MEASURING INFORMATION QUALITY AND SYSTEMS QUALITY: AN EMPIRICAL STUDY

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ABSTRACT

Organizations depend heavily on information systems and their outputs to achieve organizational goals and facilitate main business processes. Quality of system's outputs "information quality" is considered an important ingredient of information system's outputs as it determines the degree to which information is used in organizations. This drives management attention towards improving information systems' quality and output quality of the systems. Information quality, provided by an information system, is a very important factor in leading people to believe in the usefulness of that information system. Quality of the system itself is also a critical factor that determines the level of information quality and system features that consequently affect the system utilization and benefits gained by the system users. This study thus focuses on user perspectives and how users perceive the characteristics of information quality. The study aims at providing a more incorporative framework and measurements to both system quality and information quality of information systems. It also aims at measuring the perceived impact of both systems quality and information quality on user evaluation and performance. Consisting with previous studies, the study provides some useful conclusions that can be used by managers to structure their information system strategies to best benefit their organizations. The study gained evidence supporting strong relationships between information quality and systems quality, and user evaluation of the information systems. The results indicated that information quality and systems quality are significant determinants of utilization and usefulness, obtained when using information systems.

KEYWORDS

Information systems, system quality, user evaluation, information quality

1. INTRODUCTION

Increased organizational dependence on information systems and their outputs drive management attention towards improving information systems' quality and output quality of the systems. Recent studies have showed that improved information systems quality is a serious concern facing both business managers and information technology professionals. Quality in information systems field is a multidimensional measure, it is important to determine what aspects of information systems are critical to both organizations and individual and how individuals perceive better benefits when using information systems [1].

Information quality depends on user perceptions of the value of the IS output. Thus, most of its measures are perceptual, including accuracy, precision, currency, output timeliness, reliability, completeness, conciseness, format, relevance, understandability, report usefulness, etc. [2] characterized system quality, as the degree to which a system possesses desired characteristics, and measured it using four factors: convenience of information, system flexibility, system integration, and response time. Since system quality measures the information processing system itself, the background characteristics of the system under study need to be outlined before developing any measurements.

The quality of information, provided by an information system, is a very important factor in leading people to believe in the usefulness of that information system. When people feel that an information system is useful to them, the chances that they will utilize that system will be higher. If the information provided an information system is vague, erroneous, or incomplete, it will arouse doubts in the user's mind about the reliability of that particular information system and possible harmful opportunistic behaviours and thus, reducing intention to use. On the contrary, an information system that provides high content quality will increase intention of users to engage in the services provided.

This study thus focuses on user perspectives and how users perceive the characteristics of information quality. The study aims at providing a more incorporative framework and measurements to both system quality and information quality of information systems. It also aims at measuring the perceived impact of both systems quality and information quality on user evaluation and performance.

2. LITERATURE REVIEW

2.1. Information Quality

Information Quality (IQ) is considered an important ingredient of IS outputs as it determines the degree to which information is used in organizations [3]. As a result, IQ research activities have increased significantly to meet the needs of organizations attempting either to measure or provide a rigorous framework for IQ [2, 4]. In view of that, there have been many different frameworks of IQ. However, even though these classifications differ in detail and in the names of the IQ measures, there are substantial overlaps among them [2]. Furthermore, despite a decade of active research and practice, the field lacks comprehensive methodologies for its assessment and improvement.

Typically, the IQ assessment framework means classifying the IQ factors so that they are testable and provides an extensive template for applications in a specific domain. In this sense, an IQ model assessment means a multidimensional structure consisting of theoretical concepts, terms and relations that identify the main characteristics of information [5]. Information characteristics have been viewed as important determinants of IQ, which include accuracy, precision, currency, output timeliness, completeness, format, and relevance. Others, however, have highlighted the domain and purpose of the interest to the information users as main characteristics of IQ or the degree to which information satisfies user requirements or is suitable for a specific process [6]. Therefore, IQ in total refers to its user's requirements.

2.2. Measures of information quality

The IQ literature reflects the existence of a number of views on what constitutes the attributes of information. A significant number of empirical studies have been conducted to develop a framework to measure IQ. Starting from the many characteristics identified by [7] such as accuracy, precision, currency, timeliness, completeness, conciseness, format and relevance. Pitt, [8] later identified five IQ characteristics of accuracy, timeliness, conciseness, convenience and relevance. Sometimes, measures of IQ focus on the output produced by a system and/or the value, usefulness or relative importance attributed to it by the user. In this sense, [9] conducted a series of studies on IQ and used accuracy, relevancy and accessibility to measure IQ.

Among several studies, researchers sometimes mixed these IQ measures based on the purpose or scope of the study. [10], used terms of usefulness, accuracy, timeliness and relevancy to measure IQ, while [11]) used clarity, relevancy, accuracy and timeliness in her research. In a similar vein, [12] used relevancy, accessibility, accuracy and interpretability. Eventually, from the user perspective, a framework was developed to capture the underlying IQ in four grouped classifications

- Intrinsic, consisting of believability, accuracy and objectivity.
- Contextual, consisting of relevancy, timeliness and completeness.
- Representational consisting of interpretability and ease of understanding.
- Accessible, consisting of accessibility and access security.

The above framework was repeatedly used in a substantial amount of prior research and was based on several studies that aimed to identify the most relevant characterises of measuring IQ [4]. To conclude, prior research provided a thorough classification of IQ measures, notwithstanding discrepancies in the definitions of most measures due to the contextual nature of both quality and IQ. However, the literature lacks a comprehensive framework that researchers and organizations can apply. Thus, by analysing these classifications, it seems possible to formulate a basic model for this study. The most commonly and widely accepted identified IQ characteristics are presented in [12, 6, 2]. This study therefore consolidates these commonly used characteristics to build an IQ framework that includes relevancy, accuracy, timeliness (currency), appropriate amount (completeness) and accessibility, as discussed below:

2.2.1. Relevancy

A key component of IQ is whether or not the information addresses the user's needs. If not, a user will find the information inadequate [7]. Thus, relevancy refers to the degree to which the information is appropriate for the users' tasks [11]. Relevancy refers to the extent to which information is applicable and helpful in performing the task at hand. Relevancy therefore links the information to the users' needs besides task requirements. [12] stated that with access to information, which can be interpreted, one needs to know if it is relevant to the domain and purpose of interest to the user. Therefore, relevancy is a critical element for IQ, making information understandable and interpretable to users and helping them use all the information that is essential to their task and to avoid any irrelevant information.

2.2.2. Accuracy

Accuracy is defined as the correctness of the output information provided by a system [13]. Researchers have discussed this concept as the main part of IQ. For example, they proposed that accuracy is the extent to which information is correct and reliable, which others call "free of error" [8]. Generally, it is believed that accuracy of information is a critical issue for users as they utilize information for various purposes. Therefore, if the information is accurate, performance will be more efficient with fewer mistakes, meaning that accuracy affects work outcomes by reducing the errors caused by inaccurate information and leading to higher quality performance.

2.2.3. Timeliness (currency)

Timeliness pertains to the degree to which information is perceived to be current [11]. Therefore, timeliness is an important component of IQ, because it gives the information currency increasing information value for users and reflecting the age of the information [5]. Timeliness refers to currency and validity. Currency refers to the age of the recorded value, while validity refers to the length of time the value remained valid. Therefore, information must be updated continuously to fit the users' needs. However, others contended that information does not wear out. Nevertheless, as it ages, it bears less and less correspondence to the real or conceptual thing(s) it is associated with.

Thus, the time from the collection of a value to its recording and the speed with which the source of the value changes over time are critical considerations for IQ [12].

Generally, timeliness is always related to updating aspects and it captures how often data changes or how often new data is created in the system. The updating process can increase the importance and value of information and make the information appropriate for user needs and tasks.

2.2.4. Appropriate amount (completeness)

Completeness refers to the comprehensiveness of the output information provided by a system. Information must be provided in an appropriate amount; too large volumes of information may make it difficult for users to access. In this regard, information needs to be sufficiently complete according to the users' domain, purposes and interests. This would help users complete their tasks on time and avoid any delay in delivering the outcomes, leading to more improved performance [12, 5].

2.2.5. Accessibility

Accessible information can be obtained when needed. Accessibility depends on the user and even the specific circumstances of that user. Basically, accessibility emphasizes that information must be accessible, but secure for all users. If the information is accessible to users and convenient when needed, users will be able to accomplish their tasks with a high degree of satisfaction achieving maximum potential usage of a system, leading consequently to more system impact on performance [10].

2.3. Systems quality (SQ)

SQ is a measure of the quality of the information transformation process itself. The determining criteria in the assessment of SQ are the performance characteristics of the system under study [14]. Assessing SQ and its impacts on users is a difficult task, because quality has several components, as mentioned previously.

In the IS literature, SQ is connected with IQ characteristics such as relevancy and accuracy, because in accessing information that can be interpreted, the user needs to know if the information is appropriate to the tasks or purpose of interest. However, if the information is not current and/or timely, then the information is irrelevant [12]. Therefore, relevancy, timeliness and currency are interrelated and each one affects the other synonymously and can affect user performance. The main measures of SQ that have been cited and commonly used in the literature are discussed below:

2.4. Measures of systems quality

Measuring the quality of information systems is a multidimensional process focusing in different aspects, because a system has several components. Typically, measuring SQ concentrates on the specifications of a target system. However, some studies have looked at the benefit and utilization of the system and its efficiency. Other studies used reliability, response time and ease of use as mentioned in different places in this research to support ERP users to perform several tasks concurrently for different purposes [15].

The typical measures of SQ in traditional studies include system stability, availability, response time and ease of use [13]. In this context, it should be noted that researchers used different measures to investigate SQ according to the nature of the research and its goals. For example, some studies focused on the technical aspects of system, while others focus on the output of the systems and its ability to provide quality information. However, most studies have many similar measures. According to [2] SQ is measured by functionality, reliability, flexibility, data quality, portability and integration, thus reflecting the dependency of users' needs regarding SQ. From a practical viewpoint, however, a high level of SQ may provide users with more convenience, privacy and faster responses.

In brief, a large number of researchers focus typically on performance characteristics of a system under study to measure SQ. These characteristics were mostly taken from a list provided by [7] of SQ measurements. The list is probably the most well known in IS literature in terms of measuring SQ [7]. The list includes response time or what is called turnaround time, reliability, flexibility and ease of use. Researchers therefore believed that the list covers all relevant parts of SQ especially. Thus, taking lessons from these studies and considering the list mentioned above, the SQ measures of reliability, response time and integration are used in this study, as discussed below

2.4.1. Reliability

The issue of system reliability is taking on greater importance as software applications become more complex. Reliability is defined as the probability that a software system performs in the user environment without failure for a period of time. This quantifies how well information systems match and meet user's requirements and expectations.

System reliability is an important attribute of SQ, together with functionality, usability, performance, serviceability and capability. Reliability is hard to achieve, because the complexity of software tends to be high. Thus, a system with a high degree of complexity will have difficulty in reaching a certain level of reliability. Therefore, reliability reflects the consistency and dependency of the output information provided by information systems [13]. This signifies the importance of reliability to users and their tasks as it affects the quality and reliability of performed tasks.

2.4.2. Response time

Response time, or turnaround time, refers to the overall time between a request for system activity and the delivery of the response, therefore measuring the efficiency and availability of the system and the output for delivery or transmission [13]. A high level of SQ may provide users with a faster response to their inquires [13, 12]. In brief, response time has been defined as the total elapsed time from when a request is made to the time it is completed. Therefore, response time is very important for users to satisfy their requirements as it affects the time taken to accomplish the tasks at hand, which consequently affects performance efficiency.

2.4.3. Integration

All activities give the users an integrated and condensed view of information [5]. System integration ensures that all the component parts of a system work as one system. It aims at enabling users to get what they want when they want it, reflecting the capacity of systems to communicate data with other systems servicing different functional areas and located in different geographical zones and/or working for other business partners [13]. System integration also refers to the technical aspects of hardware, the interconnectivity of computing components and making different pieces of equipment work together, including software, data and communication. Thus, system integration can help users save time and obtain the information they need on time.

3. RESEARCH METHODS

This study focuses on IQ and SQ measures and their perceived impacts on user evaluation and performance. The study was conducted in enterprises utilizing Enterprise Resource Planning Systems (ERP) with the aim of testing the impacts played by above mentioned factors and subsequent measures on user evaluation of the systems utilized. The study factors and their proposed relationships are illustrated in figure 1.

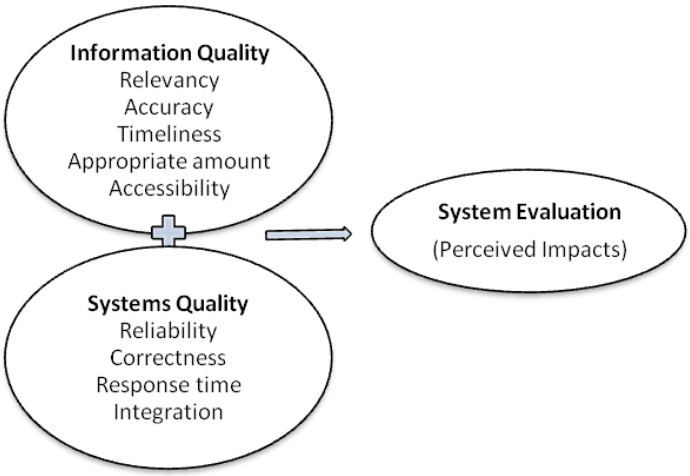

Figure 1. The Study Model

3.1. Hypotheses

In light of the above discussion and the review of the literature regarding both SQ and IQ, the current study tests a set of hypotheses as follows

System quality will be positively related to user evaluation of information systems.

Information quality will be positively related to user evaluation of information systems.

3.2. Sample, Procedure and Instruments

The population of this study was enterprise systems users in two hospitals. The inclusion criterion of sample selection is users who had experience using the hospital systems in their work. A total of 203 users from deferent departments were surveyed. The method used to gather information in this research was through questionnaires composed of measures. The questionnaires were gleaned and compiled from previous validated instruments. However, some modifications were made to wording to suit the context of the health enterprise systems. Items were adapted from previous literature of system quality and information quality [2]. Most items were rated on a Likert-7 point scale of 1-7 (1 = strongly disagree, 4 = neutral and 7 = strongly agree). The data gathered questionnaires were checked to ensure their suitability and completeness. 6 questionnaires were excluded from further analysis due to incompleteness. A total number of 197 questioners were analyzed using SPSS software. Factors analysis and regression analysis were used to test the study model and examine the relationship between the study factors as explained in the nest section.

4. DISCUSSION AND FINDINGS

4.1. The impact of systems quality on user evaluation

[2] identified categories for system impacts by mapping aspects of information systems success. A major part of their analysis focuses on SQ and IQ and their impacts on user evaluation of a system. According to their model, SQ and IQ will lead to more system impact. In other words, when the system is perceived as having high quality and when the output of the system (information) is perceived as having high quality, the user will rely on the system and utilize its output in performing tasks, thus leading to more impacts on performance [2]. This part therefore tests whether or not

the SQ and IQ of the information systems lead to more impacts and improved performance, depending on how users perceive the systems and the information provided by the systems as discussed below:

*Table 1. Regression analysis for SQ and user evaluation

*Factors**	*B*	*S.E*	*β*	R	R^2	F	*t*	*Sig*
Constant	-.023	.197	.765				-.119	.906
SQ: H_1	1.36	.059		.765	.586	544.4	23.33	.002

*The results of stepwise regression

Model	R	R^2	*β*	Adjusted R^2	Sig
Correctness	.704	.495	.425	.494	.001
Integration	.774	.599	.321	.597	.002
Response time	.789	.623	.193	.620	.001

**Tables were merged to facilitate comparison*

As shown in Table 1, SQ affects user evaluation of the system significantly and positively (β = .765, P < .01). This shows that SQ improves perceived impacted by users. The analysis yielded a regression function (R = .765) that explained 58.6% of the variance in user evaluation and thus, hypothesis H_1 was supported. Users perceive SQ as a critical factor that plays an important role in enhancing their performance and helping them to perform tasks more quickly with less time and effort.

The findings showed that a large part of user evaluation and impacts could be explained by SQ. This confirms that the greater the SQ, the better the user perceived benefits of the systems performance of the systems. This result is consistent with what is proposed in the literature, as previous studies mentioned that when the system is perceived as having high quality, the benefits and the individual impacts will be greater.

Although the whole model shows a positive relationship between SQ and user performance, it would be useful to investigate the individual contribution of each factor to the whole relationship. To do so, a stepwise regression was also carried out using reliability, correctness, response time and integrations as independent factors. The results first confirm the previous results of the regression analysis. However, reliability was excluded from the model, as it does not contribute significantly to user evaluation. The other factors contribute significantly to the model. Correctness contributes uniquely and significantly to user evaluation, (β = .425). Therefore, correctness plays a critical role in helping users reduce the mistakes in their work and even helps users to correct mistakes when they happen. Similarly, system integration adds a unique value to the model and contributes significantly to user evaluation (β = .321). Therefore, system integration supports perceived performance and impacts by combining data from other systems and allowing for integrations with other systems. Lastly, response time or responsiveness was found to be a very critical factor that affects perceived impacts of the systems. It has a significant contribution to perceived performance, (β = .193).

4.2. The impact of information quality on user evaluation

The impact of IQ on user evaluation of the system impacts was measured by accuracy, relevancy, timeliness, completeness and accessibility. The results of the analysis indicate that IQ affects user evaluation positively; the whole model was significant and positive (F = 227, df = 2, 384, R = .609, P < .01), reflecting strongly significant and positive impacts of the IQ on perceived user performance and evaluation of the system, explaining 37.1% of the variance in user performance (R^2 = .371, β = .606), and thus, hypothesis H_2 was supported. Table 2. Regression analysis for IQ and user evaluation

Factor	*B*	*S.E*	*β*	R	R^2	*F*	*t*	*Sig*
Constant	.364	.278					1.312	.190
IQ: H_2	1.147	.076	.609	.609	.371	227	15.061	.001
The results of stepwise regression								
Factor	R	R^2	Adjusted R^2	*β*			S.E	Sig
Completeness	.557	.310	.308	.341			.949	.001
Accuracy	.597	.356	.353	.213			.918	.002
Timeliness	.618	.383	.378	.197			.900	.001

The result was further explored using stepwise regression to identify the most important factors of IQ that affect user evaluation from the user's perspective. As shown in the Table 2, based on the β value (β = .341), completeness or the volume of the information was the most important measure of IQ that contributes significantly to user performance. Therefore, users pay high attention to the quantity of the information or the degree of completeness of the information. Similarly, accuracy was found to be an effective factor that affects user evaluation of the systems. The last factor in the model was timeliness, or getting the information in a timely manner. This factor also contributes significantly to user evaluation and perceived performance and adds a unique value to the whole model, (β = .197). Getting updated information from the systems on time helps users improve their performance. It also helps improve performance efficiency and effectiveness, because it saves the user's time. In respect to the other factors of relevancy and accessibility, these were excluded from the model, as they did not make any significant contributions to user evaluation. This might be due to the normal accessibility to the system and information by users, so they do not see any significant differences in this point.

5 . CONCLUSIONS

This study investigated the impact of information quality and system quality on user evaluation of information systems. The study provided a framework solicited from prior research in different information system environments

with the aim of building a more inclusive measurement model to both information and system quality. Consisting with previous studies, the study provides some useful conclusions that can be used by managers to structure their IS strategies to best benefit their organizations. For example, enhancing IS quality can subsequently improve individual performance. Similarly, improving IQ can also improve user evaluation and perceived performance as discussed below:

5.1. Information quality and user evaluation

Information quality (IQ) measures are very important as they determine the degree to which information is used. This in turn affects perceived user performance, which sit at the core of the D & M model. Consistent with previous studies in various types of information systems, the results of the current study indicated that the impact of IQ on user evaluation was significant and positive. However, the relationship was not as strong as SQ in term of predicting the variance in user evaluation [2]. Overall, this study proved the importance of IQ as an essential factor influencing positively user evaluation within an ERP system environment. These finding support the findings in previous studies and confirmed again the importance of D & M model in predicting user performance.

All IQ measures were analysed to determine the significance of each of the measures and determine which made a significant contributions in predicting user performance. Amongst these measures, completeness, accuracy and timeliness were deemed to be the most important attributes of IQ needed to support users when using ERP systems to perform tasks. System users give high attention to information completeness as it contributes significantly to their performance. They reported that the completeness of the information available through ERP systems helps them achieve their performance goals and improves the quality of the work performed. Accuracy also was found to be very important for users, and contributes uniquely to improve user evaluation. It leads to more accurate work with less mistakes and errors as users rely on the systems to get accurate information needed to perform their tasks and achieve job goals.

To conclude, IQ is associated with high user impacts and evaluation. IQ should be improved in several to increase benefits for users. For example, "by aligning IT strategy with business strategy, using data mining techniques to improve business intelligence, and using data warehousing techniques to aid business decision making. By linking IT strategy with business strategy, information outputs can be designed to provide information that enhances organizational effectiveness [1, p222]. Similarly, data warehousing and data mining techniques provide relevant information (implicit and explicit) to decision makers, which will improve decision making".

5.2. System quality and user evaluation

Research in IS has resulted in various validated instruments to measure SQ. Among these instruments, SQ was determined using different measures. In this study, SQ was measured using reliability, correctness, response time and integration to identify their impacts on user performance. The study confirmed the main proposition of DeLone and McLean's model (D & M) as SQ performed in a similar fashion as in the original model.

System integration is a main component of SQ and one of the ERP packages core capabilities. This capability is important as it affects the level of system usability [13]. ERP users reported that the ability of ERP systems to

communicate data with other systems servicing different functional areas helped them attain different types of data to perform tasks more efficiently by saving time and enhancing the ability to correct errors. Furthermore, the ability to effectively combine data from different functional areas and provide the right meaning of the information for users also helps to increase the perceived efficiency of user performance.

The study also gained evidence supporting strong relationships between SQ and IQ and user evaluation of the information systems. The results indicated that IQ and SQ are significant determinants of utilization and usefulness, obtained when using ERP systems. However, SQ exhibited a stronger effect than IQ, leading to more systems' utilization and thus more impacts on user performance. This is consistent with similar studies that measured different aspects of information systems' impacts including system use and utilization and user performance [16].

Prior research defined the nature of the relationships between SQ and individual performance using the D & M's model. The model collects information on SQ, IQ, user satisfaction, and users' attitudes, organizational and individual impacts. It has been articulated by many researchers that perceived usefulness must precede system impacts and benefits, although not necessarily causing them, suggesting that perceived usefulness of a system should be added to the above factors when investigating user performance. This was confirmed in the current study and referred to above in the explanation of the system impacts.

Last but not least, system compatibility also has a strong impact on performance of ERP users. Therefore, in addition to developing easy to use systems, designers of ERP systems must pay sufficient attention to user requirements analysis to identify users' expectations and requirements for ERP systems' content, and then incorporate relevant materials and functions into these systems. For example, designing the systems with multiple user interfaces for different levels of users can be useful in improving perceived user performance [17]

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