researchers in measuring IS in this era. It categorised nature of IS into multiple measurable dimensions: systems quality, information quality, use, user satisfaction, individual impact, and organisational impact. However, these six dimensions are not independent measures but interdependent measures as shown in Figure 2.1.

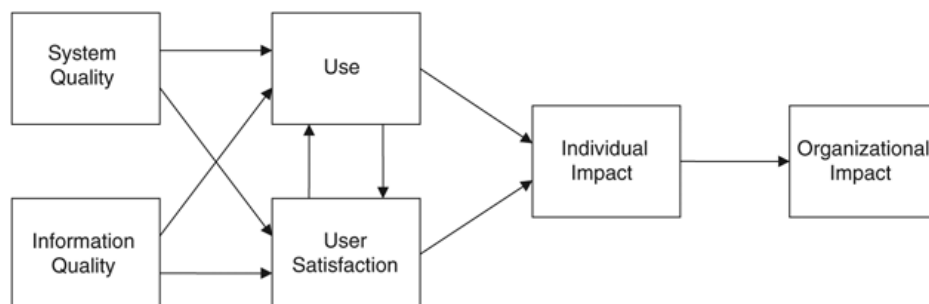


Fig. 2.1: DeLone and McLean IS Success Model (1992)

Since 1992, modifications were done to enhance the DMSM (Myres *et al.*, 1997; Pitt *et al.*, 1995; Seddon *et al.*, 1999). Service quality was included as additional measure dimension on top of system quality and information quality (Pitt *et al.*, 1995). Individual and organisational impacts were removed after receiving criticism that an IS can affect levels but not individual and organisational levels instead. The success of IS impacts are not limited to

individual and organisational but workgroups, industries, societies and more. A final enhanced model was completed as Updated DeLone and McLean IS Success Model (2003) as shown in Figure 2.2. In this updated DMSM, use dimension was further explained as “use” must precede “user satisfaction” in a “process” sense, but positive experience with “use” will lead to greater “user satisfaction” in a “causal sense”.

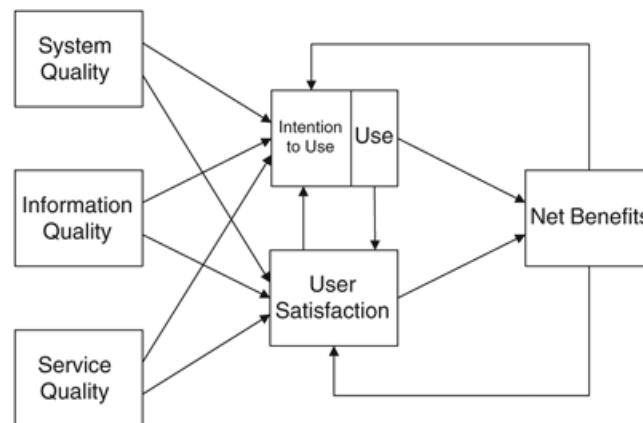


Fig. 2.2: Updated DeLone and McLean IS Success Model (2003)

3.0 Research Method:

This section presents the methodology. Figure 3.1 shows the entire stages of the methodology.

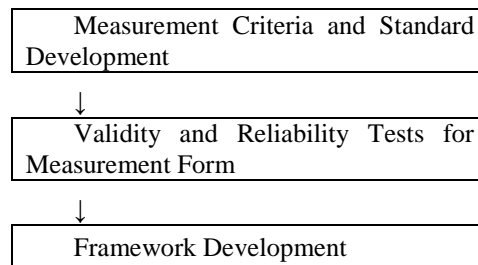


Fig. 3.1 Stages of Methodology

Measurement Criteria and Standard Development:

Literatures related to quality of information system performance were carried out using Systematic literature review (SLR) approach (Kitchenham and Charters, 2007; Sook-Ling *et al.*, 2015). A set of measurement criteria and standard were identified based on data extraction and data synthesis from the extensive review of literature (Wen, *et al.*, 2011). A measurement form was designed for the measurement criteria and standard.

Validity and Reliability Tests for Measurement Form:

The main goal of this stage is to confirm the validity and reliability of the survey instruments developed in the standard and criteria. The measurement form was distributed to five industrial and five academic experts respectively to pilot test

the survey instrument. The measurement form was then revised based on the advices and comments from pilot testing and experts' reviews respectively in this stage.

Framework Development:

Eight face-to-face interviews were conducted with five SME managers on the week of 23rd-29th March 2015. The collected data was analysed using descriptive statistical analysis. A set of measurement criteria and standard were confirmed. Based on the results, a new measuring information system framework was proposed in compliance with the current industrial needs in Malaysia.

4.0 Findings And Discussion:

4.1 Types of Information System:

In this study, six major types of IS are adopted (Laudon, K. and Laudon, J., 2006) as presented in Table 4.1.

Table 4.1: Types of Information Systems for the Present Study

Types of IS	Description
Executive Support System (ESS)	EIS is the top level information system, it used by top managers to design a long term plan of the organisation. The information of ESS is generated from internal sources like data in MIS/DSS and integrated with external sources like internet news feeds. Thus, it requires high level quality of information, stability information system, and faster transmission speed of data within organisation.
Management Information System (MIS)	An MIS is a decision level information system; it helps managers with reports that generated through accumulation of transaction processing data. MIS always provides information in report or statistic format. The users of MIS usually is middle level manager Its information quality should be high and the transmission speed of data used to generate the reports should be easy to obtain in short time.
Decision Support System (DSS)	DSS support professionals and staffs to analysis a nonspecific and unstructured condition. Professionals may use DSS to search by the characteristic of the data and rearrange them to solve or analysis the unstructured conditions and provide a clearer direction to top management level. DSS require higher quality of information, well data transmission within organisation and ease to use information system.
Knowledge Work System (KWS)	KWS and OS serve the information needs at the knowledge level of the organisation. KMS aids knowledge workers, whereas OS primarily aids data workers (although they are also used extensively by knowledge workers).
Office Systems (OS)	
Transaction Processing System (TPS)	TPS is a basic business system that serves the operational level. It is a computerised system that performs and records the daily routine transactions necessary to the conduct of the business. For example: a payroll system. Measurement on TPS is more reply on Individual, and information domain, because most of the input of TPS is manual key and the information must be accurate and reliable.

4.2 Measurement Standard and Criteria:

Petter *et al.* (2008) has scrutinised prior research related to IS success. In this study, measures of IS success were summarised, empirically tested and

applied in both individual and organisational contexts. Three more dimensions were included to make up to six main dimensions as criteria for measuring IS performance; as presented in Table 4.2.

Table 4.2: Criteria for Measuring Information System Performance for the Present Study

Criteria	Description
System Quality	The desirable characteristics of an information system. For example: ease of use, system flexibility, system reliability, and ease of learning, as well as system features of intuitiveness, sophistication, flexibility and response times.
Information Quality	The desirable characteristics of the system outputs; that is, management reports and Web pages. For example: relevance, understandability, accuracy, conciseness, completeness, understandability, currency, timeliness and usability.
Service Quality	The quality of the support that system users receive from the IS department and IT support personnel. For example: responsiveness, accuracy, reliability, technical competence and empathy of the personnel staff.
System Use	The degree and manner in which staff and customers utilise the capabilities of an information system. For example: amount of use, frequency of use, nature of use, appropriateness of use, extent of use and purpose of use.
User Satisfaction	Users' level of satisfaction with reports, Web sites, and support services.
Net Benefits	The extent to which IS are contributing to the success of individuals, groups, organisations, industries, and nations. For example: improved decision-making, improved productivity, increased sales, cost reductions, improved profits, market efficiency, consumer welfare, creation of jobs and economic development.

4.3 Assessment Criteria:

Palmius, J. (2007) continued and restructured the concept of DMSM into a more measureable model. It discarded the causality relationship which indicated in DMSM. He introduced "Weight" to quantify the index and present the impact for all domains. The domains are distinct and free to be defined based on organisational policies or objectives. For instance, the weight of organisation domain is scaled higher than other domains for some organisations that are focused on organisational benefits.

Sub-domains were derived from the domains for better measuring through weight index. Each domain requires deep investigation to overcome domain and relationship issues.

4.4 Marking Approach:

In this paper, index weight will be computed using domain base approach (Akoka and Wattiau, 2010). A hierarchy tree is built to compute the final score of an IS (Figure 4.1).

Root represents largest domains inside the hierarchy tree; D is a non-terminated node represented Domain under the Root; SD is Sub-Domain under the Domain; T is those Tests/Criteria which are actionable or explicit defined to measure the grade of the Domain/Sub-Domain; W is Weight represented the important of the Test; G is Grade represented score of the Test. All the grades are using a quantitative scale. At any level of tree, the sum of the weight of any node's children should be equal to one.

An example of the marking approach is described based on Figure 4.1. Two domains are

under one “Root”, namely “D1” and “D2”. “D2” has a sub-domain, namely “SD2.1”, and another branch which does not have any sub-domain, but has direct link to the test, namely “T2.2”.

Subscripted numeric number represents the level of the alphabet and its relationship with its upper level and lower level. For example, “1” and “2”

represent domain level, “2.1” and “2.2” are one level lower than domain level “2” and they are smaller category of “2” but both of them are bounded by scope of “2”; “2.1.1” to “2.1.3” are branches of “2.1” and also bounded by the scope of “2.1”, and so on. In summary, “the more levels of the number has, the more branches the root has”.

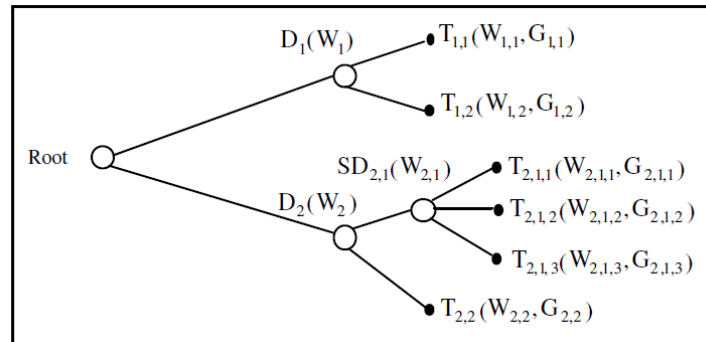


Fig. 4.1: The Hierarchical Tree (2003)

4.5 Proposed Framework:

In this paper, a measuring framework for SME’s IS is proposed. The end-users will have their options and preference in measuring an IS for SME. This free choice is in line with Palmius, J. (2007)’s principle – “the domains are distinct and free to be defined based on organisational policies or objectives”.

The description for each stage of the proposed framework is as follows:

Stage 1 – “Select” is used as the end-user has the option to choose one of the most appropriate IS category/type for the testing IS. For instance, users can select anyone type of “Executive Support System” (ESS), “Management Information System” (MIS), “Decision Support System” (DSS), “Knowledge Work System” (KWS), “Office System” (OS) and “Transaction Processing System” (TPS).

Stage 2 – Each IS will have a distinct set of weightage indices for all the six domains: “System Quality”, “Information Quality”, “Service Quality”, “System Use”, “User Satisfaction” and “Net Benefits”. The weight for all domains of each IS is distinct between IS types.

Stage 3 – Scores will be summed up to obtain the final score for all the interested information systems as described below:

D1 to D6 represents “System Quality”, “Information Quality”, “Service Quality”, “System Use”, “User Satisfaction” and “Net Benefits”. If under D1 have three sub-domains: “D1.1” - performance, “D1.2” - control and “D1.3” - economy, and four questions to measure the standard of performance (T1.1.1 – T1.1.4). Sum of the weight of same level nodes must equal to 1, and average distribute to every nodes. For example, D1 to D6 are same level nodes, weight of them must be 1 divided by 6 (0.1667).

Therefore, formula to calculate Score of D1.1 is derived as follows:

$$D1.1 = (W1.1.1 * G1.1.1) + (W1.1.2 * G1.1.2) + (W1.1.3 * G1.1.3) + (W1.1.4 * G1.1.4)$$

For example, D1.1 is Performance of IS, T1.1.1 to T1.1.4 are questions to measure performance. Therefore the weight of each of the questions will be 0.25, because there are four questions in the same level. The grade of those questions is based on the answer of users and the highest score of every question is 5; the lowest score is 1. Assume user score 3,4,3,4 in those questions.

Then the Score of Performance is $(0.25 * 3) + (0.25 * 4) + (0.25 * 3) + (0.25 * 4) = 3.5 / 5.0$, and the Weight of Performance is based on how many same level nodes of its parent nodes have.

Stage 4 – End-user can decide the best IS based on the obtained scores.

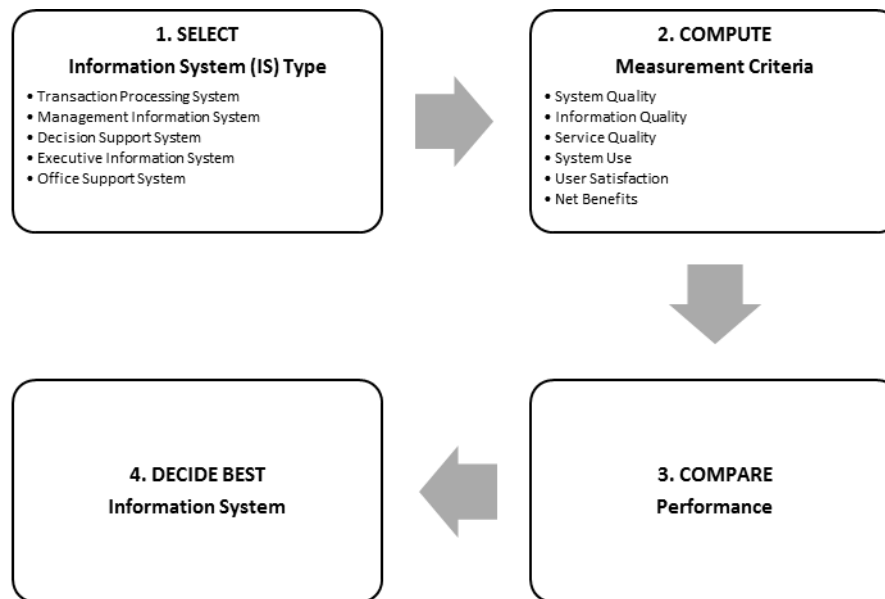


Fig. 4.2 Proposed Framework

Conclusion:

By blending the prominent IS measurement criteria and standards, a more holistic IS measurement criteria is proposed. In this paper, the IS measurement is fitted and empirically tested to/with Malaysian SMEs. The most favorable criteria and standards were obtained from exposure to real-world testing of SME managers.

Further works will have to propose weight indices for all the domains and determine relationships such as criteria interdependencies among criteria from exposure to real-world testing of SME managers.

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