8-2010

A structural model of information system quality: an empirical research

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ABSTRACT

Assessing the quality of a delivered system has been one of the major challenges for researchers as well as for the practitioners (organizations). There is the need of a multidimensional instrument capable of measuring the quality of an information system, that instrument would provide valid information that helps an organization to take decisions in order to improve and assure the quality of its information systems. On the other hand, the majority of IS researchers are still not sufficient validating their instruments and there is the need of empirical findings.

This research-in-progress paper proposes a model to measure the quality of an information system and uses the statistical approach Partial Least Squares (PLS) for its validation.

Keywords (Required)

Information System, quality, success, measures, Structural Equation Modeling, Partial Least Squares.

INTRODUCTION

It is well-known the importance of the IS in the organizations since the success of an organization depends on the quality of its information systems. Consequently, an organization spends amounts of time, resources and money on Information Technology (IT). In 2009, despite the global crisis, a Gartner study estimated that the total annual worldwide expenditure on IT is to grow at about 2,3% in 2010 (Van Hoy et al. 2009).

Therefore, assessing the quality of the delivered system becomes a very crucial strategic objective for the organizations. However, few organizations implemented quality principles. Surveys of IS managers found that a minority of IS managers (41%) understood the basic principles of Total Quality Management (TQM), and thought they would be useful to the IS function. Even in the cases where TQM principles were understood, they often were not implemented in the IS function (Stylianou and Kumar 2000).

Moreover few quality models exist to help organizations to evaluate and assure the quality of their IS. Furthermore, these models are not completed and neither empirically nor formally validated (Boudreau et al. 2004).

The main objective of the present research is to put forth a theoretical model that measures information system quality. This model must be robust and flexible enough to accommodate variability, change and refinement. The importance of the present research stems from the fact that very few IS quality models are available and even they exist, they are not completed and neither empirically validated.

This paper is structured as follows. First we provide the background of this study. This is followed by the proposal research model and the corresponding hypotheses based on the model. Thereafter, we present the research methodology to validating our conceptual model. And finally the conclusions and further research are given.

THEORETICAL BACKGROUND

Before presenting the different IS quality models it is central to answer the so often asked question: "what is IS quality?" in order to understand better the different quality models available on the market.

In general, quality is a complex concept, for which no universal definition exists. Quality means different things to different people, thus it is highly subjective and context dependant. However, there are many definitions of quality in circulation. Crosby (1979), one of the quality management gurus, defines quality as "conformance to requirements"; the International Standards Organisation (ISO) (1986) defines quality as: "*the totality of features and characteristics of a product, process or*

*service that bear on its ability to satisfy specified or implied needs"; a*nd the IEEE (1998) defines quality as "*the degree to which a system, component, or process meets specified requirements and customer or user needs or expectations"*.

In IS context, the concept of "quality" has not been well defined (Ding and Straub 2008) but there is an agreement that it is a multidimensional concept and it has to be studied from many different perspectives. Garvin (1984) suggests five perspectives: (1) transcendental perspective: quality is recognisable but not definable; (2) user perspective: quality means fitness-for-purpose; (3) manufacturing perspective: quality means conformance to specification; (4) product perspective: quality is tied to inherent characteristics of product and (5) value-based perspective: quality is dependent on how much customer is willing to pay.

One of the most researched and practiced topics during last two decades in IS literature is IS success (Seddon et al. 1999). It is not the case of IS quality. Although quality has been one of the main goals of software engineering in the last decades, its importance in the context of IS has recently been recognized by the IS community.

Therefore few quality models are available and even they exist, they are not completed and neither empirically nor formally validated. Most of them used the DeLone and McLean (D&M) IS Success model as a starting point.

Along the rest of this section, D&M IS Success model and IS quality models available are described. It is worth to note that we do not describe those models which have focused on a single dimension of quality, we only address those which have reflected the big picture.

The DeLone-McLean Model for IS Success

DeLone and McLean (1992) reviewed the large number of studies on IS success and created a taxonomy of IS success. They identify six categories for categorizing the different measures of IS success: system quality, information quality, use, user satisfaction, individual impact and organizational impact. The model is a mixed process and causal model and it assumes that system quality and information quality, both individually and jointly, affect user satisfaction and use. Additionally, the model suggests user satisfaction and use to be reciprocally interdependent, and presumes them to be direct antecedents of individual impact. Ten years later, DeLone and McLean (2002) reviewed more than 100 papers dealing with some aspect of IS success. As a result, they updated their original model based on suggestions and re-specifications (Figure 1).

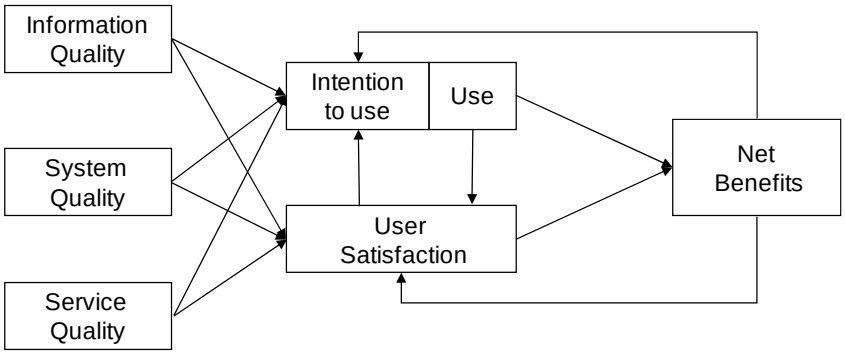

Figure 1: Updated D&M IS success model (Source: DeLone and McLean, 2002)

The primary differences between the original and the updated model are: (1) the addition of "service quality" to reflect the importance of service and support in successful e-commerce systems; (2) the addition of "intention to use" to measure user attitude as an alternative measure of "use"; and (3) the collapsing of "individual impact" and "organizational impact" into a more parsimonious "net benefits" construct.

Through a review of empirical studies that test the initial D&M IS success model, Sedera et al. (2004) reflects that few studies have considered all six dimensions of success. That result was corroborated by (DeLone et al. 2008). They reviewed papers dealing with some aspect of IS success since the updated D&M model was published and they said that researchers and practitioners still tend to focus on single dimensions of IS success and therefore do not get a clear picture of the impacts of their systems and methods.

Concerning validation, there is no exist any empirical study that test all the six dimensions of the updated D&M model DeLone et al. 2008; Urbach et al. 2008).

IS quality models

As we mentioned before, few models exist that measure IS quality as a complex multifaceted concept. Table 1 shows a summary of the existing models. They are listed in chronological order. For each model, we indicated its dimensions (in bold the different ones from D&M model), if it is a measurement model and if it is validated.

IS quality model	Dimensions	Metrics	Validation
MODEL1 Stylianou & Kumar (2000)	• **Infrastructure** • Software • Data • Information • **Administrative** • Service	NO	NO
MODEL 2 Kanungo & Bhatnagar (2002)	• (IS quality) -> MODEL 1 • **People factors** • **Process factors** • **IS/IT factors** • **Management & Culture factors**	NO	YES Influence of the factors on the IS quality using descriptive statistics and interpretive structural modeling
MODEL 3 Duggan & Reichgelt (2006)	• **People** • **Process** • Product • **Practices** • **Perceptions** • Success	NO	NO
MODEL 4 Wilkin (2007)	**(D&M model based):** • System • Information • Service	YES	YES The most important measures for each dimension using basic statistics + Model reliability using coefficient alpha and cronbach's alpha.
MODEL 5 Chutimaskul et al. (2008)	**(D&M model based):** • Process (system) • Service • Information	YES	YES The most important measures for each dimension using basic statistics
	• **Environment** • **Stakeholders & Policy** • **Information and Communication Technology** • **Development Methodology**	YES	NO

Table 1. IS quality models

We can observe that only 3 of the presented models are validated (model 2, 4 and 5) and only two (model 4 and 5) of these are measurement models. If we have a look at these two models, we can note that both of them considered the system, information and service quality dimensions and for each of these dimensions they proposed a range set of metrics; next using basics statistics they tested what metrics are more important than others.

On the other hand, models 2 and 3 evidence the importance of other dimensions like people, process and organization. It is worth to note that Chutimaskul et al. (2008) also proposed as a future work extending its model with dimensions related with people, process and organization.

In conclusion, there do not exist any global IS measurement quality model that is validated formally and empirically.

RESEARCH MODEL AND HYPOTHESES

Based on the review of the aforementioned IS quality models, and taking the D&M model as a foundation, we proposed the IS quality model in Figure 2 as our research model.

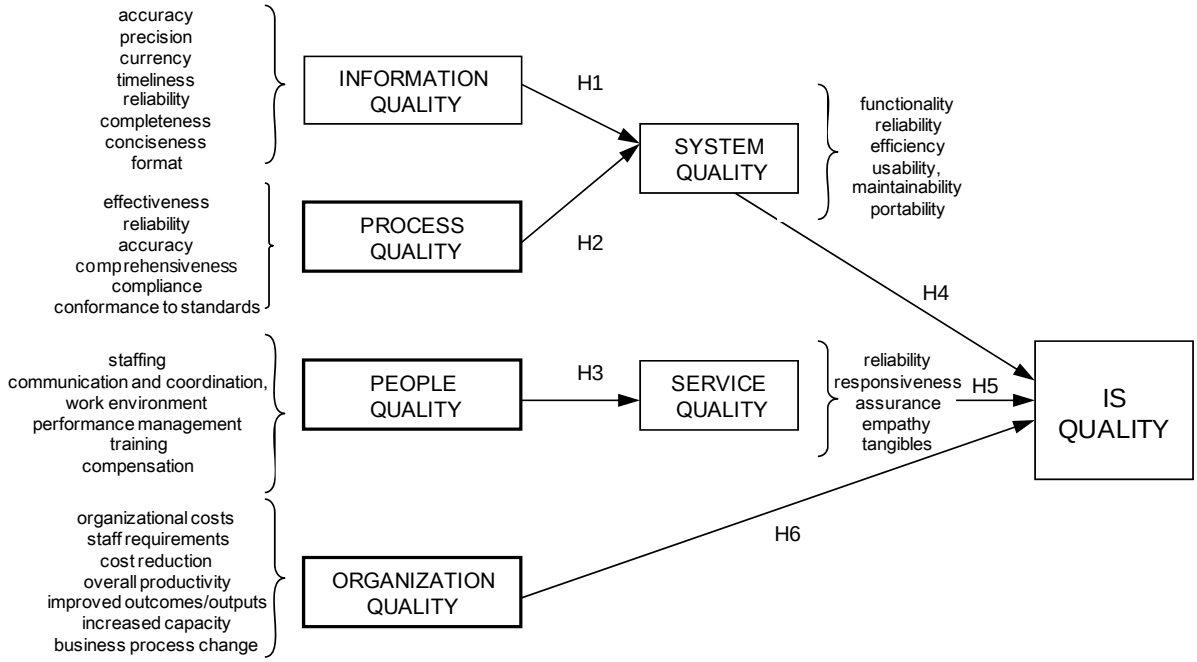

Figure 2: Rodriguez&Casanovas proposed IS quality model

Figure 2 also depicts the hypothesis we propose to test:

- H1: Hypothesis H1 assumes that information quality will be positively related to system quality;
- H2: Hypothesis H2 assumes that process quality will be positively related to system quality;
- H3: Hypothesis H3 assumes that people quality will be positively related to service quality;
- H4: Hypothesis H4 assumes that system quality will be positively related to IS quality;
- H5: Hypothesis H5 assumes that service quality will be positively related to IS quality and,
- H6: Hypothesis H6 assumes that organization quality will be positively related to IS quality.

Next, for each construct, initial measures are proposed. Whenever possible, measures were selected from previously theoretical models or frameworks or verified empirically studies.

- **Information quality or data quality** - the quality of the system inputs and outputs. The information quality should be measured in terms of: accuracy, precision, currency, timeliness, reliability, completeness, conciseness, format of input/output and relevance (Bailey and Pearson, 1983).
- **System quality** - the quality of the information system itself. It can also be called product quality. Measures proposed are from ISO/IEC 9126-1, 2, 3, 4 (2001) standards. They are measures of functionality, reliability, efficiency, usability, maintainability and portability (Chutimaskul et al. 2008). Methods exist for buiding such quality ISO/IEC-based quality models (Franch and Carvallo, 2003).
- **Service quality** - the quality of the support that users receive from the IS department IT support team. Measures proposed for service quality are those used in the popular instrument SERVQUAL, adapted from the field of marketing (Pitt et al. 1995). SERVQUAL consists of five dimensions: reliability, responsiveness, assurance, empathy and tangibles.
- **Process quality** - the quality of the process to develop and maintain the system. Measures proposed are selected from methodologies like CMMI-DEV (2006) and those proposed by Urbach et. (2009). The process quality should be measured in terms of: effectiveness, reliability, accuracy, comprehensiveness, compliance and conformance to standards.
- **Organization quality –** the quality of the organizational aspects**.** Measures for organization quality are those proposed by Sedera et al. (2004): organizational costs, staff requirements, cost reduction, overall productivity, improved outcomes/outputs, increased capacity and business process change.
- **People quality** - the quality of the stakeholders involved during all the information system life cycle phases. Measures proposed are selected from the framework People Capability Maturity Model, level 2 (P-CMM 2001), and they are related to staffing, communication and coordination, work environment, performance management, training and development and compensation.

RESEARCH METHODOLOGY

To develop the model we have followed the scientific research methodology proposed by Mackenzie and House (1979) and McGrath (1979) to develop a standardized instrument. It consists of two main phases: *exploratory phase* and *confirmatory phase*. The purpose of the exploratory phase is to develop a hypothesized measurement model (a priori model, with its dimensions and measures) that will be tested in confirmatory phase against new data gathered. This methodology has been applied successfully in several empirical studies in the IS community (e.g. Sedera et al. 2004 and Green and Pearson, 2004).

In exploratory phase the content validity, construct validity and item reliability analyses have to be done in order to validate the a priori model (Straub et al. 2004). The a priori model will be empirically tested using data gathered from the IS PRISMA, one of the 5 principal IS of the Spanish Technical University of Catalonia (UPC)**.** PRISMA is a system developed by an internal IT unit that supports the management of all the UPC studies throughout its life cycle: processes of planning, development and evaluation. At present, 1349 personal and research staff have access to the system. Moreover, during the 2009, approximately 35000 students accessed to the PRISMA eSecretaria (the student web services).

The methodology adopted to gather data is the survey to the users of the IS and the face-to-face interviews using a structured questionnaire with the PRISMA development team. Survey, interviews and a literature review will be used to assess content validity. Construct validity will be achieved using the SEM technique PLS (as a consequence item reliability is included). SEM is selected because it is taking on an increasingly important role in the examination of theory and measurement issues in information systems (Boudreau et al. 2004; Evermann, J. 2009). Among SEM techniques, we have chosen PLS instead of LISREL, EQS or AMOS because (1) is more suitable for predictive applications and theory building which is the purpose of this exploratory phase (Chin and Newsted, 1999); (2) a study exists that applies PLS in the IS UPC context (Esteves et al. 2003), more specifically the use of PLS to define relationships between Critical Success Factors (CSFs) for ERP implementation projects; (3) PLS reports item reliability.

In confirmatory phase construct validity and reliability analyses have to be done in order to validate the resulted model. We will validate the model with new data obtained from other UPC IS (note that it will be also interesting to use data from other IS out of the UPC to contrast if the findings are specific to UPC context or not).

CONCLUSION AND FUTURE RESEARCH

In our review of the IS quality literature, we found few models that measure quality as a complex multifaceted concept. Moreover, there do not exist any global IS measurement quality model that is validated empirically using the Structural Equation Modeling technique: PLS. From the field of the IS success, we use the widely accepted D&M IS Success Model as a basis and we propose a structural model for measuring IS quality.

The main contributions of this research are: (1) from the research perspective, this model integrates results from different IS quality studies and provides the most complete and comprehensive IS quality state-of-the art to date which is a reference for researches interested in IS quality; (2) on the other hand, from a practical point of view, the application of this model would provide valid information that helps organizations to know in each moment the grade of quality of its information systems, in order to take decisions to improve and assure the quality of its information systems. Furthermore, it will be useful to organizations to make predictions; (3) finally, the application of the SEM technique PLS in the IS quality research area.

Future work will focus on empirically validating the model and applying it in practice.

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