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A Framework of Data Warehouse Systems Success: An Empirical Study

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***Abstract* — These Increased organizational dependence on data warehouse (DW) systems drives management attention towards improving DW systems success. However, the successful implementation rate of DW systems is low and many firms did not achieve intended goals. A recent study shows that improves and evaluates DW success is one of the top concerns facing IT/DW executives. In addition, it is important to determine what aspects of DW systems success are critical to organizations to help IT/DW executives to devise effective DW success improvement strategies. Therefore, the purpose of this study is to further the understanding of the factors which are critical to evaluate the success of DW systems. The study also attempted to develop a comprehensive model for the success of DW systems. Researcher models the relationship between the quality factors on the one side and the net benefits of DW on the other side. This study used quantitative method to test the research hypotheses by survey data. The questionnaire measured six independent variables and one dependent variable. The independent variables were meant to measure system quality, information quality, service quality, relationship quality, user quality, and business quality. The dependent variable was meant to measure the net benefits of DW. The research results indicated that there are statistically positive causal relationship between each quality factor and the net benefits of DW. Implications of our results for practice and research are discussed.**

***Keywords* — Data warehouse, success implementation, information system, knowledge management, decisions making, decisions support system, quality factors.**

I. INTRODUCTION

Today many organizations possess Information Technology (IT) infrastructures that provide limited data management, integration, and access. These organizations would be better served by IT infrastructures that offer appropriate data and tools to support decision makers. DW appeared in the early 90s as a decision support technology that could integrate data from multiple sources, and that had a subject orientation in the way data was organized and presented. Inmon [1] defined DW systems as "a subject-oriented, integrated, time-variant, non-volatile collection of data in support of management decisions". Literature is rich with evidence that DW provides a unique opportunity to improve the IT infrastructure [3]. DW addresses data management, integration, and access issues by creating a repository of quality data that can be manipulated to meet changing business data along common business subjects or dimensions and let users navigate through attribute hierarchies. Users can drill down, across, or up level in each dimension [4].

DW systems experienced substantial growth in the past ten years [5]. So, companies invested heavily in this large integrated application software suite with a high expectation of enhancements in business strategies and decision making. A study of [6] reports an average cost of $2.2 million for a typical DW, while the study of [7] claims that the market of enterprise DW is expected to experience double-digit growth through 2008. Moreover, Vesset [8] found that the market of DW tools repeated its 2004 performance in 2005 with an 11.3% growth rate to reach $9.6 billion in revenue. Another research [9] expects that the size of DW market is likely to approach $7 billion in 2008. According to the main finding highlighted by the report from The 451 Group's Information Management [10], "The data warehousing market will see a compound annual growth rate of 11.5% from 2009 through 2013 to reach a total of $13.2bn in revenues".

Recognizing the need for an effective DW system in an organization is just a first step. The real challenge is to make it an integral part of decision-making process and to help an organization in sustaining its competitive advantage. To date, little empirical research has been found in DW literature on factors affecting the successful implementation of DW. According to [11] there is little empirical research to measure the success of DW projects. Mukherjee and Souza [12] argue that, the precise nature of the success factors and their impact on DW are still unclear. Other authors [13-15] contend that more studies in factors that impact the success of DW need to be conducted. According to [11], "more work is needed, however, to examine exactly how the dimensions of DW success interrelate". They also acknowledge that there is also a need to explore the role of other success dimensions in DW context.

The understanding of how organizational decision makers perceive DW may enable organizations to implement DW initiatives more efficiently [13]. According to [16], however, there is a lack of evidence on how organizations perceive to DW benefits. In addition, the net benefits of DW influence DW implementation success significantly [15, 17]. The failure to achieve the net benefits of DW system is one of the major causes of failure in DW initiatives [18]. Therefore, perception of DW system benefits may influence the success of DW system in the organizations.

Building DW is reported to be a complex, expensive and time-consuming tasks. Expert practitioners in this field have stated that these software applications are high-risk/high return projects and these applications are expensive to implement [1]. In fact, the use of DW has not always led to significant organizational improvements. In many cases, the estimation for the success of DW systems

is very limited in meeting users' expectations [3, 11, 13, 19, 20]. Moreover, there are many reports regarding the failure rates of DWs. The reported percentages vary based on the reporting agency however the average failure rates are between 20%-50% [16, 21-23].

Despite the huge investment in DW, organizations are still unable to reap the expected benefits from these investments [24]. Bhansali [14] indicated for a criticism regarding the effectiveness and contribution of DW in achieving competitive advantage. On the other hand, the tremendous benefits associated with the successful DW initiatives have encouraged and stimulated the continuing of implementation of DW and have motivated the researchers to study extensively the causes of DW failure and try to tackle it out [17].

Regardless of the high rate of DW failure, there are substantial opportunities of the successful DW where it will help an organization achieves internal operational efficiencies through managing internal resources more effectively as well as attaining strategic advantages by improving users' expectations [25]. According to Mathew [26], from the scale and complexity point of view, DW system implementation is more difficult than a software package implementation. Furthermore, DW is a solution for business people to make decisions and take the right action. It's not something that you want to do just for the sake of doing it; over time, you will have to show the impact of business to top management [25, 27]. Therefore, there is a need to understand where the business value is in DW [25: p. 270].

In general, the success in information systems area is difficult to define and measure since it means different things to different people [28]. Additionally, Shin [29] pointed out that there are a set of challenges that faced by DW implementers such as: (a) data management issues includes data quality insurance, derived data and attribute production, and the maintenance of historical data, (b) a complex data structure, and (c) complexity in the system architecture. So, an organization that would like to achieve the optimum success of its DW system must measure what they have already done right, as well as what they have done wrong [25, 27].

Among the causes or reasons of failure on DW implementations are the poor information provided to DW system [30, 31]. Another issue is argued by [18] who refers to the disappointing result of DW systems to the difficulty in integrating data from multiple sources. Additionally, from the causes of DW initiatives' failure is that lack of software flexibility [13], the nature of bad technologies [27], and the difficulty to use and learn DW system [32]. Therefore, information quality and system quality are important to be considered in evaluating the success of DW.

Another issue causes of DW initiatives' failure is that the low data reliability and lack of appropriate user training [29]. Moreover, Ramamurthy et al., [13] stated that the reliability, responsiveness, and assurance of DW systems have not been studied extensively. Shin [29] also acknowledged that service quality is an important aspect in ensuring the success of DW systems. Other possible reasons of failure on DW initiatives are the lack of commitment, communication, and cooperation between DW managers and users [14]. In addition, Hwang et al. [19] and Perkins [33] pointed out that because of the reasons such as lack of coordination and lack of trust, organizations have been very slow in the implementation of DW. Chang and Ku [34] argue that relationship quality is the overall appraisal of the strength of a relationship and the extent to which it meets the expectations and needs of the parties on the basis of successful encounters. Therefore, the significant of service quality and relationship quality can be tested in relation to the success of DW systems.

There are also another reasons and issues of DW failure. According to [19, 35], there is additional risk in the form of DW users in terms of their needs to strong analytical and technical skills. Furthermore, Chen et al. [36] concluded that use of DW suffered because users found the system difficult to use. Other researchers [14, 19, 37] stressed that the lack of project team competencies, lack of DW users to the necessary experiences, and the difficulty in understanding the organizations' requirements are the main causes of failure on DW implementation. Moreover, business quality indicated as an important factor of improving the success of DW systems [38]. According to several authors [18, 27, 38], there is a lack of studies that considered business quality in the context of DW success. Therefore, user quality and business quality are important to be considered in assessing the success of DW.

In addition, it is also important for organizations to learn about quality needs to be emphasized before the actual DW is built [25, 27, 39]. In the area of DW, little studies are conducted on the quality factors of DW success models. For instance, studies of [11, 16, 17] focus on the two quality factors only: information quality and, system quality. Furthermore, there is an insufficient empirical evidence to assess the relationship between quality factors and the net benefits of DW systems [24, 27, 40, 41]. Therefore, many factors such as: service quality, relationship quality, user quality, and business quality that could evaluate the success of DW are not explained [19, 27, 29, 37, 38, 42, 43]. It becomes a fact, there are no comprehensive studies examining the interrelationships among system quality, information quality, service quality, relationship quality, user quality, and business quality andtheir effect on net benefits in DW success. Thus, this study examines the following research objectives:

1) To identify the quality factors influence the success of DW systems.
2) To determine the effects of quality factors on the net benefits of DW systems.

II. THEORETICAL BACKGROUND

By comparison to ISs research and other academic fields, theories on DW systems success have been given less attention. Most published articles on the field of DW systems success unavoidably lack theoretical support. Thus, in this study IS literature is reviewed in an attempt to find theories that could be adapted to DW field.

A. DW Systems Success Literature

Most empirical studies related to DW success models have dealt with original D&M [44] model rather that the updated D&M [45] model. Wixom and Watson [16] followed the work of D&M [44] and Seddon [46] and developed a three-dimensional model of system success with DW: data quality, system quality, and perceived net benefits. They used a cross-sectional survey to investigate their DW success model. DW measures and data suppliers from 111 organizations completed paired mail questionnaires on implementation factors and success of the warehouse. In addition, Shin [29] conducted an exploratory study to assist in the understanding of DW problems from the perspective of information systems success, using system quality, information quality and service quality as they influence user satisfaction. Empirical data were gathered at a large enterprise from three different information sources: a survey, unstructured group interviews with end-users, and informal interviews with an IT manager who was in charge of DW. Shin found that user satisfaction with DW was affected by system quality factors such as data quality, ability to locate data, and system throughput. In addition, the study indicated that users had a high level of satisfaction with data currency although in separate interviews, data currency was listed as a problem.

The study conducted by Hayen et al., [11] used a case study to investigate a model of DW success. IT staff at Financial Service Company (FSC) was also interviewed concerning the implementation factors and DW success. The results from the case study and interview identified significant relationship among the system quality, data quality, perceived net benefits. It was found that management support and adequate resources help address organizational issues that arise during DW implementations; resources, user participation, and highly-skilled project team members increase the likelihood that DW projects will finish on-time, on-budget, and with the right functionality. The implementation's success with organizational and project issues, in turn, influences the system quality of DW.

Moreover, Hwang and Xu [17] developed a structural model of DW success. The model combined both critical success factors and DW success dimensions. DW success depicts by four dimensions: system quality, information quality, individual benefits, and organizational benefits. While critical success factors represent by four categories: operational, technical, schedule, and economic. The relationship between the critical success factors and success dimensions was tested using data collected from a survey of around 100 DW professionals. The result found that technical factor is positively influences information quality, while both economic and operational factors have a positive impact on system quality. In addition, it found that system quality have a positive effect on information quality which in turn have a positive impact on individual benefits. According to [17], the model is general and new dimensions and variables can be added easily.

However, these studies have addresses only some aspects of the important issues and generally agreed that there is a scarcity of comprehensive models in DW success evaluation. While there is a shortage of comprehensive models of DW success, a models in the area of IS success has been well established. The next section discusses the IS success models.

B. IS Success Literature

In information system (IS) area, success is difficult to define and measure since it means different things to different people. However, Myers [2] suggests that success is achieved when an information system is perceived to be successful by stakeholders. IS quality is an important measure of IS success. A stream of research has been conducted to identify IS success measures. D&M [44] introduced a comprehensive taxonomy to organize this diverse research. Based on a review of over 180 empirical studies, they developed a model of ''temporal and causal" interdependencies between six categories (system quality, information quality, system use, user satisfaction, individual impact, and organizational impact) of IS success. All of the empirical measures that D&M used focused on the context of the organization.

In the following ten years, the original D&M model was studied in hundreds of research articles. Many researchers have validated the dimensions and confirmed the interrelationship between the dimensions of the model [47, 48]; some researchers suggested modifications [such as 46, 49]. Pitt et al. [50] discussed "service quality" as a measure of IS success and argue it should be included. They argued there is a danger that IS researchers will miss measure IS effectiveness if they ignore "service quality". They assessed service quality in there different types of organizations in three countries. Subsequently, Seddon [46] re-specified and extended the work of D&M [44]. He reformed the original IS model into two partial variance models and he argued for the removal of "system use" as a success measure, claiming that use is a behaviour that is appropriate for inclusion in the process model but not the variance model. Segars and Grover [51] used the D&M IS success model [44] as a theoretical foundation to develop a model for strategic information systems planning success in 550 firms in which senior IS managers hold the job title of CIO, VP, Director of MIS, or Director of Strategic Planning. Segars and Grover's study also focused on IS success within the context of the organization.

In 2003, D&M concluded the research findings of over 200 D&M model studies, and presented by the updated D&M model. The major revision is the addition of a new dimension "Service Quality". In addition, they replaced the individual impact and organizational impact constructs of their original IS success model with ''net benefits" constructs in their ''updated" model; the authors argue that their revised IS success model can be applied at multiple levels of analysis depending on the task at hand.

In recent studies, Jennex and Olfman [52] adapt the updated D&M IS success model to Knowledge Management (KM) success. They conclude that IS success model is a useful model for predicting KM success and designing effective KM. Furthermore, Petter et al. [53] review 180 papers in the academic literature conduct in relating to some aspect of IS success using a qualitative

literature review technique. Petter's et al study describes the measures for the six success constructs and analyzes the association of 15 relationships among the success constructs in both organizational and individual contexts. They found that most research studies focus on a single dimension of success such as information quality, net benefits, or user satisfaction. Few studies are conducted to measure the multiple dimensions of success and the interrelationships between these dimensions.

Moreover, Wang [54] re-specifies and validates the updated D&M IS success model for assessing the e-commerce systems success using structural equation modelling techniques. Wang's study reforms the updated D&M IS success model by considering user satisfaction, perceived value and intention to reuse to be forms of net benefits measures. Wang's study also argues that intention to reuse an e-commerce system is influenced by user satisfaction and perceived value, which, in turn, are affected by system quality, information quality and service quality. In addition, Petter and McLean [55] empirically evaluate the relationships for the updated D&M IS success model using the quantitative method of meta-analysis. They state that the majority of the relationships posited in the updated D&M IS success model are supported. The next chapter discusses the proposed research model and its justifications.

III. Research Model

This research develops a primary research model based on the underlying models as well as the review on the applications of those models in IS/DW fields. Various factors identified in studies on IS-related fields were also taken into considerations. The model development is done by combining IS success model by D&M [45] and other models on IS/DW-related fields. Four factors, they are: information quality, system quality, service quality, and net benefits were selected from D&M IS success model [45]. Relationship quality factor was adapted from other IS success studies by [56, 57]. Business quality factor adapted from model developed by Salmela [58] and study conducted by Thomann and Wells [27], while user quality factor was adapted from DW literature. This combination of models was adapted in this study in order to develop a specific research model of DW success.

D&M [45] recommend that researchers can select proper measures for the success model based on the research context. This prompted Shin [29] to consider IS success model that introduced by D&M [45] as a good framework in understanding the success of DW. Therefore, this study identifies the appropriate variables and measures for DW success. The research model of this study has seven constructs as shown in Fig. 1. The model posits system quality, service quality, information quality, relationship quality, user quality, and business quality as independent variables and net benefit as a dependent variable.

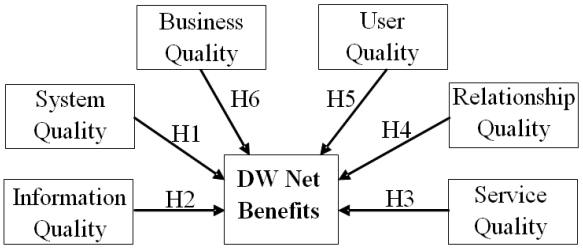


Fig.1. DW System Success Model

IV. Construct Development and Hypotheses

According Sekaran and Bougie [59], a hypothesis can be defined as a logically conjectured relationship between two or more variables expressed in the form of a testable statement. They added that relationships are conjectured on the basis of the network of associations established in the theoretical framework formulated for the research study. By testing the hypothesis and confirming the conjectured relationships, it is expected that solutions can be found to correct the problem encountered [59]. All the hypotheses in this research are directional in stating the positive relationship between two variables or comparing two groups' terms. Hence, the following sections discuss the hypotheses and dimensions of the research model in detail.

A. System Quality

Quality of the information system represents through the quality of system, which includes tools and data components, and it is a measure of the extent to which the system is technically reliable [60]. They also stress that a well designed and implemented system is a dynamically prerequisite to deriving benefits for the organization. The benefits that are deriving include: increased revenues, cost reduction, and improved process efficiency [61]. In contrast, a system that is not well designed and built will probably run into occasional system crashes, which will be detrimental to result in increased product costs and business operations to the organization. Moreover, a system that is easily managed has a longer life, resulting in the spread of software costs over a longer time, which in turn leads to lower costs to the company [60, 62].

Previous studies [45, 46] consider system quality as non-existence of errors in the system, ease of use, the consistency of the user interface, quality of the program code, and documentation quality. In information systems, system quality is describes as an important success factor [53], as it is believed that higher information systems quality should be considered as easier to use and essentially have higher levels of success [46, 63]. Nelson et al. [63] on the other hand regards the system quality construct that produces the information output, which can expresses in terms of flexibility, accessibility, integration, reliability, and response time and has also often been measured as the system success. In addition, several researchers examine the effects of DW on decision performance and indicate the evidence that support the

effects of quality DW systems on decision performance through system use [46, 64].

The relationship between system quality and net benefits is strongly supported in the literature especially in measuring the success of information systems of different environments. Generally, there is a significant relationship between perceived ease of use as a measure of system quality and perceived usefulness [65-67]. In addition, a study of e-commerce systems states that system quality, measured by ease of use, flexibility, reliability, and convenience of access is significantly related to decision-making satisfaction [68]. Seddon and Kiew [69] and Shih [70] indicate a significant relationship between system quality and perceived usefulness as measured by productivity and decision-making quality. Moreover, [71] identify a significant relationship between system quality and net benefits in e-government environment. Furthermore, the quality of DW system is significantly associated with net benefits in the study conducted by [16]. They also state that system quality of DW is positively related to decreased effort and time for decision making.

The above arguments lead to the hypothesis that DW systems with high flexibility characterized by high maintainability and many useful system features have high benefits in terms of achieved a competitive advantage and improved decision making for the firms. Hence, the corresponding research makes the following hypothesis:

H1: System quality is positively associated with DW net benefits.

B. Information Quality

Information quality refers to the quality of outputs produced by the information system, which can be in the form of reports or online screens [45]. Researchers use a variety of attributes for information quality. For instance, Nelson et al. [63] use the constructs of currency, completeness, accuracy, and format to measure the information quality factor. Huh et al. [72] define four dimensions of information quality: completeness, accuracy, consistency, and currency. In the context of DW systems, information quality indicates as an important aspect influence in DW success [16, 17, 27, 29, 31, 63, 73] among many others.

Users including managers are unaware of the quality of data they use in DW systems [40]. Data quality in DW systems is generally poor and there are many foreseeable setbacks such as economic failure and ineffective planning of business strategies [31]. However, the growth of DWs systems and the direct access of information from various sources by managers and information users increase the need of high quality information in organizations [74]. Additionally, DW is anticipated to enable the production of information of higher quality as well as the new information for innovative use. For instance, [75] discuss one of DW advantages as its ability to provide quantitative values, or metrics that allow a company to benchmark performance in an effort to measure progress.

On the other hand, several studies examine the relationship between information quality and net benefits of the success models. However, Gatian [76] argues that information quality is related to decision-making efficiency. The quality of the information considered also a significantly associated with quality of work and time savings [70] and decision-making support [68]. Moreover, the perceived information quality is positively associated with net benefits [48, 69, 70, 77]. Prybutok et al. [71] also study the impact of information quality on net benefits in e-government environment and found largely significant results. However, in the context of DW systems, information quality is directly related to individual benefits [17]. Additionally, a study of DW success conducted by [16] acknowledges that the relevance of the information retrieved is significantly associated with perceived net benefits.

At the organizational level, the results of the relationship between information quality and net benefits are positive. Information quality is directly related to organizational image, organizational efficiency, and sales [78] and to better perceptions of the work environment (i.e., interesting work, job content, morale) [79]. Moreover, data quality is significantly related to perceived decrease in effort and time for decision making [16].

As a result, high information quality in terms of information content and usefulness can lead to high benefits of DW systems in terms of information support (i.e., anticipating customer needs) and internal organizational efficiency (i.e., high quality decision making). Thus, the above discussion leads to the first hypotheses.

H2. Information quality is positively associated with DW net benefits.

C. Service Quality

Information system (IS) departments in the organization act as service units for several users, and organizational success depends on the quality of those services that are delivered. Kettinger and Lee [80] acknowledged that the primary use of SERVQUAL, as amended for service quality of IS, is typically related to the information services delivered by IS departments. Therefore, IS services delivered by the IS unit on time and with free error performance will result in timely and effective decision making, which in turn leads to increased benefits of using IS systems (such as: DW system, ERP system, and etc.).

By having knowledgeable DW specialists who have best interests to meet users' needs, are able to better understand the needs of users (empathy), and preserve good communication through interactions with business units (assurance), DW services will become better aligned with organizational goals, resulting in improved profitability and improved quality of decision-making (organizational efficiency), more accurate sales forecasting and better expectation of customer demands (support of market information). Moreover, the services provided by IT unit to end users (responsiveness) will enable immediate responses through market information support to new business opportunities [60].

According to Gorla et al. [60] "the impact of IS service quality can be understood from the impact of a firm's service quality on the firm performance". Delivering

quality service is a very important aspect for business success that leads to lower cost, higher profitability [81], long-term economic returns for the firm, and increased customer satisfaction [39]. In DW context, services deliver to two types of users, they are: external users such as suppliers and customers and internal users such as managers and decision makers. Therefore, providing reliable and prompt services by DW specialists to users and by understanding the specific needs of users can better expect and serve user needs through appropriate service enhancements. In addition, the provision of dependable services (reliability) by DW specialists can ensure the success of business operations and take benefit of them. As a result, service quality of DW system is positively associated with decision making support, business operations enhancement, and organizational efficiency, which means a direct impact on net benefits.

Nevertheless, few researches examine the direct relationship between service quality and net benefits. More research examines the relationship between service quality and user satisfaction [53]. A study conducted by [71] contends that the relationship between service quality and net benefits in e-government environment is significant. Additionally, user training provides by the computing department and responsiveness of perceived developer is positively correlated with system usefulness [82]. Leonard and Sinha [83] also indicate that the developers' technical performance, based on their ability to respond to problems, is significantly associated with improving efficiency. Gorla et al. [60] identify a significant relationship between system quality and organizational impact as measured by organizational performance enhancement. In DW environment, Ramamurthy et al., [13] suggest that the examination of responsiveness for both current and future DW projects can increase the chances of success.

The above arguments imply that the service quality dimension would be a significant contributor of DW net benefits. Thus, the current study suggests the following hypothesis:

H3: Service quality is positively associated with DW net benefits.

D. Relationship Quality

Lee and Kim [84] define the relationship quality as the overall evaluation of the effectiveness of a relationship indicate by the extent to which the parties in the relationship meet mutual needs and expectations through mutual commitment, cooperation, and coordination. As mentioned earlier, the data in DW system is collected from transactional systems from different departments or firms. Therefore, the existences of better quality of relationship between these departments or firms are absolutely necessary for achieving the business goals and reach success. In addition, Sun et al. [85] acknowledge that the relationship quality is a key factor that connects IS factors and business profitability factors (such as commitment and trust).

Managing the relationship of DW parties is critical for success of DW system in terms of commitment, trust, cooperation, coordination, and communication [14, 18, 19, 32, 73, 86]. Moreover, a good relationship between DW managers and business users could potentially reduce the time and effort which would lead to make decisions in a timely manner and with high accuracy [14]. Generalizing the above discussion, relationship quality is described in terms of the user's expectation of benefit from the relationship. Additionally, DW system is actually about tightly integrating different business functions, so the close cooperation, commitment, trust, and communication across disparate business functions would be a natural prerequisite in DW system success.

Unfortunately, there is a scarcity of studies that examine the direct relationship between relationship quality and net benefits. On the other hand, little research investigates the relationship between relationship quality construct and user satisfaction. Chakrabarty et al. [57] indicates that relationship quality is significantly associated with user satisfaction in IS outsourcing success. In the context of e-commerce systems, Wu [87] considers relationship quality as an additional quality dimension to IS success model for DeLone and McLean through its impact on use and user satisfaction. Moreover, in a study of customer relationship management (CRM), Chang and Ku [34] contends that relationship quality is positively correlated with organizational performance.

Based on the above discussions, this study suggests that relationship quality may have important impacts on DW net benefits. Thus, the corresponding study develops the following hypothesis:

H4: Relationship quality is positively associated with DW net benefits.

E. UserQuality

According to [88], the underlying objective of user quality is to ensure efficient use of software. They also state that software should be ready for use when needed, the users need to be capable to use it properly, and help must be available when problems occur. In DW environment, user quality factor also performs an essential role in identifying the success of DW systems in a competing company [16, 19, 37]. Particularly, the skills of the users have an important effect on the outcome of DW success. In addition, quality users equips with business, analytical and technical skills are essentials as DW benefits can be only utilized by these users who are competent of analysing information and turn them into proper business decisions [37].

As a result, quality of the user reflects the level of benefits resulting from the use of DW system. Therefore, it can obtain more realistic estimate of DW benefits when the user consider other skills such as business, analytical, and technical. More important aspects of DW which regards to integrating organization's requirements and priorities require people with unique skills in order to provide the right outcome. Unfortunately, [37] state that most enterprises have difficulty finding people with the right skills to deliver these important tasks. Thus, the success adoption of DW requires provision of adequate and sufficient training for DW parties to acquire necessary skills such as concepts of DW and the use of data-access tools [19].

Overall, few studies investigate the relationship among user quality and net benefits. One study analyzes the influence of IS user quality on business benefits [58]. The author indicates that the quality of IS user is positively associated with organizational benefits. Furthermore, a study of DW systems concludes that a high level of user skills is significantly related to project implementation success [16]. Another study shows similar results when examining the relationship between skills of project team and the adoption of DW technology [19].

Therefore, it can conclude that the capability of DW users that possess required skills such as business, analytical, and technical can positively impact the net benefits of complex systems such as data warehouse. Hence, the researcher constructs the following hypothesis:

H5: User quality is positively associated with DW net benefits.

F. Business Quality

According to Salmela [58], business quality requires the ability to identify critical requirements of IS, ability to determine the beneficial uses of IS, and ability to support the implementation of IS with business changes. In contrast, other authors [39] argue that poor business quality leads to an information system that provides little value because they have no real prospect for benefits, or because they lack a critical capability, or because of the continued changes of business planning.

Business quality consider as an important aspect of DW systems success [27, 38]. In spite of this, few studies examine the relationship between business quality and net benefits. Therefore, more research is needed to explore and confirm the relationship between business quality and net benefits. However, the components of business quality examine in several studies. For instance, Croteau and Bergeron [89] contend that business strategy is significantly related to organizational performance. In DW environment, Hwang et al. (2004) identify a significant relationship between business competition and DW success adoption. Moreover, Bhansali [14] stresses that DW success affected by business plans and business strategies.

Previous studies [14, 27, 38] suggest the need of business quality to be integrated with technology in the overall DW deployment. Therefore, the researcher believes that the quality of business offered by DW system would significantly influence the net benefits of data warehouse. Hence, this study postulates the following hypothesis that relates to business quality:

H6: Business quality is positively associated with DW net benefits.

G. Net Benefits

DW is a useful technology for a huge data and a large number of modern applications [90]. Today, improved access to timely, accurate and consistent data needs to be shared easily with team members, decision makers and business partners for efficient decision making [91]. Many organizations recognize the strategic importance of knowledge hidden in their large databases and have therefore built DW [92]. The Gartner Group says "organizations employing a data warehouse architecture will reduce user-driven access to operational data stores by 75 percent, enhance overall data availability, increase effectiveness and timeliness of business decisions, and decrease resources required by IS to build and maintain reports" [93: p. 48].

According to Haley [73], DW benefits can include: better decision making, improved business processes, improved customer satisfaction, rapid response to organizational events, improved morale, and rapid response to market and technology trends. Furthermore, DW offer benefits such as: cost savings from the consolidation of heterogeneous decision support platforms, improvements in the quality of data used to support decision-making, and productivity improvements resulting from redesigned of business processes [94]. Other authors [24] conclude that the greatest benefits from DW occurs when use it to improve business processes, support decisions, support strategic business objectives, provide better information, and time saving for users. In addition, the findings from the survey study conducted by Garner [18] shows that the most benefits derived from implementing DW are: (1) more facts for better decision making, (2) broader information access and data discovery, (3) corporate security and governance, (4) better assessment of corporate performance, (5) more complete view of the business, (6) more complete view of each customer, (7) accurate regulatory reporting, and (8) supply chain optimization.

The above discussion highlights the benefits of DW to an organization. It shows that DW can have a strategic as well as long term value for an organization.

V. RESEARCH METHOD

A. Sample and Data Collection

A field questionnaire-based survey was considered appropriate for data collection to ensure greater external validity and generalizability of the results. An initial version of the survey for measuring the study's constructs was developed based on IS and DW literature. Multiple indicator items were used to measure the constructs and, wherever available, scales used in prior empirical studies were adapted to suit the research context. The questionnaire was pre-tested with several experienced academics and DW specialists to increase the face validity of the research instrument. These people had knowledge in business, database, DW, and general information technology and similar backgrounds to the actual respondents. Respondents were asked to examine the wording of each scale item for clarity and meaning. The overall consensus of the respondent panel with respect to both the constructs and items suggested that the measurement scales had adequate face validity. The revised questionnaire was given to DW researchers for feedback and comments. Minor revisions to the phrasing of some statements emerged from these pilot-tests. These pre- and pilot-tests suggested a fair degree of initial content validity to the survey instrument.

A web-based questionnaire was developed to collect data from The Data Warehouse Institution (TDWI)

members. TDWI is the premier provider of in-depth, high-quality education and research in the business intelligence (BI) and DW industry. In addition, TDWI had over 27,000 members around the world working in a variety of industries and they are different in terms of their experience levels such as DW specialists, DW administrators, DW managers, DW consultants, and DW analysts. A web-based survey was mailed to 3000 of the most active members selected from TDWI membership list. A reminder email was sent to non-respondents four weeks after the initial mailing. The mailing resulted in a total response of 244 usable questionnaires, representing approximately an 8.1% response rate. Since the survey was unsolicited, fairly complex, and resource constraints, researcher expected a low response rate.

The questionnaire included items that asked respondents about their background information and DW systems of the organizations in which they work. Regarding DW net benefits, the respondents were to give on a 7-point scale (1 = strongly disagree, 7 = strongly agree) their perceptions regarding a statement such as, ‘‘DW system facilitates decision support system applications that show actual performance versus goals”.Regarding quality items, respondents were required to answer on a 7-point scale (1 = strongly disagree, 7 = strongly agree)regarding their overall perception of DW systems they use.

Table 1: Characteristics of Sample Data

Characteristics		Percent
(a)	*Frequency distribution of job function*	
	DW Business Analyst	12.7
	DW Manager	10.2
	DW User	11.5
	DW DBA	11.5
	DW Specialist	16.8
	IT Manager	15.2
	IT Specialist/Staff	16.8
	Other	5.3
(b)	*Frequency distribution of current status of DW project*	
	Live	51.2
	In development	30.3
	Planned	17.2
	Don't know	1.2
(c)	*Frequency distribution of organization’s industry*	
	Financial services	13.9
	Healthcare	9
	Government: Federal	12.1
	Consulting/professional services	7
	Education	6.1
	Manufacturing	10.2
	Software/Internet	5.3
	Insurance	4.9
	Telecommunications	4.1
	Utilities	9.9
	Hospitality/Media	8.7
	Construction/architecture/engineering	6
	Agriculture/Advertising	1.6
	Other	1.2

The demographic characteristics of the sample are shown in Table 1. The respondents were drawn from a broad range of job functions, with some 64.3% from DW background and 35.7% from an IT background. 18.4% had job titles at DW Business Analyst level and 12.1% had either the title of DW Specialist. In addition, the respondents represented wide range industries with largest participation (12.6%) drawn from financial services sector. Some 8.2% came from government/federal sectors, 8.2% from healthcare sector, and 6.6% from computer manufacturing sector. The remaining 64.4% distributed on the other industries. Almost half (45.1%) of those responding had at least one DW application either live. While nearly 53.3% are still in the development or planned stages. These results show that the majority of respondents have implemented DW applications, they also have sufficient experience, and they are involved from several industries.

B. Reliability Analysis

The psychometric properties of the constructs were tested using factor analysis (FA) using SPSS 17.0. The data were analyzed with reliability analysis using Cronbach’s alpha (α), which is based on the average correlation of items within a test if the items are standardized. If the items are not standardized, it is based on the average covariance among the items. Because Cronbach’s α can be interpreted as a correlation coefficient, it ranges in value from 0 to 1. In general, Cronbach’s α is reasonable if its value is more than 0.80; a value of 0.70 or larger is acceptable; 0.60 or above neither good nor bad; 0.50 or above is miserable; and below 0.50 is unacceptable [95]. Table 2 indicates that Cronbach’s α values range from 0.791 to 0.919, so the reliability of this study is acceptable.

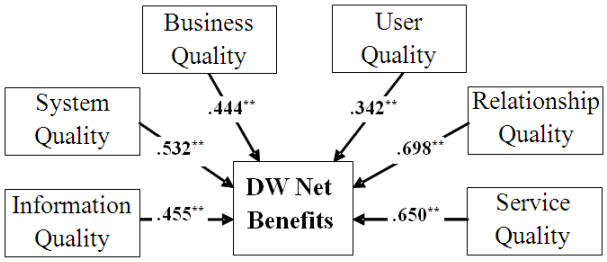
Table 2: Reliability Analysis

Dimensions	Cronbach’s α
Information Quality	.916
System Quality	.918
Service Quality	.919
Relationship Quality	.887
User Quality	.791
Business Quality	.872
Net Benefits	.889

C. Hypothesis Testing

Having established the reliability and validity of the constructs, the next step is to test the structural model for the hypothesized paths. As noted previously, six quality dimensions have been identified to be included in this research. Fig. 2 shows the results of the Pearson correlation analysis conducted on the relationship between the six quality dimensions and net benefits dimension. The level of confidence can range from 0 to 100 percent. A 95 percent confidence is accepted level for most research, denoting the significance level as $p< 0.01$. As can be seen from Figure 2, all hypothesized paths are significant: b = 0.455 for the path information quality → net benefits, b = 0.532 for system quality → net benefits, b = 0.650 for service quality → net benefits, b = 0.698 for relationship quality → net benefits, b = 0.3420 for user quality → net benefits, and b = 0.444 for the path business quality → net benefits. Overall, the hypothesized research model was

supported. Furthermore, a total of 56% of the variance (R^2=0.561) of net benefits is explained by all quality factors together.



** p<0.001, * p<0.01

Fig.2. Final Model of DW Systems Success

VI. Discussion

In this research, researchers postulate that there are linkages between quality factors and net benefits based on the premise that variance in net benefits can be addressed through variance in quality dimensions. The hypothesized model is then empirically validated using data collected from a field survey of TDWI members. The study findings show significant direct impacts of quality dimensions on DW net benefits. The reflections on the findings were discussed in the following sections.

A. Reflection on findings regarding system quality

The finding of this research revealed that system quality had positive and significant impact on the net benefits. The reasons of this positive influence of system quality state as follows: firstly, DW systems with easy to use and easy to learn will encourage business users to perform ad-hoc data analysis and reports that assist decision-makers to make decisions quickly and accurately, thereby, obtaining competitive advantages. Secondly, DW systems that is easy to manage and easily maintainable has a longer life over a longer period, which in turn leads to lower costs to the organization. Thirdly, DW systems with high flexibility and accessibility characterized by many useful system features result in high benefits in terms of achieved a competitive advantage and improved decision making capabilities. Fourthly, a well-designed and implemented DW system is a necessary prerequisite to deriving the potential benefits include increased revenues, cost reduction, and improved decision making process. Fifthly, DW system that is not well designed likely to run into accidental system breakdown, which will be detrimental to business processes and result in increased software and hardware costs to the organization. In addition, improvements in system quality can help provide easy-to-understand information outputs and timely reports, and changed information needs can be quickly met. Furthermore, a poor system (software and hardware) could place the organization at a competitive disadvantage because of its inability to provide quality information, specifically in terms of accuracy and content.

B. Reflection on findings regarding information quality

Research results show that a positive significant relationship exists between information quality and net benefits. Organizations require DW systems to develop and promote strategies that emphasize on accuracy, completeness, currency, relevant, format, and integrity of information. Given the importance of information quality dimension to business users' in organizations, DW systems should, therefore, not only provide depth and width in information, but also enables competitive advantage and business effectiveness. Furthermore, effective business decision-making depends on good quality information, and poor information quality can be costly and sometimes disastrous. Without quality information DW systems will fail to achieve the highest benefits for the organization.

C. Reflection on findings regarding service quality

The finding of this study indicated that service quality had positive and significant impact on the net benefits. The conclusion was reached having in minded the following reasons: IS services delivered on time by the IT unit could lead to timely and efficient decision making, which in turn results to better organizational efficiency. Moreover, by having knowledgeable DW specialists who are able to maintain communication well through interactions with business units could results to better services aligned with organizational goals. In addition, the existence of users' best interests at heart who are able to understand the needs of business users better, leading to improve profitability and improve the quality of decision-making. Furthermore, by promoting better services to business users via DW systems would enable rapid responses to new business opportunities. Another reason of this positive influence is great services delivered by IT unit and DW system could lead to enhances cooperation, coordination, and communication; increases trust; and create commitment between DW parties. Besides that user who perceives their system as not providing the expected services or the desired outcomes could not give attention or serious cooperation with DW parties. Finally, by having knowledgeable DW team members who are able to do their jobs well and understand the specific needs of business users could results to better communication and cooperation between them.

D. Reflection on findings regarding relationship quality

The finding of this study revealed that relationship quality had positive and significant impact on the net benefits. This finding is justified by the fact that quality of the relationship between DW parties could potentially reduce the time and effort, which in turn leads to make decisions in a timely manner and with high accuracy. Likewise, DW managers and business managers need to be jointly responsible for collaborate continuously through strong partnerships and appropriate allocation of resources. Added to this, the effective communication, coordination, and cooperation between DW parties will facilitates the identification of areas for development in DW with the best return on investments. Another possible explanation could be for the positive result is the successful communication, coordination, and cooperation between DW managers and business are absolutely help in avoiding paradoxical decisions.

E. Reflection on findings regarding user quality

The finding of this study indicated that user quality had positive and significant impact on the net benefits. The reasons of this positive finding are most likely because, the capability of DW users that possess required skills such as technical, business, and analytical could leads to better management of data which in turn provides accurate analytical reports and statistics to serve decision making in the organization. In addition, by having knowledgeable DW users, who able to understand the organization requirements and have the determination to make action based on available data could results to improve the organization business processes.

F. Reflection on findings regarding business quality

The finding of this study evident that business quality had positive and significant impact on the net benefits. The reasons of this positive influence of business quality are stated as follows: firstly, DW system that built in response to business strategies and plans will leads to serve the organization needs for greater flexible and timely reporting, as well as for providing a wider breadth of data. Secondly, DW system that provides several business requirements and responsive to a change in business needs would results to enhance the capability of the organization to make appropriate decisions. Finally, the integration of DW and business planning process could leads to improve the organization planning processes.

VII. CONTRIBUTIONS OF THE STUDY

This study investigated the factors that lead to evaluate the success of DW systems. It explored the causal relationship between the four quality factors and net benefits, which potentially trigger a new stream of research. In particular, it is the first time that adapted IS success model of D&M (2003) to be a model for evaluating the success of DW systems. The following is a brief discussion of the most important contributions offered by this study.

A. Contributions to Theory

This study represents an important contribution to theory by integrating various theoretical perspectives to identify quality factors that influence the success of DW. It draws upon IS success model of D&M (2003) and other IS/DW success models. In the context of DW success, this study fills a theoretical gap by developing a research model from literature and further enriched through a quantitative field study. The research model was evaluated by using an empirical data set comprising perceptions of TDWI members.

The theoretical contribution of this study is also the identifying of quality factors specifically for DW systems. The research strengthened the former findings because in the previous studies only two quality factors (information quality and system quality) were examined. Moreover, this study expanded significantly the existing knowledge on the impact of quality factors by combining the most important determinant variables that positively link with net benefits. In addition, the findings of this study strongly support the appropriateness of using D&M IS success model attributes to predict the successful DW deployment. Three of D&M IS success attributes of information quality, system quality, and service quality were observed to have significant influence on DW net benefits. The new model of this study also contributes to IS/DW success research by indicating the prominence and relevance of relationship quality, user quality, and business quality as contributors to DW net benefits. Finally, a high proportion of the variance (R2) in net benefits was explained by quality factors. This may provide good justification to consider direct paths from quality factors to the net benefits construct.

B. Implications for Practice

Practitioners are highly interested in understanding the success of DW systems. Often, organizations invest millions of dollars and large amounts of corporate resources in DW initiatives. Failed efforts can impact the organization through wasted investments and unrealized needs. This study offers practitioners an empirically tested model of successful DW. Its findings can be used as a basis for guidelines for DW managers who are interested in protecting DW investments. The guidelines offer an understanding of the quality factors that ultimately impact the success of DW systems. The following is to clarify the contributions for practitioners:

First, taking into account the system quality, DW managers could have the preeminent effect on quality if they concentrate on creating an accessible, reliable, flexible, and integrated system. In addition, DW managers may need to know that the quality of the system strongly affects the users' needs with its output and focus on enhancing the quality of the system accordingly. Second, high information quality is associated with high organizational impact. Information quality can be improved in several ways: for example, by aligning IT strategy with business strategy, using data mining techniques to improve business intelligence, and using business intelligence 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. Similarly, business intelligence and data mining techniques provide relevant information to decision makers, which will improve decision making.

Third, any actions taken to enhance DW service quality can subsequently improve organizational performance. More emphasis should be placed by DW managers on training DW staff to develop better attitudes toward service orientation. Moreover, DW managers and business managers should be made aware of the importance of services provided by IT unit to increase the chances of DW success. Furthermore, service quality is important for the long-term health of both DW team and the organization as a whole. Short-sighted and quick solutions could give rise to more expensive fixes in the future, which would result in high costs for the organization.

Furth, high relationship quality between DW managers and DW business users can help in the effective management of DW projects. Furthermore, maintaining flexibility and good relationship between DW parties also

help in problem-free execution of the projects, avoids cost and time over-runs during implementation of DW projects. In a high quality relationship, it is expected that DW team makes beneficial decisions for the users, provides assistance when needed, and is always sincere. These actions build trust between DW team and DW users and add to the success of DW system. Additionally, successful execution of DW project requires high commitment from DW team towards keeping promises. The success of DW system can be negatively affected by any differences in organizational cooperation. Hence, by making efforts to align their respective cooperation, attempting to understand each other's business rules and practices, and arrive at mutually acceptable processes for problem solving, decision making, and communication DW system success can improve.

Fifth, the results of this study can provide pointers to the practitioners about the aspects of user quality. Practitioners can be put in place to create a development team that demonstrates essential skills that include both interpersonal and technical skills. Further to this, DW managers have to make sure those DW users having the necessary skills such as analysis, technical, and business skills.

Finally, DW managers should aim at developing valuable, inimitable, and non-substitutable DW system capabilities to increase competitive advantage to the organization. The researcher believe that the findings of this study would be useful for DW managers in enabling them to take into consideration the key determinants identified in this study and explore how well these organizations could successfully develop strategies and action plans for DW systems. In addition, DW managers need to consciously try to allocate time to evaluate these new technologies and develop a vision for the use of DW in order to remain competitive.

VIII. LIMITATIONS

To the researcher's knowledge, this study is the first to examine the essence of the quality factors of DW systems success. For this reason, the reader is cautioned that this research has some limitations. First, this is the first study of its type and additional research is needed to confirm the results. Second, this research is subject to common method variance. Common method variance occurs when observed correlation between variables are inflected or is affected by some sort of systematic respondent bias. Third, the professionals responding to this study were actively involved in DW. The sample is not limited to one industry or specific type of DW. The sample is adequately representative of the population of professionals who are involved in DW projects development. However, the generalization of the results must be done with caution. Fourth, the sample size of only 244 usable survey responses is relatively small for the number of questionnaire items and the number of constructs tested in this study. Finally, all the questionnaire items were adopted from the validated scales and literature in previous research. It may be possible that academic researchers and practitioners may be interested in alternative measures used in literature for these constructs.

IX. DIRECTIONS FOR FUTURE RESEARCH

This empirical study has several limitations that can be addressed in the future research. First, this study provided a starting point for a new direction for research on an enduring topic. DW quality is an on-going process in industry. It is therefore especially appropriate to examine the impacts of DW quality variables on DW systems success over time. The present study only examined one point in time. Perhaps the effects of DW quality on performance do not show up until a period of time has elapsed. Naturally, a more extensive longitudinal study may uncover other important findings with regard to the effects of DW quality on corporate performance. Second, the research may be repeated for different IS contexts, such as web-based information systems, e-commerce, enterprise resource planning (ERP), customer relationship management (CRM), or outsourcing. Such contexts may provide additional perspectives on the topic. Finally, this research attempts to cover all aspects of overall DW systems success, there may be some other aspects and relations that may have been omitted from the research model or over looked. Any future study, therefore, needs to continuously refine the scale of overall DW success proposed and supported in this study.

X. CONCLUSION

Previous research indicated that "Improve DW success" is one of the top concerns facing IT/DW executives. As IT quality is a multidimensional measure, it is important to determine which aspects of IT quality dimensions are critical to organizations. This could assist IT/DW executives to device effective DW system improvement strategies with which scarce resources can be allocated more effectively. This study found that DW success appears to be multidimensional consisting of different seven dimensions. The seven dimensions are system quality, information quality, service quality, relationship quality, user quality, business quality, and net benefits. Under each dimension there are many different measures. The quality factors could be the trend in IS/DW success studies in the future, so more studies of this nature should be carried out. This research has illuminated many of the practical and theoretical issues of DW systems success. There are reasons to be positive and continue to pursue the success of DW systems. However, DWs' research community is invited to continue these initial investigations about the success of DW systems. DW systems likely have value although it could cost more than expected.

This research in DW systems success appears promising. Initial results are encouraging. Studies can now look at the success of DW systems with more ideas to couch their dialogue and decisions. If knowledge is power, then the additional knowledge from this research should provide DW managers, researchers and practitioners with

greater power to make more intelligent and informed decisions during, before and after implementation process. The interesting finding was the idea that the all quality factors are considered as important in evaluating the success of DW systems. Yet, little thought seems to have been given to what DW success is, what is necessary to achieve the success of DW, and what benefits can be realistically expected.

Finally, the tunnel vision seems to inhibit DW managers' ability to think creatively. Many DW managers, especially those with good experience, do not seem to be able to envision alternatives to accomplish DW objectives. Therefore, it appears nearly certain and plausible that the way DW systems success is implemented in the future will also change. This will require us to re-think what DW systems success "is" in the future before we have completely determined what DW systems success "is" now.

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