EXAMINING QUALITY FACTORS INFLUENCING THE SUCCESS OF DATA WAREHOUSE

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Abstrak

Kebergantungan organisasi kepada sistem gudang data (Data Warehouse) yang semakin meningkat masakini menyebabkan pihak pengurusan memberikan perhatian khusus kepada peningkatan kejayaan sistem tersebut. Walau bagaimanapun, kadar kejayaan implementasi gudang data adalah rendah dan kebanyakan organisasi tidak mencapai objektif yang disasarkan. Kajian terbaru menunjukkan bahawa penambahbaikan dan penilaian terhadap kejayaan gudang data merupakan salah satu perkara yang dititikberatkan oleh eksekutif IT.Disamping itu, kajian yang menyentuh isu-isu faktor kejayaan implementasi gudang data adalah kurang.Tambahan pula, adalah penting bagi sesebuah organisasi untuk mempelajari kualiti yang perlu diterapkan sebelum gudang data sebenar dibangunkan.Adalah penting untuk mengenalpasti aspek-aspek kejayaan sistem gudang data yang kritikal kepada organisasi bagi membantu eksekutif IT membuat strategi penambahbaikan gudang data yang berkesan.Oleh itu, kajian ini bertujuan untuk memahami dengan lebih mendalam faktor-faktor kritikal dalam penilaian kejayaan sistem gudang data.Kajian ini membangunkan satu model komprehensif untuk sistem gudang data yang berjaya dengan mengaplikasikan DeLone and McLean IS Success Model.Penyelidik memodelkan hubungan di antara faktor kualiti dan kebaikan gudang data.Kajian ini menggunakan kaedah kuantitatif untuk menguji hipotesis kajian.Kutipan data dibuat menggunakan kajiselidik berasakan web.Sampel kajian melibatkan 244 ahli kepada The Data Warehouse Institution (TDWI) yang bertugas di dalam pelbagai industri di seluruh dunia.Borang soal selidik mengandungi 6 pembolehubah tidak bersandar dan satu pembolehubah bersandar.Pembolehubah tidak bersandar digunakan untuk menilai kualiti sistem, kualti maklumat, kualiti perkhidmatan, kualiti hubungan, kualiti pengguna dan kualiti perniagaan.Manakala pembolehubah bersandar pula digunakan untuk menilai kebaikan sistem gudang data.Analisis kajian menggunakan kaedah analisis deskriptif, analisis faktor, analisis korelasi dan analisis regresi yang menyokong semua hipotesis.Hasil kajian menunjukkan bahawa terdapat hubungan kausal yang positif di antara setiap faktor dengan kebaikan sistem gudang data.Ia juga menunjukkan bahawa kebaikan sistem gudang data akan bertambah sekiranya keseluruhan kualiti bertambah.

Katakunci: gudang data, kejayaan gudang data, faedah gudang data, kualiti maklumat, kualiti hubungan, kualiti pengguna, business intelligence, pembuatan keputusan.

Abstract

Increased organizational dependence on data warehouse (DW) systems has drived the management attention towards improving data warehouse systems to a success. However, the successful implementation rate of the data warehouse systems is low and many firms do not achieve intended goals. A recent study shows that improves and evaluates data warehouse success is one of the top concerns facing IT/DW executives. Nevertheless, there is a lack of research that addresses the issue of the data warehouse systems success. In addition, it is important for organizations to learn about quality needs to be emphasized before the actual data warehouse is built. It is also important to determine what aspects of data warehouse systems success are critical to organizations to help IT/DW executives to devise effective data warehouse 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 data warehouse systems. The study attempted to develop a comprehensive model for the success of data warehouse systems by adapting the updated DeLone and McLean IS Success Model. Researcher models the relationship between the quality factors on the one side and the net benefits of data warehouse on the other side. This study used quantitative method to test the research hypotheses by survey data. The data were collected by using a web-based survey. The sample consisted of 244 members of The Data Warehouse Institution (TDWI) working in variety industries around the world. 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 data warehouse systems. Analysis using descriptive analysis, factor analysis, correlation analysis and regression analysis resulted in the support of all hypotheses. The research results indicated that there are statistically positive causal relationship between each quality factors and the net benefits of the data warehouse systems. These results imply that the net benefits of the data warehouse systems increases when the overall qualities were increased. Yet, little thought seems to have been given to what the data warehouse success is, what is necessary to achieve the success of data warehouse, and what benefits can be realistically expected. Therefore, it appears nearly certain and plausible that the way data warehouse systems success is implemented in the future could be changed.

Keywords: data warehouse, data warehouse success, data warehouse net benefits, information quality, relationship quality, user quality, business intelligence, decisions making.

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In the name of Allah and his mercy, the more you learn, the more you realize how little you know. We come to understand that our accomplishments are not possible without the help of Allah. The following are just a few of the countless people who have helped me to complete my Ph.D. studies.

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Lastly, I dedicate this thesis to the spirit of my brother Mohammed, who was martyred during the war on Gaza, the end of 2008, and to the spirit of my uncle Mahmoud Al-Mabhouh who was killed by the Israeli Mossad in Dubai, the beginning of 2010.

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List of Abbreviations

DW	**Data Warehouse**
IS	Information System
MIS	Management Information System
IT	Information Technology
PCs	Personal Computers
CSFs	Critical Success Factors
TDWI	The Data Warehouse Institution
DSS	Decision Support System
KM	Knowledge Management
OLAP	Online Analytical Processing
OLTP	Online Transaction Processing
ETL	Extract, Transform and Load
MDD	Multi-Dimensional Database
RDBMS	Relational Database Management System
B2C	Business-to-consumer
B2B	Business-to-business
CRM	Customer relationship management
ERP	Enterprise Resource Planning
VCF	Virtual Case File
FSC	Financial Service Company
GUI	Graphical User Interfaces
IV	Independent Variable
MV	Mediator Variable

DV	Dependent Variable
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
PCA	Principal Components Analysis
KMO	Kaiser-Meyer-Olkin
MAS	Measure of Sampling Adequacy
SPSS	Statistical Package for the Social Sciences

CHAPTER One

INTRODUCTION

In this chapter, the researcher discusses the background of the data warehouse's technologies. Then starts with the statement of the problem, the research questions, the research objectives, the significance of the study, the scope of the study, and finally the structure of the study.

1.1 Introduction

A data warehouse is an Information System (IS) that provides the means to extract the knowledge from the operational data stores of the business. Data warehouse can also provide information about suppliers, customers, markets, and financial results. Thus, according to Ganczarski (2006), it is enabling the organizations to adapt to the present, learn strategically from the past, and position for the future. Furthermore, a data warehouse is a collection of data from multiple sources, integrated into a common repository and extended by summarized information for the purpose of analysis (Ester *et al.*, 1998). This repository allows enterprises to collect, organize, interpret and leverage the information for decision support (Groth, 2000; Wixom & Watson, 2001; Gupta & Mumick, 2005). It provides the foundation for effective business intelligence solutions for the companies seeking competitive advantage (Chenoweth, Corral, & Demirkan, 2006). Popularity of the data warehouse for data analysis has grown tremendously, as the conventional transaction processing systems have matured while becoming faster and stable (Raden, 1996; Humphries, Hawkins, & Dy, 1999; Phipps & Davis, 2002; Parida, 2005).

Currently, businesses focus increasingly on gaining competitive advantages. Where, organizations have recognized that the effective use of the data is the key element in the next generation of enterprise information technology (Kayworth, Chatterjee, & Sambamurthy, 2001; Carr, 2004). The strategic use of information technology becomes a fundamental issue for every business, because information technology can enable the achievement of the competitive and the strategic advantage for the enterprises (Kearns & Lederer, 2000). The technology for accessing, updating, organizing, and managing a large volume of data developed over the past twenty years (Sabherwal, Jeyaraj, & Chowa, 2006; Biehl, 2007). Moreover, many organizations have difficulties in processing a large amount of data into valuable information, until the boom of data warehouse techniques. There is an increasing awareness of data warehouse technology at many organizations to support evidence-based decision making (Wixom & Watson, 2001; Garry, 2004; Gupta & Mumick, 2005). The field of data warehouse addresses the question of how best to use this vast amount of historical data to discover general regularities and to improve the process of making decisions.

A data warehouse offer data integration solutions and improved access to timely, accurate and consistent data (Ang & Teo, 2000; Ingham, 2000). According to Meyer and Cannon (1998), the data warehouse equips its users with effective decision support tools by integrating corporate wide data into a single repository from which users can run reports and perform ad hoc data analysis. Moreover, the data warehouse leverages the investments already made in legacy systems and provides business users the potential for much greater exploitation of informational assets

(Counihan, Finnegan, & Sammon, 2002). In addition to this, the data warehouse helps to reduce the cost; increases value added activities and improve efficiency (Zeng, Chiang, & Yen, 2003). On the other hand, the data warehouse like all information systems faces factors that affect the success of its implementation (Adelman, 1997; Haley, 1997; Wixom & Watson, 2001; Kanar & Oz, 2002; Shin, 2003; Chenoweth *et al.*, 2006; Hayen, Rutashobya, & Vetter, 2007; Hwang & Xu, 2008; AbuAli & AbuAddose, 2010). Hwang and Xu (2008) and Mukherjee (2003) demonstrate that the success factors for data warehouse implementation are based on four categories: Organization, Technique, Usage, and System.

Inmon (1996) defines the data warehouse systems as a subject-oriented, integrated, non-volatile, time-variant collection of data in support of management's decision making process. Moreover, the concept of integrated data for management support is not new, but management information systems and executive information systems have been practiced since the early 1970's (Shim *et al*., 2002). However, the operational Information Technology (IT) environment in most large companies is very heterogeneous as a result of decades of changing technologies (March, Hevner, & Ram, 2000). In addition, data resides in legacy systems in various technologies and environments, ranging from Personal Computers (PCs) to mainframes. In other words, legacy systems are incapable of supporting management decision processes due to a lack of data integration (Robertson, 1997).

Data warehouse appeared in the early 90s as a decision support technology that could integrate data from multiple sources (Watson & Ariyachandra, 2005). Currently, many organizations possess Information Technology (IT) infrastructures that provide limited data management, integration, and access. This is why organizations would better serve by IT infrastructures that offer appropriate data and tools to support decision makers (Bhansali, 2007).

Information is one of the most valuable assets of enterprises, and when it is utilized properly it can help decision-making intelligently that can improve the operations of enterprises significantly (Lin, 2005). Lin also argues that data warehouse is a technology that allows information to be efficiently, easily, accurately and timely accessed for decision-making purposes. In addition, a data warehouse can look at as an 'informational database' that is maintained separately from an organizations operational database. In the broadest sense of the term, a data warehouse uses to refer to a database that contains very large stores of historical data. The data stored in a series of snapshots, where each record represents data at a specific time. This snapshot of data allows a user to reconstruct the history and to make precise comparisons between different periods of time (Khan, 2003).

Data warehouse systems experienced substantial growth in the past ten years (Winter, 2008). 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 conducted by Gagnon (1999) reports an average cost of $2.2 million for a typical data warehouse, while the study (Garry, 2004) claims that the market of enterprise data warehouse is expected to experience double-digit growth through 2008. Moreover, Vesset (2006) found that the market of data warehouse tools repeated its 2004 performance in 2005 with an 11.3% growth rate to reach $9.6 billion in revenue. Another research (Pendse, 2007) expects that the size of data warehouse 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 (The451Group, 2010), "*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*" (p. 1).

This study aims to determine the quality factors that could evaluate the success of the data warehouse systems, and to provide a comprehensive examination of the relationship among them. Researcher also examines the influences of the quality factors on the net benefits of data warehouse systems. Many authors state that the success of data warehouse can be achieved by obtaining the net benefits of it (Wixom & Watson, 2001; Mukherjee, 2003; Hwang & Xu, 2008; among many others). Moreover, net benefits dimenssion used as a dependent variable in two studies of data warehouse success conducted by Wixom and Watson (2001) and Hayen *et al*. (2007).

According to Ramamurthy *et al.* (2008) and Bhansali (2007), there are several advantages of applying a success measurement in data warehouse systems, especially for top management. These reasons include: First, data warehouse systems expenses are significant, as data warehouse systems disbursement grows and becomes a significant portion of business costs. This is why stakeholders become more interested in being able to compare the value of this expenditure with the obtained benefits and compare those benefits with how other organizations benefit from similar data warehouse systems. Second, to find out the benefit generating areas, top management wants to find the benefit generating points so that they can further exploit these and apply corrective measures where the benefits are small. Third, data warehouse systems have a fundamental impact on the decision making in the organizations. Finally, as an aid for innovation and as a consequence of the above, top managers can identify and exploit areas for deploying innovative business strategies.

In addition, by understanding the relative importance of quality factors, data warehouse managers can allocate resources accordingly and efficiently. Hence they may also plan for an effective data warehouse success. In sum, the research provides an evidence for additional links in successful model of IS which are not explicitly incorporated in the DeLone and McLean (2003) as mentioned by (Petter, DeLone, & McLean, 2008). Finally, the research proposes new dimensions such as “relationship quality”, “user quality”, and “business quality” which improve the thoroughness of the model and ensure a better evaluation of data warehouse in order for it to succeed (Chen *et al.*, 2000; Hwang *et al.*, 2004; Kimball, 2006; Bhansali, 2007).

The gaps in the literature are examined and the research questions and the objectives addressed by this study are described in the following sections.

1.2 Problem Statement

Recognizing the need for an effective data warehouse 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 data warehouse literature on factors affecting the successful implementation of data warehouse. According to Hayen *et* *al*. (2007) there is little empirical research to measure the success of data warehouse projects. In addition, few studies assess the success factors of data warehouse in general and Critical Success Factors (CSFs) in particular (Hwang & Xu, 2007; Hwang & Xu, 2008). Mukherjee and Souza (2003) argue that, the precise nature of the success factors and their impact on the data warehousing are still unclear. Furthermore, Ramamurthy *et al*. (2008), Bhansali (2007), and Mukherjee (2003) contends that more studies in factors that impact the success of data warehouse need to be conducted. According to Hayen *et al*., (2007: p. 550), "*more work is needed, however, to examine exactly how the dimensions of the data warehouse success interrelate*". Moreover, they acknowledge that there is also a need to explore the role of other success dimensions in the data warehouse context.

The understanding of how organizational decision makers perceive data warehouse may enable organizations to implement the data warehouse initiatives more efficiently (Ramamurthy, Sen, & Sinha, 2008). According to Wixom and Watson (2001), however, there is a lack of evidence on how organizations perceive to the data warehouse benefits. In addition, the net benefits of data warehouse influences the data warehouse implementation success significantly (Mukherjee, 2003; Hwang & Xu, 2008). The failure to achieve the net benefits of the data warehouse system is one of the major causes of failure in data warehouse initiatives (Garner, 2007). Therefore, perception of the data warehouse system benefits may influence the success of the data warehouse system in the organizations.

Building data warehouse 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 (Inmon, 2005). In fact, the use of data warehouse has not always led to significant organizational improvements. In many cases, the estimation for the success of the data warehouse systems is very limited in meeting users' expectations (Hwang *et al.*, 2004; Johnson, 2004; Chenoweth *et al.*, 2006; Hayen *et al.*, 2007; Ramamurthy, Sen, & Sinha, 2008). Moreover, there are many reports regarding the failure rates of data warehouses. The reported percentages vary based on the reporting agency however the average failure rates are between 20%-50% (Wixom & Watson, 2001; Conner, 2003; Agosta, 2004; Ambler, 2006).

Despite the huge investment in data warehouse, organizations are still unable to reap the expected benefits from these investments (Watson, Goodhue, & Wixom, 2002). Bhansali (2007) indicated for a criticism regarding the effectiveness and contribution of data warehouse in achieving competitive advantage. On the other hand, the tremendous benefits associated with the successful data warehouse initiatives have encouraged and stimulated the continuing of implementation of data warehouse and have motivated the researchers to study extensively the causes of data warehouse failure and try to tackle it out (Hwang & Xu, 2008).

Regardless of the high rate of data warehouse failure, there are substantial opportunities of the successful data warehouse 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 (Mohanty, 2006). According to Mathew (2008), from the scale and complexity point of view, data warehouse system implementation is more difficult than a software package implementation. Furthermore, data warehouse 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 (Thomann & Wells, 1999; Mohanty, 2006). Therefore, there is a need to understand where the business value is in data warehouse (Mohanty, 2006: p. 270).

In general, the success in information systems area is difficult to define and measure since it means different things to different people (Thomas & Fernandez, 2008). Additionally, Shin (2003) pointed out that there are a set of challenges that faced by the data warehouse 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 data warehouse system must measure what they have already done right, as well as what they have done wrong (Thomann & Wells, 1999; Mohanty, 2006).

Among the causes or reasons of failure on data warehouse implementations are the poor information provided to the data warehouse system (English, 1999; Rudra & Yeo, 2000). Another issue is argued by Garner (2007) who refers to the disappointing result of data warehouse systems to the difficulty in integrating data from multiple sources. Additionally, from the causes of data warehouse initiatives' failure is that lack of software flexibility (Ramamurthy *et al.*, 2008), the nature of bad technologies (Thomann & Wells, 1999), and the difficulty to use and learn the data warehouse system (Ganczarski, 2006). Therefore, information quality and system quality are important to be considered in evaluating the success of data warehouse.

Another issue causes of data warehouse initiatives' failure is that the low data reliability and lack of appropriate user training (Shin, 2003). Moreover, Ramamurthy *et al*., (2008) stated that the reliability, responsiveness, and assurance of the data warehouse systems have not been studied extensively. According to Shin (2003), service quality is an important aspect in ensuring the success of data warehouse systems. Other possible reasons of failure on data warehouse initiatives are the lack of commitment, communication, and cooperation between the data warehouse managers and users (Bhansali, 2007). In addition, Hwang *et al.* (2004) and Perkins (2001) 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 data warehouse. Chang and Ku (2009) 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 the data warehouse systems.

There are also another reasons and issues of data warehouse failure. According to Payton and Zahay (2003) and Hwang *et al.* (2004), there is additional risk in the form of the data warehouse users in terms of their needs to strong analytical and technical skills. Furthermore, Chen *et al*. (2000) concluded that use of data warehouse suffered because users found the system difficult to use. Other researchers (Hwang *et al.*, 2004; Avery & Watson, 2004; Bhansali, 2007) stressed that the lack of project team competencies, lack of data warehouse users to the necessary experiences, and the difficulty in understanding the organizations' requirements are the main causes of failure on data warehouse implementation. Moreover, business quality indicated as an important factor of improving the success of data warehouse systems (Gosain & Singh, 2008). According to several authors (Thomann & Wells, 1999; Garner, 2007; Gosain & Singh, 2008), there is a lack of studies that considered business quality in the context of data warehouse success. Therefore, user quality and business quality are important to be considered in assessing the success of data warehouse.

In addition, it is also important for organizations to learn about quality needs to be emphasized before the actual data warehouse is built (Andersson & Eriksson, 1996; Thomann & Wells, 1999; Mohanty, 2006). In the area of data warehouse, little studies are conducted on the quality factors of the data warehouse success models. For instance, studies of Wixom and Watson (2001), Hayen *et al*. (2007), and Hwang and Xu (2008) focus on the two quality factors only: information quality and, system quality. In addition to that, there is an insufficient empirical evidence to assess the relationship between quality factors and the net benefits of the data warehouse systems (Thomann & Wells, 1999; Vassiliadis, 2000b; Watson, Goodhue, & Wixom, 2002; Watson & Ariyachandra, 2005). Therefore, many factors: service quality, relationship quality, user quality, and business quality that could evaluate the success of data warehouse are not explained (Thomann & Wells, 1999; Shin, 2003; Hwang *et al.*, 2004; Avery & Watson, 2004; Mathew *et al.*, 2006; Carr, 2006; Gosain & Singh, 2008). 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 and their effect on net benefits in data warehouse success area.

In sum, organizations highly concern about the quality of data warehouse due to inadequate efforts made to improve the success of data warehouse in their organizations. Based on the issues discussed above, it found that there is insufficient attention given to data warehouse success and that refers to a set of issues and factors related to the data warehouse success. In addition, few studies have tried to investigate the most significantly influencing characteristics among quality factors and net benefits in the context of data warehouse success.

1.3 Research Questions

In order to address the aforementioned issues, this research examines the quality factors contributing to the success of data warehouse systems. The research questions are:

a) What are the quality factors that influence the success of data warehouse systems?
b) What is the effect of the quality factors (system, information, service, relationship, user, and business) on the net benefits of the data warehouse systems?
c) What is the effect of information quality, relationship quality, and business quality on the relationship between system quality, service quality, and user quality and the net benefits of the data warehouse systems?

1.4 Research Objectives

The main aim of this study is to develop and validate a model for the success of data warehouse systems. The objectives are:

a) To identify the quality factors influence the success of the data warehouse systems.

b) To determine the effects of quality factors on the net benefits of the data warehouse systems.

c) To ascertain the relationship between system quality and information quality with regards to the net benefits of the data warehouse systems.

d) To ascertain the relationship between service quality and relationship quality with regards to the net benefits of the data warehouse systems.

e) To ascertain the relationship between user quality and business quality with regards to the net benefits of the data warehouse systems.

1.5 Significance of the Study

The effective implementation of data warehouse is governed and facilitated by certain factors. Organizations can certainly benefit from a comprehensive understanding of the factors which are critical to validate the success of data warehouse systems.

Net benefits are the overall evaluation of the effectiveness and performance of the data warehouse systems by the extent to which it meet the needs and expectations of the organizations. Data warehouse success is the accomplishment of the objectives of data warehouse – strategic, planning, business, operational, and technical. In an attempt to investigate the implementation of data warehouse, the research uncovers a theoretical model to implement the success of data warehouse. Current literature is deficient in empirical research related to the data warehouse success.

Thereby, this study compares and reviews the existing success factors proposed by various authors. This research also conducts an analysis to identify their possible weaknesses and deficiencies to improvise in the future. In addition, it improves the literature of the understanding the relationship of quality factors with net benefits. This research also measures the relationships between quality factors as the determinate variables of net benefits as well as the relationship between system quality and information quality; service quality and relationship quality; and user quality and business quality. It also creates awareness regarding the importance of quality factors towards the net benefits of the data warehouse systems.

As for the researcher, this study provides a comprehensive model that needs to be included in the future empirical tests. Consequently, the model broadens the understanding of the issue that is becoming gradually more important with regards to the net benefits of the data warehouse systems. The factors contributing to net benefits of data warehouse that are tested in this study are: system quality, information quality, service quality, relationship quality, user quality, and business quality.

Finally, from the practical side, it is expected to realize a better understanding of determinant factors for the net benefits of data warehouse systems. Mainly, developers of data warehouse applications, practitioners and data warehouse users such as business analysts and decision makers can use the model to find the primary needs to concentrate on improving most valuable features of their data warehouse systems.

1.6 Scope of Study

The main aim of the research is to identify quality factors that might influence the success of data warehouse systems. Additionally, this research entails two main phases: An exploratory phase to develop the measurement model and, confirmatory phase to validate the model. The updated DeLone and McLean IS Success Model (2003) and a collection of other knowledge that have been combined from IS and data warehouse literature are employed to investigate the quality factors of data warehouse success. Since data warehouse is considered to be the higher level of information system that normally used by decision makers and to accomplish their decision-making tasks, executives, managers, and data warehouse business users are selected from the members list of The Data Warehouse Institution (TDWI) to be the source of the survey. This list contains the contact information of over 29,000 data warehouse professionals around the world. The samples from 3000 members of TDWI are used in the quantitative approach. It is also worth mentioning that this research is not covering data warehouse from a technical point of view; it is mainly emphasizing on the evaluation and validation of the success of data warehouse systems.

1.7 Structure of the Study

This thesis is organized into six separate chapters. These chapters are closely related to each other and their relationships are illustrated in Figure 1.1. The contents of every chapter are provided as follows:

Chapter 1 **Introduction**. This chapter is an introduction and overview of the study including research background providing an overview of the overall structure of the research, identifying problem statements and setting up the context of the research with respects to success of data warehouse. This is followed by statements of the research questions and research objectives, which set the scope of the study and finally, the significance of potential contributions of the study is provided.

Chapter 2 **Literature Review**. Previous researches relating to the research domain are provided covering the main areas including success of data warehouse and its relations with net benefits of data warehouse systems. Review of the core models relating to data warehouse success and IS success models are presented in details. This chapter also extensively illustrates quality factors contributing to data warehouse success. It also discusses data warehouse development processes.

Chapter 3 **Research Model and Hypotheses**. This chapter presents the conceptual model of this study based on the background models and related studies described in the previous chapter. It also describes the development of the hypotheses.

Chapter 4 **Methodology**. This chapter discusses the research methodology and design incorporated in the study. It then followed by a description of the instrument developed and the reference sources of the measurement items. The chapter concludes with a brief description of validity, reliability, and pre-testing of the survey instrument that was undertaken.

Chapter 5 **Data Analysis and Findings**. This chapter presents the analysis of the quantitative data, using multivariate data analysis approach. The initial section describes the demographic profile of respondents. It then followed by factor analysis, validity, and reliability tests. Finally, this chapter presents the main findings of the study in terms of the nine hypotheses proposed.

Chapter 6 **Discussion and Conclusions**. This chapter discusses the findings of results by discussing the major research questions and the hypotheses proposed in this study. Finally, it provides an overview of the study and presents its theoretical and practical contributions. The chapter also discusses the limitation and weaknesses of this study and concludes with a brief discussion of the possible future research directions in the subject area of this study.

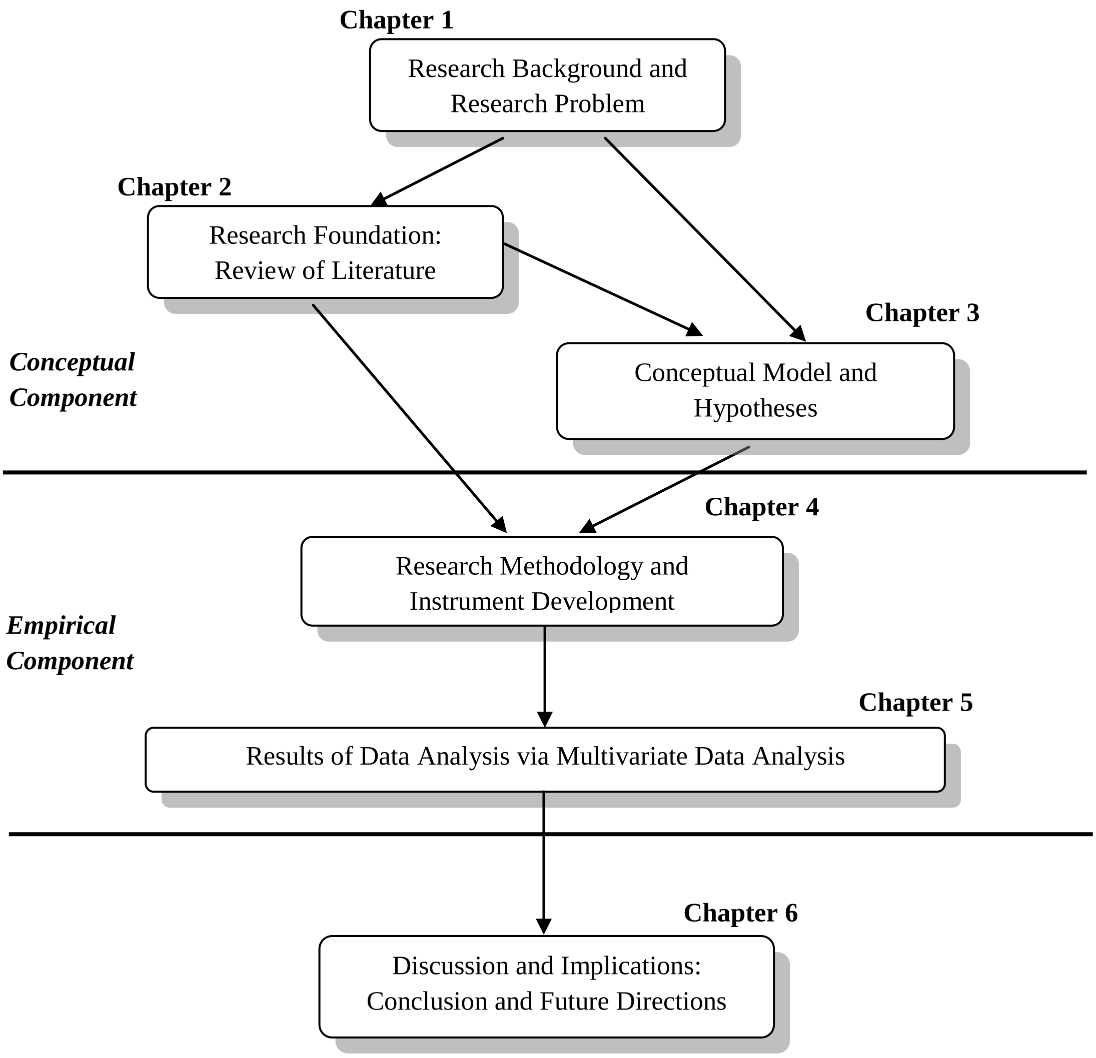


Figure 1.1: General Research Framework

1.8 Summary

On the whole, this study provides an identification of the quality factors that evaluate the success of data warehouse systems. The research present the overview of the study particularly on the research background, problem statement, research questions, objectives, significance of the study, and scope of study.

CHAPTER Two
LITERATURE REVIEW

The strategic use of information technology becomes a fundamental issue for every business where the information technology can enable the achievement of competitive and strategic advantage of the enterprise (Kearns & Lederer, 2000). Data warehouse technology makes a huge impact in the world of business, where with its help data turned to information that early adopters could leverage for enormous competitive advantages (Bhansali, 2007). Yet, there are few studies (Wixom & Watson, 2001; Shin, 2003; Hayen *et al.*, 2007; Hwang & Xu, 2008) specifically in the factors that evaluate the success of data warehouse systems. This chapter introduces the data warehouse technology. It also presents a review of existing research's and literature on the data warehouse. This chapter contains nine sections. The first two sections present overview and definitions of data warehouse. The third section presents the components and complexity of the development process of the data warehouse. Section four discusses the data warehouse success, benefits, and challenges. The fifth section reviews the previous studies of a data warehouse success. Section six addresses the issues of the existing data warehouse studies. Section seven identifies the quality factors within data warehouse. Section eight introduces the information system (IS) success model adapted in this study. The final section summarizes the review.

2.1 Overview of Data Warehouse

In the mid-80s Barry Devlin worked on an analysis-oriented way of constructing intelligent decision support systems which are called “Information Warehouses”. In 1991, Inmon published the first book about data warehouse, entitled “Building the Data Warehouse”, and then he is recognized as the father of the data warehouse.

Data warehousing 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. By the mid-90s, it became very clear that building an enterprise data warehouse was incredibly difficult, and the focus shifted to departmental data marts. In 1994 Ralph Kimball's first book “The Data Warehouse Toolkit” he provided the lacking design guidance on how to optimize data for analysis. By the late 90s, many organizations were implementing data warehouses to assist in making strategic decisions about the changes needed, in order to remain competitive in an environment of rapid change (Heise, 2005).

The concept of integrated data for management support is not a new one. Management information systems and executive information systems have been around since the early 1970’s (Shim *et al.*, 2002). However, the operational IT environment in most large companies is very heterogeneous as a result of decades of changing technologies (March *et al.*, 2000). Data resides in legacy systems in various technologies and environments, ranging from PCs to mainframes (Robertson, 1997). As a result they are incapable of supporting management decision processes due to the lack of data integration. Data warehouses offer data integration solutions and improved access to timely, accurate and consistent data

(Ang & Teo, 2000; Ingham, 2000). A data warehouse equips its users with effective decision support tools by integrating corporate wide data into a single repository from which users can run reports and perform ad hoc data analysis (Meyer & Cannon, 1998). The data warehouse leverages the investments already made in legacy systems, allowing business users the potential for much greater exploitation of informational assets (Counihan *et al.*, 2002). A data warehouse helps to reduce the cost, increases value, added activities, and improves efficiency (Zeng *et al.*, 2003).

The data warehouse also allows sophisticated analyses of data. The capability of the data warehouse to perform the analysis has been documented by Srivastava and Chen (1999). In the data warehouse, data is periodically replicated from operational databases and external providers of data, and is conditioned, integrated and transformed into a read-only database to discern patterns of behavior; support decision support systems and enable online analytical processing. According to Little and Gibson (2003) data warehouses also help in accessing, aggregating and analyzing large amounts of data from diverse sources to understand historical performance or behavior and to predict and manage outcomes.

Data warehouse technology is inherently complex (Stephen, 1998), requires huge capital spending (Wixom & Watson, 2001) and consumes a lot of development time. The complexity of data warehouse implementations is subject to ongoing research (Lee, Kim, & Kim, 2001). The adoption of data warehouse technology is not a simple activity of purchasing the required hardware and software, but rather a complex process to establish a sophisticated and integrated information system (Vassiliadis, 2000a; Wixom & Watson, 2001). Building a data warehouse consists of a complex process involving data sourcing, data extraction and conversion, population of the data warehouse database, data warehouse administration, creation of metadata and access of the data warehouse database for decision support and business intelligence (Berndt & Satterfield, 2000; Watson, Fuller, & Ariyachandra, 2004).

As discussed above, a data warehouse differs in many ways from a traditional operational system. The data warehouse supports management decision-making and plays a role in supporting the strategic direction of the organization; it also integrates enterprise-wide data and provides sophisticated analyses of the data (Srivastava & Chen, 1999) facilitating business understanding (Sullivan, 2001). Therefore, it appears that for an effective implementation of the data warehouse in an organization, aligning the data warehouse to business goals and strategies would be an appropriate and necessary measure.

The day-to-day management of the data warehouse is also different from the management of an operational system (Chaudhuri & Dayal, 1997), because the volumes can be much larger and require more active management (Stephen, 1998), such as creating/deleting summaries, or rolling data on/off the archive. In essence, a data warehouse is a database that is continually changing to satisfy new business requirements (Stephen, 1998).

In practice, data warehouses must be designed to change constantly to adapt to changes in the business area (Armstrong, 1997). In order to provide this flexible solution, Anahory and Murray (1997) have found that the process that delivers a data warehouse has to be fundamentally different from a traditional waterfall method.

The waterfall method is a sequential software development method in which development flows downwards (like a waterfall) through the phases of requirement analysis, design, implementation, testing, integration and maintenance. The underlying issue with data warehousing projects is that it is very difficult to complete the tasks and deliverables in the strict, ordered fashion demanded by a waterfall method. This is because the requirements are rarely fully understood, and are expected to change over time (Strong, Lee, & Wang, 1997). Table 2.1 adapted from Sperley (1999) presents a comparison between the data warehouse and operational system characteristics.

Table 2.1: Comparison of Data Warehouse and Operational Systems (Sperley, 1999)

Data Warehouse Systems	**Operational Systems**
Used by management	Used by front-line workers
Strategic value	Tactical value
Supports strategic direction	Supports day-to-day operation
Used for on-line analysis	Used for transaction processing
Subject oriented	Application oriented
Stores historical data	Stores current data only
Unpredictable query pattern	Predictable query pattern

2.2 Definition of Data Warehouse

In order to understand the essence of data warehouse, one must have a definition of this multi-faceted concept. However, clearly defining the term data warehouse is not simple task, since there are many definitions to be found in the literature. The Bill

Inmon's book "Building the Data Warehouse" contains the most widely published definition of a data warehouse:

> *"A data warehouse is a subject-oriented, integrated, nonvolatile, and time-variant collection of data in support of management's decisions"* (Inmon, 2005: p. 29).

The above definition emphasizes the support for management, as contrary to operational systems supporting the daily work routines. Furthermore, the definition clearly expresses the key characteristics of the data stored in data warehouse and distinguishes between these types of systems and traditional operational systems. As stated in the book, these characteristics are described as follows:

- Subject-orientation mandated a cross-functional slice of data drawn from multiple sources to support a diversity of needs. This was a radical departure from serving only the vertical application views of data or the overlapping departmental needs for data.
- The integration is not the act of wiring applications together. Nor is it simply merges data from a variety of sources. Integration is the process of mapping dissimilar codes to a common base, developing coherent data element presentations and delivering this data as broadly as possible.
- Time variance at its essence, it calls for storage of multiple copies of the underlying detail in aggregations of differing periodicity and/or time frames. Data might be available in daily, weekly, monthly, quarterly and yearly aggregates of differing duration. The time variant strategy is essential, not only for performance but also for maintaining the consistency of reported summaries across departments and over time.

- Non-volatile:literally means that after data are loaded into the Data Warehouse, it is never modified. This is necessary to preserve incremental net change history. This, in turn, is required to represent data as of any point in time. When the data row updated, the information will be inaccurate. It can never recreate a fact or total that included the unmodified data.

Data warehouse has different definitions. Generally, most authors agreed on the conception of data warehouse, but, rather each author has promoted his or her own idea of its inferred meaning. Table 2.2 summarizes some definitions used by researchers.

Table 2.2: Some Definitions of Data Warehouse

Author(s)	**Data Warehouse Definitions**	**Approach**
Chaudhuri & Dayal (1997)	Data warehouse is a collection of decision support technologies.	Technical
Armstrong (1997)	An environment to collect, manages, and distributes data.	Technical
Haley (1997)	Data warehouse is the process of creating, maintaining, and using a decision support infrastructure, and it offers a unique opportunity to improve the IT infrastructure as a whole.	Managerial
Gray (1998)	Databases technology that provide decision makers with clean, consistent and relevant data.	Technical
Gray & Watson (1998)	Data warehouse is a repository of data that can be used to support queries, reporting, online analytical processing (OLAP), decision support system (DSS), and data mining.	Technical
Theodoratos & Sellis (1999)	Data warehouse is a database that collects and stores data from multiple remote and heterogeneous information sources.	Technical

Watson (2001)	Data warehousing is a critical enabler of strategic initiatives such as business-to-consumer (B2C), business-to-business (B2B), customer relationship management (CRM), and balanced scorecards.	Managerial
Khan (2003)	A centralized repository for enterprise data that is used by staff at all levels to support operational and management decision making.	Managerial
Shin (2003)	Data warehouse is a platform for the integrated management that supports many tasks such as decision making, planning, data analysis, target marketing, and customer services.	Managerial
Parida (2005)	Data warehouse is a relational database contains historical data derived from transactional data which is designed for query and analysis rather than for transaction processing.	Technical
Line (2006)	A data warehouse can be viewed as a very large database that integrates the data stored in several different operational data sources.	Technical
Kimball (2006)	A decision support database that is maintained separately from the organization's operational databases.	Technical
Chenoweth, Corral, & Demirkan (2006)	Data warehouses have powerful potential to provide information for effective business intelligence solutions for companies seeking competitive advantage.	Managerial
March & Hevner (2007)	Critically dependent upon the availability of integrated, high quality information organized and presented in a timely and easily understood manner.	Managerial
Gosain & Singh (2008)	Data warehouse development differs from those of the traditional operational systems, as goals and strategies of the organization need to be taken into consideration for data warehousing environments.	Managerial

Table 2.2 shows that almost all definitions share the same focus, even though definitions have been defined from two broad perspectives of managerial and technical. The managerial approach sees data warehouse as a process that gathers data from inside and outside of organizations and integrates them in order to generate information relevant to decision-making process. While the technical approach presents data warehouse as a set of tools that support the process. Despite the differences in approach, they all include the idea of analysis of data and information. In addition, the above definitions highlight the important elements of data warehouse. The first crucial part of data warehouse is the gathering, cleaning, storing and managing data available internally and externally. The critical analysis of available data using data warehouse tools emphasizes the intelligence of data warehouse. The definitions also emphasize the complex and competitive information provided by data warehouse, which is crucial for executives and decision makers in organizations.

2.3 Data Warehouse Development Process

Data Warehousing is a system architecture, not a software product or application (Agosta, 1999). Similarly, Manning (1999) believes that the data warehouse was intended to provide an architectural model for the flow of data from operational systems to decision support environments. Building a data warehouse requires the integration of many tasks, components, and coordination of efforts of many people (Kimball, 2006). Several researchers (Meyer & Cannon, 1998; Murtaza, 1999) identify various data warehousing components and dimensions. Figure 2.1 illustrates the overall architecture of a data warehouse by identifying the major components and how data flows through the system.

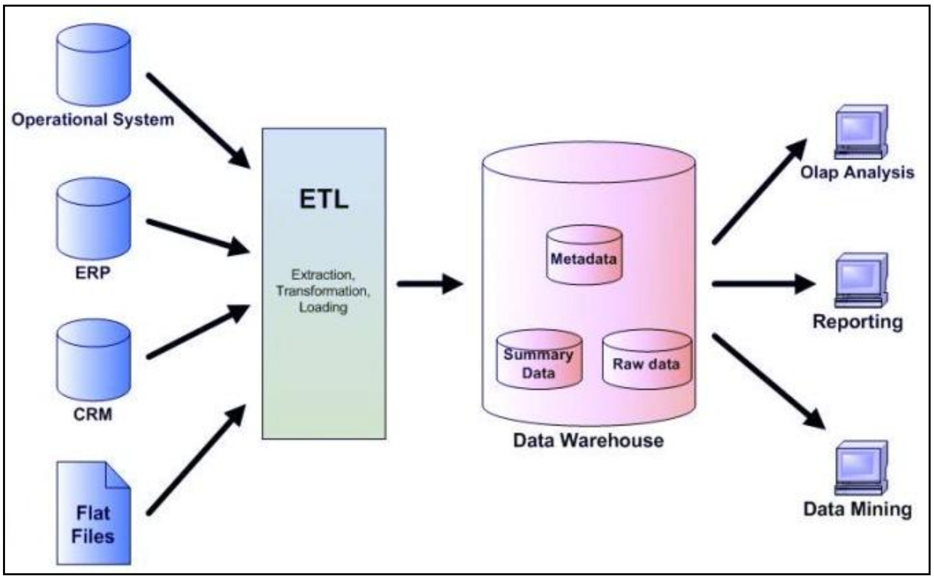


Figure 2.1: Architecture of a Data Warehouse (Humphries, Hawkins, & Dy, 1999)

According to (Meyer & Cannon, 1998), a datawarehouse can categorize into six major components as:

Data sourcing–Building a data warehouse is a complex and lengthy process. To build a data warehouse, first, the information needs of the organization have to be identified. This in turn helps to determine the data requirements that fulfill these information needs. These requirements are used to develop a data model that provides business reasons for building a data warehouse (Little & Gibson, 2003). Sources of data are then identified in the transactional legacy systems, enterprise resource planning (ERP), e-commerce systems, and etc.

Data extraction and conversion–The next step in building the warehouse is data preparation and data cleansing. It involves the extraction of source data, transformation into new forms and loading into the data warehouse environment. As organizations realign their information infrastructure toward integrated data warehouses and decision support systems, the complex problem of accurately identifying and merging databases becomes critical (Berndt & Satterfield, 2000). According to Manning (1999), the cost of extracting, cleaning and integrating data represents 60-80% of the total cost of a typical data warehousing project. Ensuring high quality data is one of the most difficult challenges faced in data warehousing (Wixom & Watson, 2001).

Data warehouse database–At the core of the data warehousing system lays a good data management system. The database server used for a data warehouse is responsible for the provision of robust data management, scalability, high performance query processing and integration with other servers (Shahzad, 1999). Warehouse servers can categorize into two types: Relational Database Management System (RDBMS) (Stephen, 1998; Vassiliadis, 2000b) and Multi-Dimensional Database (MDD) (Dinter *et al.*, 1998). The implementation of RDBMS is based on a two-dimensional relationship of related data called tables (Blaha, Premerlani, & Hwa, 1994). MDD can view as a cube, where information is piled on the various axes or dimensions of the cube (Buzydlowski, Song, & Hassell, 1998; Timo Niemi, 2003). It is a technique that allows multi-part questions to be posed of the database. For example, instead of a report on revenue by branch, MDD might report revenue by branch, sub divided by product lines and by region (Sullivan, 1996). RDBMS has an edge on MDD when considering its huge data storage capacity, portability issues or security. MDD is popular for its instant response, implementation ease and integration with Meta data (Shahzad, 1999).

Data warehouse administration –Data warehouse brings many complex administration issues that are different from transactional or decision support applications (Benander, Fadlalla, & James, 2000). Data warehouse administration keeps the data warehouse environment working. With the number of subject areas and amount of historical data, a data warehouse requires significant amounts of disk storage and extensive planning (Stephen, 1998). Data warehouse administration provides query management, access control (Roussopoulos, 1998), disaster recovery (Armstrong, 1997; Sen & Jacob, 1998), tool integration (Freude & Konigs, 2003), directory management, security (Stephen, 1998), request control (Agrawal *et al.*, 1997), capacity planning (Chaudhuri & Dayal, 1997), data usage auditing (Stephen, 1998; Vassiliadis, 2000a), and user administration (Chaudhuri & Dayal, 1997; Katic *et al.*, 1998). Effective governance is considered a key to data warehouse success (Watson *et al.*, 2004).

Business intelligence tools–Once the data is loaded into the database, various access tools are used for end user interaction. Gray and Watson (1998) define the access tools as decision support tools that allow users to analyze information with ease. Business intelligence tools being able to consolidate and analyze data for better business decisions can often lead to a competitive advantage. The selection of the right end-user tool is important as the ease of use and range of functions provided by the access tools determine the user's perception of the value and success of the data warehouse. In addition, data mining is the most commonly used business intelligence tool by organizations. Mining the data warehouses provides new insights into value adding business processes, customer buying patterns, fraudulent activity and product profitability. Moreover, data miningcan define as analyzing the data in large databases to identify trends, similarities, and patterns to support managerial decision making (Zorn *et al.*, 1999).

Metadata–Another important component of a data warehouse is the metadata. Metadata is data about the data; it is data that is used to describe other data; it indexes information and monitors its use (Sullivan, 1996). In the context of the data warehouse, organizations need metadata for tool integration, data integration and change management. Sen (2004) describes two types of metadata: back room metadata and front room metadata. The back room metadata guides the extraction, cleaning and loading processes. The front room metadata is more descriptive and helps query tools and report writers. According to (Lee *et al.*, 2001), metadata empowers the data warehouse users by helping them meet their own informational needs, finding where data exists, what it represents and how to access it. Furthermore, Lee *et al*., (2001) proposed a metadata oriented data warehouse architecture that consists of seven components: legacy system, extracting software, operational data store, data warehouse, data mart, application and metadata. They point out that metadata must be integrated with data warehousing systems because without metadata, the decision support of data warehouse is under the control of technical users.

The above discussion highlights the important components of data warehouse development process. It concludes that the data warehouse development process is complex because it requires numerous components and passes through several stages. This complexity occurs at every step of the way, from identifying data sources and data integration through system administration and business intelligence access tools. It also shows that one of the greatest implementation challenges is integrating all of the components required to design, transform, store, and manage a data warehouse. The next section discusses the data warehouse challenges in details.

2.4 Data Warehouse's Challenges

Despite the many benefits that a data warehouse can offer, data warehouse is still considered a large, expensive and risky investment. Because data warehouses use advanced hardware and software capabilities (e.g. symmetric multiprocessing, the ETL process), most organization have to hire outside consultants. As the requisite knowledge does not exist in-house (Goeke, 2006). Furthermore, data warehouses often require meaningful changes in corporate culture. For example, data warehouse represents a marked departure from traditional data processing, because data warehouse requires that the organization's functional units share data (Goeke, 2006). This is not easy to accomplish. Therefore, upper management support for a data warehouse project is crucial, and is considered as one of the strongest predictors of implementation success (Wixom & Watson, 2001; Watson & Ariyachandra, 2005).

Moreover, even though data warehouse emerges as a powerful tool in delivering information to users, creating competitive advantage and building support for decision making (Berson, Smith, & Thearling, 1999; Groth, 2000; Inmon, 2005; Hwang & Xu, 2008). According to Agosta (2004); Conner (2003); Wixom and Watson (2001), 20-50 percent of these multimillion dollar projects fail to meet the desired levels of success although few companies actually abandon data warehouse after an initial failure (Koch, 1999). One of the most recent, high profile and highly visible failures of data warehouses was the Virtual Case File (VCF) commissioned by the FBI costing more than a $175 million (Goldstein, 2005). VCF is commission as a response to September 11, 2001 incident, to allow US federal agents and intelligence agencies to share vital investigative information, and develop a system to help spot patterns that might signal a future attack by terrorists on the United States of America. This failure has been the subject of a study by Goldstein (2005). Goldstein (2005) also suggests that the organizational structure, communication and implementation were the key reasons of failure.

In addition, implementing a data warehouse can be a very complex endeavor, because a data warehouse integrates data from both internal and external sources (for example, a data warehouse can have 100 source files) which makes the firms may face more challenges in maintaining a high quality data environment (Agosta, 1999; Inmon, 2005; Ramamurthy *et al.*, 2008). This is also emphasizes in a study conducted by Shin (2003), which indicates three challenges facing the implementation of data warehouse systems: (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. Furthermore, Haley (1997) identifies three challenges with data warehouse. First, implementing data warehouse system costs a great deal of money. Second, data warehouse can change the business processes and the ownership of data in the organization. This can result in political resistance, coordination problems, and change in the organizational infrastructure. Third, data warehouse implementations also are technically complex undertakings that often require a medley of software and hardware products from a variety of vendors and advanced IS skills.

Moreover, Walker (2011) identifies four key areas present challenges in any data warehouse:

1. Configuration and change management: it operates at every level of the organization.
2. Managing and improving data quality: is often considered a major issue because of the garbage-in garbage-out principle.
3. Engagement with the enterprise architecture: enterprise architecture depends on how an organization's strategy and architecture teams define the current state of processes and systems, how they define the future state of those processes and systems, and how they build a migration path between the current and future states.
4. Enhancing return on investment: the on-going cost of running a data warehouse, especially in times of economic hardship, is often questioned. It is therefore common to look for ways to improve the return on investment.

However, even if the data warehouse is successfully installed and implemented, there is additional risk in the form of end-user of the data warehouse system. End-users need strong analytical skills in order to properly setup and interpret oftentimes unexpected results. There has been a paucity of empirical research on end-users and data warehouse. For example, Chen *et al*. (2000) measure end-user satisfaction in a data warehouse environment and argue that it is difficult to use the data warehouse, even with users who have one or more years of experience. In another study, Cooper *et al*. (2000) present a case study on the success of a data warehouse in a banking environment. Despite the enormous financial benefits, the bank learned that the successful use of the data warehouse required analysts with different and more advanced skill sets. While some analysts could be retrained to work in the new data warehouse environment, many could not. After working for a year with the data warehouse, many of the existing analysts moved to other positions or left because of the difficulties they experienced using the bank's data warehouse. Payton and Zahay (2003) also use case a study methodology to better understand why the marketing function of a large regional health care payer didn't use the data warehouse in which its firm had made a substantial investment. The authors concluded that use of the data warehouse suffered because end-users found the system difficult to use. Finally, Watson *et al*. (2001) survey 106 firms with data warehousing implementations. The authors measured 27 data warehouse benefits, both before implementation (expected benefits) and after (realized benefits). Interestingly, none of the realized benefits exceeded the expected benefits, and the least realized benefit dealt with the ability of users to create their own reports. The handful of data warehouse success studies that have been published to date are briefly reviewed in the next section.

2.5 Data Warehouse Success

The impacts resulting from data warehouse systems are arguably difficult to measure and to determine success metrics (Hwang and Xu, 2008; Shin, 2003; Wixom & Watson, 2001; Haley, 1997). Data warehouse system entails many users ranging from top executives to end users; many applications including data integration (i.e. ETL), data analysis (i.e. Cube), business intelligent, and data mining applications that span the organization; and a diversity of capabilities and functionalities. These contemporary system characteristics (along with other matters addressed in the literature review section on high cost, process changes, and complexity of data warehouse systems) suggest that existing models of data warehouse system success may not be entirely sufficient for measuring data warehouse success.

According to Chenoweth *et al*,(2006), "The success of data warehouses depends on the interaction of technology and social context". Furthermore, Hwang and Xu (2007; 2008) indicate that the data warehouse success is an important issue for both practice and research. Relatively few studies have been conducted to assess data warehousing practices in general and critical success factors in particular. Wixom and Watson (2001) point out that data warehouses have unique characteristics that may shift the importance of factors that apply to it. Moreover, Thomann and Wells (1999) describe three types of success aspects as they related to data warehouse as follows:

1. Economic success: is the ability of the data warehouse to provide information to those who need it, in order to have a positive impact on the business.
2. Political success: is the ability of the organization to provide awareness, access tools, knowledge, and skills for their users to use the functions offered by the data warehouse system.
3. Technical success: is the ability of chosen appropriate technologies for the data warehouse tasks and applied it correctly.

According to Rasul (2009), success of a data warehouse project is a challenge because of the complexity, size and diverse requirements. The researcher addresses some success strategies for this challenge as:

1. Determine data warehouse project objective.
2. Find data warehouse quality drivers.
3. Seek quality-driven data warehouse benefits.
4. Establish data warehouse project success strategies.
5. Set data warehouse project management success strategies.
6. Ensure success through active data warehouse project manager roles.
7. Capitalize on strengths of the data warehouse project manager he/she must.
8. Review the data warehouse benefits.

Frolick and Lindsey (2003) consider several reasons caused failure across many of the organizations that implement data warehouse. Some of the reasons are: weak sponsorship and management support, poor choice of technology, wrong or poorly analyzed project scope, data quality problems, problems with end-user access tools, insufficient funding, inadequate user involvement, unclear organizational politics, and turnover of organizational personnel. The majority of failures have multiple reasons. The most common factors are the weak management support and inadequate user involvement (Frolick & Lindsey, 2003). With few exceptions, the reasons for failure were organizational rather than technical.

Previous studies also discuss some factors of the data warehouse systems success. In this research, two groups of potential antecedents' studies are defined. The first group of antecedents is based on the critical success factors (CSF's) or implementation success factors (ISF's) that could contribute to data warehouse success. While the second group of antecedents is adapted from the models of data warehouse success.

AbuAli and AbuAddose (2010) discover the main critical success factors (CSF's) that efficiently affected the data warehouse implementation. A case study approach was carried out for two organizations namely: First American Corporation (FAC) and Whirlpool Corporation to identify a more general CSF's. Based on their study, CSF's categorize into five main categories as follows:

- Organizational factors (such as top management support).
- Environmental factors (such as business competition).
- Project factors (such as skills of project team and end-user involvement).
- Technical factors (such as quality of data sources).
- Educational factors (such as training courses).

A study to examine the key determinants of data warehouse adoption and a technology that falls into the category of an infrastructure type innovation was carried out by Ramamurthy *et al.* (2008). They propose a research model that posited the direct impact of five organizational and two innovation factors on successful adoption of data warehouse. The model is empirically validated using data from a large-scale field survey of nearly 200 firms in both manufacturing and service sectors located in two major states in the continental U.S. An analysis of the data indicated support for the proposed effects of five of the seven variables considered as being important in distinguishing adopters from non-adopters. Those five variables are: organizational commitment, absorptive capacity, organizational size, relative advantage, and complexity. In addition, they suggested that a data warehouse success would confer “flexibility” and “responsiveness” for both current and future research.

Hwang and Xu (2008) develop a structural model of data warehouse success as shown in Figure 2.2. The model combined both critical success factors and data warehouse success dimensions. Data warehouse 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 data warehouse 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.

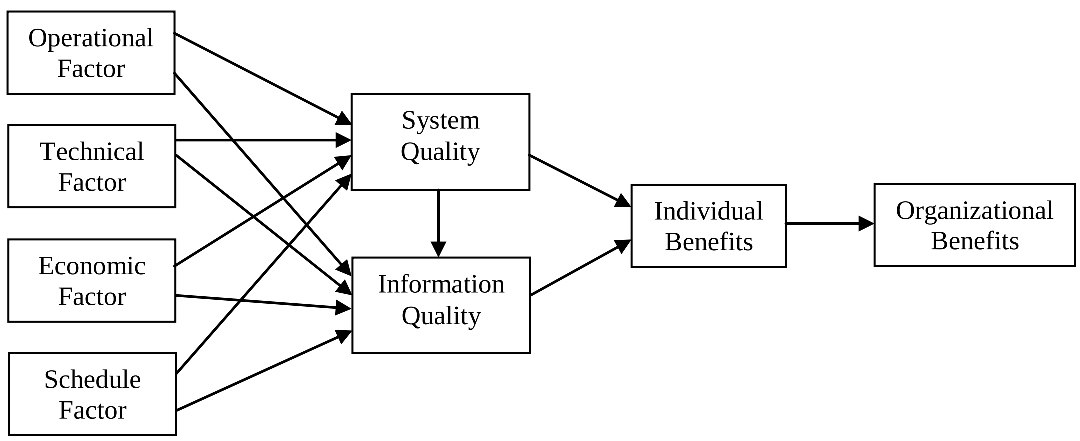


Figure 2.2: Data Warehousing Success Model (Hwang & Xu, 2008)

Hayen *et al*. (2007) investigate the success of IS in numerous ways, such as by measuring the satisfaction of users, system quality, and the perceived usefulness of specific applications. Researchers developed a model for metrics that can use to manage the success of data warehouse implementation project. A case study of the Financial Service Company (FSC) in the southeastern United States was used to validate the model. The results from the case study identify significant relationship among the system quality, data quality and perceived net benefits. It also shows that management support and adequate resources help address organizational issues that arise during data warehouse implementations. In addition, the results show that resources, user participation, and highly-skilled project team members increase the likelihood that data warehouse projects will finish on-time, on-budget, and with the right functionality. Finally, the results show that the implementation's success with organizational and project issues, in turn, influences the system quality of the data warehouse.

Hwang *et al*. (2004) intended to explore the critical factors affecting the adoption of data warehouse technology in the banking industry in Taiwan. The focus scope was on the following packaged-factors (Organizational, Environmental, and Project factors). A questionnaire survey was designed and used to achieve the study's objective. A total of 50 questionnaires were mailed to CIOs in local banks. After an intensive review of prior relevant studies, a total of ten factors influencing the success of data warehouse project are developed (Size of bank, Champion, Top management support, Internal needs, Degree of business competition, Selection of vendors, Skills of project team, organization resources, User participation, and

Assistance of information consultants). They also conclude that top management support, size of the bank, effect of champion, internal needs, and degree of business competition would affect the adoption of data warehouse technology in banking industry in Taiwan.

Mukherjee and Souza (2003) present a framework that might help the data warehouse people to visualize how critical success factors can be included in each phase of data warehouse implementation process. They show that the data warehouse implementation process follows the three phased patterns of evolution, they are: Pre-implementation, Implementation, and Post-Implementation phases. In the related-studies, a list of 13 critical implementation factors were developed; data, technology, expertise, executive sponsorship, operating sponsorship, having a business need, clear link to business objectives, user involvement, user support, user expectation, organizational resistance, organizational politics, and evolution and growth. They also discuss each factor and the contribution of each factor on every phase of data warehouse implementation process.

Shin (2003) conducts an exploratory study to assist to fully understand the data warehouse problems from the perspective of information systems success. The researcher investigates the impact of system quality, information quality, and service quality on user satisfaction. Empirical data was collected 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 the data warehouse. The study shows that the impact of the variables pertaining to the system quality, information quality, and service quality on user satisfaction were significant. In general, the study indicates that the IS success model introduced by DeLone and McLean (2003) become a good framework to understand the success of data warehousing.

Watson *et al*. (2002) present an explanation of why some organizations realize more exceptional benefits than others after data warehouse installation. The authors start by giving a basic background about a data warehouse. Then they go through the obtainable benefits gained from data warehouse installation in general by the adopters. Three case studies of data warehousing initiatives, a large manufacturing company, an internal revenue service and a financial services company, are discussed within the context of the suggested framework. The results from the case studies highlight the benefits achieved by the three organizations. The researchers noticed that some of them considered more significant payoffs than the other adopters. The researchers built an argument about the main issues behind the success in the three cases. This argument led to the following critical success factors: business need, champion, top management support, user involvement, training matters, technical issues (adequate tools), accurate definition of the project's objectives, growth and upgradeability, organizational politics, and skillful team.

Wixom and Watson (2001) conduct empirical investigations on the implementation factors that influence data warehouse success among the American organizations. They also identify the significant relationship between the system quality, the data quality dimensions and perceived benefits as shown in figure 2.3. A cross-sectional survey is used to build up a model of data warehousing success. To gain relevant data about implementation and success factors of data warehouse, a questionnaire is distributed among data warehouse managers and data suppliers from 111 organizations. They cite seven factors, they are management support, project champion, resources, user participation, team skills, quality source systems, and better development technology which considered crucial in the success adoption and implementation of data warehouse.

The results reveal that only six factors, they are management support, resources, user participation, team skills, quality source systems, and better development technology have a big and positive influence on the successful adoption and implementation of data warehouse project. The results also show that the two hypotheses related to champion factor were not supported.

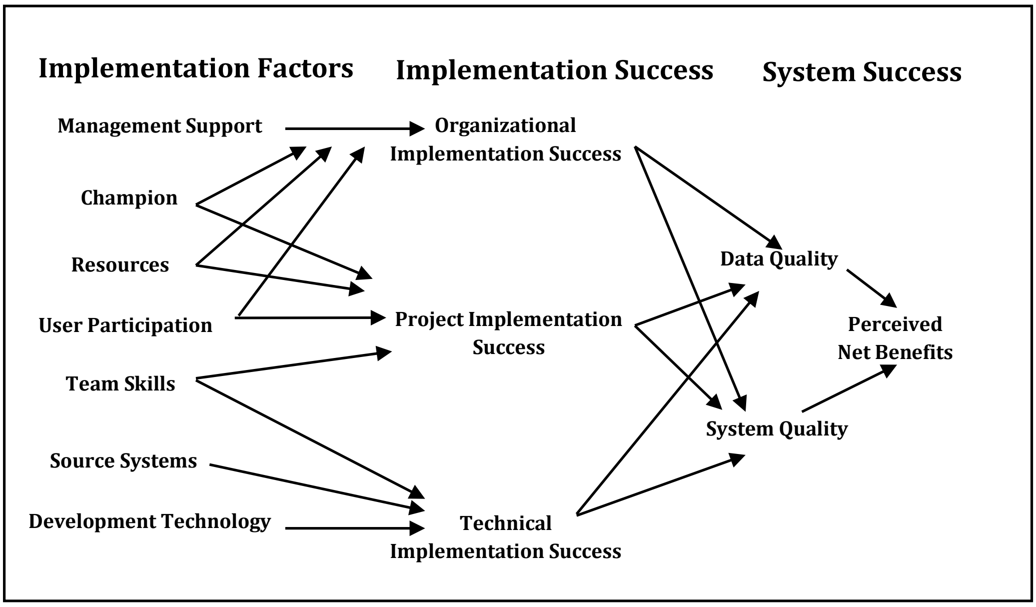


Figure 2.3: Data Warehousing Success Model (Wixom & Watson, 2001)

Haley (1997) analyzes the relationships between organizational, project, and infrastructure factors and data warehouse success. Two survey instruments were distributed to measure success factors and implementation factors among an organization's data warehouse users and data warehouse managers, respectively. Structural equation modeling technique is used to test the research model. At the individual level of analysis, the results show that organizational, project, and infrastructure factors are associated with the expected organizational, project, and infrastructure outcomes, respectively. The results also show that organizational and project factors are positively influences data warehouse success. Only one hypothesis is not supported. Infrastructure factor is not associated with data warehouse success. Generally, the study suggested that there is a great need for academic research especially the area of data warehouse success must be better understood as well as how to measure the success.

As discussed above, some attempts have been made to explore and examine the success factors of data warehouse. A few case studies have also investigated the success of data warehouse implementation at selected companies (e.g., Watson *et al.*, 2004; Hayen *et al.*, 2007). Other studies measured critical success factors while some others measured data warehouse success; however, only two studies (Wixom & Watson, 2001; Hwang & Xu, 2008) measured both critical success factors and data warehouse success together. Researchers have also defined and measured different success factors and data warehouse success variables. For example, user satisfaction was used as a measure for success in a study conducted by Shin (2003), but not in the others (Wixom & Watson, 2001; Hayen *et al.*, 2007; Hwang & Xu, 2008). The two studies conducted by Haley and Ramamurthy and colleagues used different success measures too. Table 2.3 summarizes some published studies, which differ widely in the factors measured.

Table 2.3: Previous Data Warehouse Researches

Author(s)	Objective	Outcome	Future research
AbuAli and AbuAddose (2010)	To discover the main critical success factors affecting DW implementation.	Five main categories of success factors: organizational, project, technical, environmental, and education.	
Ramamurthy *et al*. (2008)	To examine the key factors of DW adoption.	Five factors: organizational commitment, absorptive capacity, organizational size, relative advantage, and complexity.	Three factors "Flexibility", "Responsiveness", and "Absorbed Slack" could include in future research.
Hwang and Xu (2008)	To examine the relationships between CSF's and DW success dimensions.	Structural model.	New variables and measures can be added easily.
Hayen *et al*. (2007)	To identify factors that potentially affects DW success.	Three main categories of success factors: organizational, project, and technical.	Suggested to apply IS implementation knowledge to an infrastructure of DW.
Hwang *et al.* (2004)	To investigate the factors influencing adoption of DW technology in the banking industry in Taiwan.	Five factors.	Future research can be focused on integrate DW technology with other information technologies such as CRM and ERP.
Shin (2003)	To investigate the effect of system quality, information quality, and service quality on user satisfaction for DW.	System quality affects user satisfaction.	IS success model introduced by DeLone and McLean (2002) can become a good framework in understanding the success of DW.
Mukherjee and Souza (2003)	To improve the chance of success implementation for DW.	Three phased for DW implementation: Pre-implementation, Implementation, and Pos-Implementation phases).	More longitudinal studies in factors that impact DW implementations need to be conducted.
Wixom and Watson (2001)	To identify significant relationships between system quality and data quality factors and perceived net benefits.	Data quality and System quality affects Net benefits.	Future research is needed to understand warehouse data quality and the factors that affect it.
Haley (1997)	To identify the key Success Factors in DW implementation.	Organizational and project factors are positively influencesDW success.	There is a great need for academic research in the area of DW success.

In addition, several studies took place in the context of a single company, such as financial service companies (Shin, 2003; Hayen *et al.*, 2007), thus making those results may not capable of being applied to all business organizations. Moreover, a reduced number of indicator items in certain constructs in the previous studies might have affected their measurement reliability and accordingly the power of the regression analysis. For instance, one or two indicator items were used for most constructs in the studies carried out by Shin (2003) and Hwang and Xu (2008).

Additionally, limited sample size in prior research might have affected the integrity of the statistical inference. For instance, the largest sample size of 111 valid survey responses is included in the study conducted by Wixom and Watson (2001). Furthermore, some antecedent studies (Wixom & Watson, 2001; Hwang & Xu, 2008) measured both critical success factors and data warehouse success dimensions in one research model. Actually, not all respondents may be able to answer all survey questions accurately. Thus, the result for success dimensions used in some previous studies is not accurate to some extent.

Moreover, DeLone and McLean (2003) suggest that in order to develop a comprehensive measurement model/instrument for a particular context, the dimensions and measures should be systematically selected considering contingency variables. Yet, most empirical studies (Wixom & Watson, 2001; Hwang & Xu, 2008) related to data warehouse success models have dealt with the original DeLone and McLean IS success model and do not elaborate on the rationale for their choice of success dimensions and success measures employed. In fact, measuring the success of data warehouse systems requires the integration of other factors in order to have a positive influence on the business. Finally, several studies (Haley, 1997; Shin, 2003; Hwang & Xu, 2008) indicate that issues pertaining to data warehouse success evaluation are of great importance to managers. Therefore, the data warehouse success measurement needs to encapsulate both tangible and intangible benefits of data warehouse success.

However, previous studies have addresses only some aspects of the important issues and are generally agreed that there is a scarcity of comprehensive models in data warehouse success area. Moreover, many authors state that the success of data warehouse can be achieved by obtaining the benefits of it (Wixom & Watson, 2001; Shin, 2003; Mukherjee, 2003; Hwang & Xu, 2008; among many others). Thus, the benefits of the data warehouse are explained in the following section.

2.6 Data Warehouse Benefits

Data warehouse is a useful technology for a huge data and a large number of modern applications (Rundensteiner, Koeller, & Zhang, 2000). 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 (Gorver Little & Gibson, 1999). Many organizations recognize the strategic importance of knowledge hidden in their large databases and have therefore built data warehouses (Ester *et al.*, 1998). 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"* (Porter & Rome, 1995: p. 48).

According to Haley (1997), the data warehouse 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. Data warehouses also 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 (Sujitparapitaya, Janz, & Gillenson, 2003). In addition, data warehouse provides the foundation for effective business intelligence solutions for companies seeking competitive advantage (Chenoweth *et al.*, 2006). Furthermore, McFadden (1996) argues that the benefits of data warehouse involve the ability to improve data quality and leverage legacy systems. Other authors (Watson *et al.*, 2002) conclude that the greatest benefits from the data warehouse occurs when use it to improve business processes, support decisions, support strategic business objectives, provide better information, and time saving for users. Kelly (1997) also identifies six benefits of the data warehouse, they are: (1) improved customer service, (2) reduced risk, (3) increased opportunity between the organization and the customer, (4) improved IT system maturity, (5) reduced cost, and (6) improved strategic decision making.

In addition, the findings from the survey study conducted by Garner (2007) shows that the most benefits derived from implementing a data warehouse are: more facts for better decision making, broader information access and data discovery, corporate security and governance, better assessment of corporate performance, more complete view of the business, more complete view of each customer, accurate regulatory reporting, and supply chain optimization.

Bhansali (2007) describes five main benefits of the data warehouse for an organization:

1. Decision Support: refers to the ability of the data warehouse to provide business decision support data by integrating information from multiple sources and making it available for querying and analysis.
2. Data Analysis: refers to the ability of the data warehouse to allow decision makers to analyze data without interfering with the transaction processing system. It also helps in accessing, aggregating, and analyzing large amounts of data from diverse sources to understand historical performance or behavior and to predict and manage outcomes.
3. Improves Efficiency: refers to the ability of the data warehouse to provide a single version of the truth and better data analysis, shrink the information delivery time between an event's occurrence and business decision making, save time for its users, and provide support for customer focused business strategies.
4. Enhanced Integrated Data: refers to the ability of the data warehouse to include data from multiple sources, integrate data across time to provide views obtained from trend analysis of the data, eliminate inconsistencies in data, and minimize data redundancies.

5. Customer Management: refers to the ability of the data warehouse to provide the foundation to build a customer relationship management (CRM) strategy, respond to the current and potential needs of the customer, and increase customer retention and revenue from existing customers.

The above discussion highlights the benefits of a data warehouse to an organization. It shows that a data warehouse can have a strategic as well as long term value for an organization. The following section discusses the association of quality factors to this study in detail.

2.7 Quality Factors of Data Warehouse

The quality in an organization defined by Reeves and Bednar (1994) in terms of quality as excellence, quality as conformity to specifications, quality as value, and quality as meeting customer expectations. Excellence in data warehouse quality involves using advanced technology, following industry software standards, establish strong control procedures, and delivering error-free performance. The value of data warehouse can achieve by improving profit margins for the organization, providing useful and easy-to-use applications, designing efficiently management tools, and supporting decision making (Inmon, 2005; March & Hevner, 2007). Data warehouse quality as conformance denotes designing systems that conform to the end users' information requirements and be compatible to industry standards. Meeting customer expectations of data warehouse quality is realized by offering appealing, user-friendly interfaces, entertaining user requests for changes, improving customer service, increasing competitive advantage, and satisfying the stakeholders of the data warehouse (Thomann & Wells, 1999; Vassiliadis, 2000b).

Calero *et al*. (2001) consider three different aspects of data warehouse system quality, they are: (1) database management system quality, (2) data model quality, and (3) data quality. In addition, information (or data) quality and system quality are the most important quality factors determining the success of data warehouse systems (Wixom & Watson, 2001; LeRouge & Gjestland, 2002; Hwang & Xu, 2008). Moreover, Thomann and Wells (1999) define the quality of data warehouse as the act of measuring its progress in terms of its ability to satisfy the potential customer base. They also identify three areas to assess the overall data warehouse quality, they are:

- Business Quality: This area refers to the ability of the data warehouse to supply the required information to the concerned users, in order to have a positive influence on the business.
- Information Quality: It concerns the data quality as well as data integration and performance (when and how the data is being used for decision making purposes?)
- Technical Quality: This area refers to the ability of the data warehouse to access necessary contents, to define a range of service provided, to respond to changes in the business environment, and to build and use a data warehouse.

2.7.1 Information Quality

Several studies (Haley, 1997; Thomann & Wells, 1999; Rudra & Yeo, 2000; Wixom & Watson, 2001; Shin, 2003; Nelson *et al.*, 2005; Hwang & Xu, 2008; among many others) suggest that information quality is an important aspect in data warehouse success as implication business decisions are based on information drawn from data warehouse systems. It seems that a data warehouse is expected to enable production of information of higher quality as well as new information that may be put to innovative use. Over the last decade, quality information research activities have increased significantly to meet the needs of organizations attempting to measure and improve the quality of information (Lee *et al.*, 2002). Furthermore, information (or data) quality is rated regularly as a top concern in data warehouse systems (Brown, 1997; English, 1999; Rudra & Yeo, 2000; Palmer, 2006).

The information quality refers to the quality of outputs the data warehouse system produces (Nelson *et al*., 2005; Hwang & Xu, 2008). In a study on the determinants of information system success, DeLone and McLean (2003) highlight the importance of relevance, timeliness, and accuracy of information. Sakaguchi and Frolick (1997), for instance, discuss one of the advantages of a data warehouse as its ability to provide quantitative values, or metrics that allow a company to benchmark performance in an effort to measure progress. In other words, both the quality and quantity of information are important. As described by Watson and Haley (1997), more and better information is one of the purported benefits of data warehousing. Wixom and Watson (2001) provide an excellent source for further research into data warehouse concepts with many examples of studies on information quality and success factors for IT projects. LeRouge and Gjestland (2002) address the subject of overall data warehouse quality. They divide the subject of data warehouse quality into the study of information quality and system quality.

Wang and Strong (1996) describe the information quality as the usefulness of the information in aiding decision-making. They expand the dimension of information quality to include dimensions such as relevance, completeness, currency, timeliness, security, integrity, and format of the information that shape the perceptions of quality in the context of use. The definitions of information quality dimensions are further illustrate in Table 2.4.

Table 2.4: Information Quality Dimensions

Dimensions	**Definitions**	**Authors**
Accuracy	The degree to which information is correct, unambiguous, meaningful, believable, and consistent.	Nelson et al. (2005); Wang & Strong (1996)
Completeness	The degree to which all possible states relevant to the users.	Nelson et al. (2005); Wang & Strong (1996)
Currency	The degree to which information is up-to-date or the degree to which information precisely reflects the current state of the world it represents.	Nelson et al. (2005); Wang & Strong (1996)
Format	The degree to which information is presented in a manner that is understandable and interpretable to the user and thus aids in the completion of task.	Nelson et al. (2005); Wang & Strong (1996)
Timeliness	The extent to which the information is sufficiently up-to-date for the task at hand.	Kahn, Strong, & Wang (2002); Wang & Strong (1996)
Relevant	The extent to which information is applicable and helpful for the task at hand.	Kahn et al. (2002); Wang & Strong (1996)
Security	The extent to which access to information is restricted appropriately to maintain its security.	Kahn et al. (2002); Wang & Strong (1996)
Integrity	The process of combining data residing at different sources and providing the user with a unified view of these data.	Lenzerini (2002)

Content usefulness refers to the value, reliability, currency, and accuracy of information. Specifically, information value is concerned with relevancy and clearness. Information reliability refers to its accuracy, dependability, and consistency. Information currency is concerned with information timeliness and continuous update. Information accuracy describes the degree to which the system information is free from error (Yang *et al*., 2004a). DeLone and McLean (1992) point out that usefulness of a system is its capability to support end-users to satisfy their information requirements. According to Shin (2003), the usefulness acquired from the data warehouse represents a variable for the information quality factors, and it's the most important determinate of the data warehouse system success. In addition, Bhansali (2007) found that the usefulness is important to achieve successful adoption of the data warehouse and its alignment to business strategies.

Data accuracy is defined as:

> "*A characteristic of information quality measuring the degree to which a data value (or set of values) correctly represents the attribute of the real-world object or event*" (English, 1999: p. 461).

In addition, accuracy is defined as the correctness in the mapping of stored information to the appropriate state in the real world that the information represents (Nelson *et al*., 2005; Strong, Lee, & Wang, 1997). The accuracy is further refine to include the idea that the information not only is correct, unambiguous, and objective, but also meaningful and believable (Nelson *et al*., 2005). The key element of this refinement is the notion that there is an important perceptual component to accuracy. Information not only must be accurate but must also be perceived to be accurate (Wang & Strong, 1996).

Beyond accuracy, information quality also can shape by completeness. Completeness refers to the degree to which all possible states relevant to the user population are represented in the stored information (Nelson *et al*., 2005). It is important to recognize that the assessment of completeness only can be made relative to the contextual demands of the user and that the system may be complete as far as one user is concerned, but incomplete in the eyes of another. While completeness is a design objective, its assessment is based on the collective experience and perceptions of the system users. Without an accurate data, organizations cannot evaluate the success of their data warehouse projects (Chen *et al*., 2000). Wixom and Watson (2001) identified information quality as measured by accuracy, comprehensiveness, consistency, and completeness as an important component of data warehouse success. According to Khan (2003), if the data is inaccurate and unreliable, the data warehouse may lose its credibility as a reliable source of information and be abandoned by the user community.

In addition to completeness, currency is identified as an important factor in contextual information quality (Canibano, Garcia-Ayuso & Sanchez, 2000). Currency refers to the degree to which information is up to date, or the degree to which the information precisely reflects the current state of the world that it represents (Nelson *et al*., 2005). Users may have different demands for currency and, as a consequence, information that is viewed as current for one task may be viewed as too dated for another (Nelson *et al*., 2005).

Format refers to the degree to which information is presented in a manner that is understandable and interpretable to the user, and thus aids in the completion of a task (Lee *et al.*, 2002). Nelson *et al*. (2005) state that the assessment of format will be shaped by the perceptions of the user completing different tasks with the system over time. Furthermore, findings from the case study conducted by Bhansali (2007) show that concerns with accuracy, reliability, format, and timeliness of data impact the successful adoption of the data warehouse.

Data integration is the process of combining data residing at different sources and providing the user with a unified view of these data (Lenzerini, 2002). Palmer (2006) defines the data integration for data warehouse system as the extent that data within an organization can be shared by various components of the organization. Also, data integration is one of the most important aspects of a data warehouse success implementation (Calvanese *et al.*, 1999; Shin, 2003; Hwang *et al.*, 2004; Palmer, 2006; Mannino & Walter, 2006; Bhansali, 2007; Ramamurthy *et al.*, 2008). While various attempts, information quality problems continue to insist in data warehouse. Poor data quality enters from operational databases and other sources of data into the data warehouse. The conventional practice is to apply data integrity practices as a onetime process when the data enters the database. The failure to link integrity rules to organizational changes is one of the reasons that data quality problems persists. One mechanism to solve this problem is to embed data integrity in a continuous data quality improvement plan (Bhansali, 2007). Lee *et al*. (2004) suggest an iterative data quality improvement process as data integrity rules define violations of these rules measure and analyze, and then these rules redefine to reflect the dynamic and global context of business process changes.

Content adequacy refers to the extent of completeness of information (Yang *et al*., 2004). Data warehouse need to provide information to facilitate users understanding of the services offered. In addition, users need supplemental services, such as information, professional advice, and statistical reports to relevant sites and contact information (Ramamurthy *et al*., 2008). In order to achieve high levels of the data warehouse success implementation, organizations should particularly focus on the adequacy of information (Mukherjee, 2003; Garner, 2007).

Nelson *et al*., (2005) stress that information quality is among the major roles in determining the successful data warehouse implementation in their study of data warehouse success factors. In addition, Nelson *et al*. (2005) argue that the successful adoption of IS is largely based upon understanding the linkages between quality, satisfaction and usage however, satisfaction and usage has been widely emphasized in the literature, while information and system quality has received little attention. They explored the fundamental of quality in their study by developing and testing as IS success model based on data warehouse environment. Their model strikes a balance between being comprehensive and parsimonious. The results of Nelson *et al*. (2005) study suggest that data warehouse project should emphasize accuracy, completeness and format as the primary drivers of information quality.

Dijcks (2004) emphasizes that information quality aspect is often ignored in data warehouse implementation and suggested a methodology for embedding data quality into overall data warehouse architecture. Rudra and Yeo (2000) contend that in order for data warehouse system to be effective is dependent on high quality information. This, understandably, can only be derived from a high-quality data resource. In any given industry naturally there are going to be disparate sources of data that are relevant to effective data warehouse. This in turn raises the issue of how such data might be cleaned up, linked together and accesses in a meaningful way. According to Ballou and Tayi (1999), since data warehouse is accessed by users with different needs, the activities of data quality should be balanced to better support the activities of the organization. Therefore, the data warehouse managers have to be aware of various issues related to enhancing data quality.

Shin (2003) suggests that the data warehouse implementation should involve process to enhance the quality of the data. Organizations need to keep a close eye on the quality of data they are capturing. This is to ensure that the information displayed later is able to boost the end-users productivity and efficiency, and ultimately the company. Wixom and Watson (2001); and Hwang and Xu (2008) consider information quality as important factor in data warehouse success as management is using data warehouse applications mostly for decision making support. Data warehouse should enable managers at all levels to get on-demand and real-time information from multiple sources. This requires data warehouse to adapt according to the way people think and work (Garner, 2007).

Above all, the importance of information (or data) quality in data warehouse success is essential as information provided will turn into actionable knowledge needed for decision-making in organizations. Without an accurate, timely, complete, integrate, relevant, secure and presentable format, information produced is of little value (Nelson *et al.*, 2005).

2.7.2 System Quality

System quality is recognized as an important factor in successful data warehouse implementation (Seddon, 1997) although issues relating to it received fewer attention than information quality in the IS literature (Nelson *et al.*, 2005). Previous researchers identify criteria for the system quality, they are: whether there are errors in the system, the consistency of the user interface, ease of use, quality of documentation, and quality and maintenance of the program code (DeLone & McLean, 1992; Seddon, 1997). They believe that higher-quality systems should be perceived as easier to use and, ultimately, have higher levels of usefulness and use.

Park (2006) agrees with Seddon (1997) that system quality is one of the factors in IS success model. They investigate the effects of data warehouse on decision performance and find out the evidence that support the basic concepts of the model that postulates positive impacts of system quality and information quality on decision performance through system use. In the context of data warehouse, Wixom and Watson (2001) empirical work showed the particular importance of system quality (i.e., system reliability and data quality) in securing benefits from the data warehouse. Furthermore, Shin (2003) identifies system quality factors such as system throughput, ease of use, ability to locate data, access authorization, and data quality, which were regarded as crucial for the success of the data warehouse.

In accordance with its focus on decision support, a successful data warehouse is generally characterized as easy to use and efficient in producing information useful to decision makers. Although some attractive features that apply to other systems, such as standardization, scalability, and security have been mentioned (Sakaguchi & Frolick, 1997), the success of a data warehouse is more than likely be judged by how easy and efficient it is for both end users and IS professionals to generate information to support decision making (Watson & Haley, 1997; Vatanasombut & Gray, 1999; Shin, 2003; Nelson *et al.*, 2005). On the other hand, a data warehouse that is not user-friendly in either its user interface or the analysis tools provided can result in millions of dollars of unused software and unrealized returns on investment (Johnson, 2004; Gorla *et al.*, 2010).

Seddon (1997) states that

> "*system quality is concerned with whether there are bugs in the system, the consistency of user interface, ease of use, quality of documentation, and sometimes, quality and maintainability of program code*" (p. 246).

In addition, DeLone and McLean (2003) suggested additional dimensions such as ease of use, reliability, functionality, data quality, flexibility, and integration as a measurement of system quality.

According to Doll and Torkzadeh (1988), system quality has referred to system flexibility, ease of use, usefulness, reliability, and user friendliness. Although some researchers equate system quality with dimensions that are closely related to service quality and ease of use, but Nelson *et al*. (2005) believe the constructs used are not the same. They define five dimensions to be associated with system quality, they are: (1) accessibility, (2) reliability, (3) response time, (4) flexibility, and (5) integration. Table 2.5 describes definitions of system quality dimensions, which represent user perceptions of interaction with system over time.

Table 2.5: System Quality Dimensions (Nelson et al., 2005)

Dimensions	**Definitions**
Accessibility	The degree to which a system and the information it contains can be accessed with relatively low effort.
Reliability	The degree to which a system is dependable overtime.
Response time	The degree to which a system offers quick or timely responses to requests for information or action.
Flexibility	The degree to which a system can adapt to a variety of user needs and to changing conditions.
Integration	The degree to which a system facilitates the combination of information from various sources to support business decisions.

Nelson *et al*. (2005) state that accessibility represents the degree to which a system and the information it contains can be accessed with relatively low effort. Access to information can be viewed as a necessary condition for system quality. It is a system property to the extent that the system itself is either accessible to a user or not accessible, regardless of the task that the user is trying to accomplish.

According to Nelson *et al*. (2005), reliability refers to the dependability of a system over time. It can be defined objectively as the technical availability of the system and can be concretely measured by metrics such as uptime, downtime, or mean time between failures. Despite the fact that reliability can be measured objectively, it also is true that individuals may have perceptions of reliability that are independent of measured reliability. Consider a user who only works with a system once a week for a short period of time. A moment of downtime during that time may have a significant detrimental effect on reliability. Thus, "*user perceptions of reliability are the key to determining system quality*" (Nelson *et al*., 2005).

Response time refers to the degree to which a system offers quick (or timely) responses to requests for information or action (Nelson *et al*., 2005). Different kinds of systems (e.g., transaction processing, decision support) often are designed or optimized to provide certain response times, and users may perceive the response time of a system based on the kind of task that they are performing. For example, users may be very tolerant of long response times for an Internet application, but they would be much less tolerant of a similar response time in a desktop application.

Flexibility relates to the degree to which a system can adapt to a variety of user needs and to changing conditions. The definition of flexibility suggests the need to adapt to changing conditions and different user needs, making it a task property of system quality. To the extent that a system will be used over time and must provide information as input to a wide variety of decision tasks, flexibility can be expected to be a key determinant of quality. The relative importance of flexibility in determining quality may depend on the degree to which task demands change over time. In a data warehouse context, for example, we might expect that flexibility is less important in the context of predefined reports (which provide information for static tasks) and more important for querying and analysis, which are less structured and more likely to change over time.

Integration refers to the degree to which a system facilitates the combination of information from various sources to support business decisions (Nelson *et al*., 2005). The needs for integration vary across tasks and contexts, and thus, integration represents a task-related property. Tasks that are more interdependent require systems that facilitate integration to a greater degree than systems that support largely independent tasks (Nelson *et al*., 2005).

Ease of use and easy to learn are probably the most commonly used constructs in the measurement of the quality system (Rudra & Yeo, 2000; Sedera & Gable, 2004; Hussein *et al.*, 2007a). Davis *et al*. (1992) defines ease of use as "*the degree to which a person believes that using a particular system would be free of effort*" (p. 320). Teo (2001) defines it as "*the degree to which the user expects the use of the system to be user friendly*" (p. 128). Perceived ease of use has also been frequently visited as an important indicator for information systems acceptance by end-users (Adams, Nelson, & Todd, 1992; DeLone & McLean, 2003). In the data warehouse context, the likelihood of adoption and use of a system is increased when that system is easy to use in finding what users are looking for (Bhansali, 2007; Hwang & Xu, 2007). Moreover, Shin (2003) recommends that it is necessary to include ease of use as a sub-dimension of system quality.

The complexity of data warehouse is evaluated highly for realizing larger setup and ongoing costs to get the job done, the need for a longer implementation period to install the system, and involving a larger workforce to complete the system (AbuSaleem, 2005). The adoption of data warehouse technology is not a simple activity of purchasing the required software and hardware, but rather a complex process to establish a sophisticated and integrated information system (Vassiliadis, 2000b; Wixom & Watson, 2001). Given the complexity of data warehouse processing, the perception of a system's "easy to manage" may significantly affect the level of its implementation and adoption by prospective organizations. This prompted Hwang and Xu (2007) to argues that "easy to manage" could become an additional success variable related to system quality.

2.7.3 Service Quality

Grover *et al*. (1996) define the service quality as the degree of inconsistency between the service receiver's expectation of service and perceptions of actual service received. The concept of service quality has attracted increasing interest in the IS field along the emergence of the role of the IS unit in an organization with the advancement in personal computing in the last decade. The notion of IS services was not well-defined initially when IS departments were primarily regarded as system developers and operators. Minimal services are rendered to users in the form of maintenance tasks such as handling bug-fixing requests and analyzing usage statistics in the final phase of the traditional system development cycle (Laudon & Laudon, 1993; Alter, 1995). The role of IS departments as a service provider became more broadly recognized with the introduction of personal computers that facilitated higher interaction with users (Pitt, Watson, & Kavan, 1995).

A wide range of services, including installation assistance and technical help counters, is provided to meet the rising demands from the data warehouse users. Pitt *et al*. (1995) observe that,

> "*Commonly used measures of IS effectiveness focus on the products rather than the services of the IS function. Thus, there is a danger that IS researchers will miss measure IS effectiveness if they do not include in their assessment package a measure of IS service quality*" (p. 173).

According to (DeLone & McLean, 2003), the service quality properly measured, deserves to be added as components of IS success. Moreover, Shin (2003) empirical work shows the particular importance of service quality in ensuring the success of data warehouse systems.

The importance of service quality and the challenges facing data warehouse services necessitate insights on the part of managers about what attributes customers use in their evaluation of services provided by data warehouse system. However, a rigorous measurement instrument of data warehouse service quality has not been available. Shin (2003) uses a single dimension “user training” to measure the service quality in the data warehouse context. In order to improve that condition, this study intends to identify the more salient data warehouse service quality dimensions and determine the relative importance of each identified dimension.

Other studies (Jun &Cai, 2001; Van Riel, Liljander, & Jurriens, 2001) identify a key dimensions of service quality in the context of narrowly defined online businesses, such as online banks, web site, and portal services. For instance, Yang, Jun and Peterson (2004b) measured consumer perceptions of online service quality using six dimensions – reliability, responsiveness, competence, ease of use, product portfolio, and security. According to Zeithaml *et al*. (2002), service quality refers to the following seven dimensions, they are: (1) efficiency, (2) reliability, (3) fulfillment, (4) privacy, (5) responsiveness, (6) compensation, and (7) contact. Furthermore, Joseph, McClure, & Joseph (1999) identify six underlying dimensions of online banking service quality, they are: feedback/complaint management, efficiency, accessibility, convenience/accuracy, queue management, and customization. Similarly, Van Riel *et al*. (2001) derive three key portal service quality attributes – user interface, supporting service, and core service. In the same vein, Santos (2003) identifies six dimensions of service quality through focus group interviews. The dimensions are primarily associated with online customer service quality. They are reliability, efficiency, support, communication, security, and incentive. Recently, Gorla *et al*. (2010) discover and statistically validate four dimensions of IS service quality, they are: reliability, responsiveness, assurance, and empathy.

Service quality is greatly recognized as a driver of perceived value, which in turn will improve customer loyalty and enhance the provider's image, sales and profitability (Parasuraman, Zeithaml, & Berry, 2001). More than a decade ago, Parasuraman *et al*., (1988; 2001) carried out comprehensive studies in different industries and developed the SERVQUAL instrument: service quality dimensions with a set of a 22-item scale to quantify a customer's appraisal of an organizations service quality. Five key dimensions of service quality – reliability, responsiveness, empathy, tangibles, and assurance – have been identified and form the foundation on which many of other studies on service quality have been built. SERVQUAL is widely acknowledged and used, and it is considered as applicable to a number of industries, including the IS and IT (Seddon, 1997; DeLone & McLean, 2003). Table 2.6 describes definitions of service quality dimensions.

Table 2.6: Service Quality Dimensions (Parasuraman et al., 1988; 2001)

Dimensions	**Definitions**
Reliability	The ability to perform the promised service dependably and accurately.
Responsiveness	Willingness to help customers and provide prompt service.
Empathy	Caring, individualized attention the company provides its customers.
Assurance	Knowledge and courtesy of employees and their ability to convey trust and confidence.
Tangibles	Appearance, physical facilities, equipment, personnel and communication materials and competence.

The Reliability is composed of the dependability, consistency, and accuracy of promised service performance (Zeithaml, Parasuraman, & Berry, 1988). Studies of new service-delivery options available with computer technology acknowledge that consistency and dependability of performance is an important dimension in the measurement of service quality, because of the user's consideration of performance risks based on new technology service (Dabholkar, 1996; Cox & Dale, 2001). This is very relevant for data warehouse services considering the fact that users are on the move and often in time-critical situations. The importance of the reliability has been emphasized by the information technology-based service (Lee & Lin, 2005).

Responsiveness defines by (Whyte & Bytheway, 1995; Parasuraman *et al.*, 2001) as the willingness of employees to provide prompt service and to deal with consumer complaints. According to (Wang, 2003), "responsiveness" measures the company's ability to support customers with the appropriate information when a problem occurs; it also refers to the mechanism for handling returns, and the ability to carry out arrangement for online guarantees. A quick response to customers' request is an indication that the company is customer-oriented. This, by its turn, is going to overcome the issue of uncertainty and increase the perceived convenience of customers (Gummerus *et al.*, 2004). Since users have identified a fast response as an element of high-quality services (Voss, 2000), This is why (Yang, Jun, & Peterson, 2004) argues that the responsiveness is the foremost critical factor in determining the customer service quality. Moreover, Ramamurthy *et al.*, (2008) suggest that the examination of "responsiveness" for both current and future data warehouse projects would increase the chances of success.

User Training is the extent to which an individual has been trained about IS through courses, training, manuals, and so on (Sabherwal *et al.*, 2006). In addition, Chen *et al*. (2000) state that the user training, as a representative service quality variable, has been repeatedly investigated as an effective way to attract potential users, enhance their understanding on the subject system, and increase user satisfaction. Given the complexity of a data warehouse system and its data structure, end user training could be especially crucial for its successful adoption and company-wide diffusion (Sakaguchi & Frolick, 1997; Quaddus & Intrapairot, 2001). Developing a data warehouse is a difficult endeavor, but realizing significant benefits is much more difficult (Ang & Teo, 2000). As such users must undergo continual, formal and systematic training to get the most from the data warehouse. Technical system quality is important to the success of a data warehouse, but just as important is the need to understand and address the human issues involved (Ang & Teo, 2000).

2.7.4 Relationship Quality

The concept of relationship quality arises from theory and research in the field of relationship marketing (e.g. Dwyer & Oh, 1987; Crosby, Evans, & Cowles, 1990) in which the ultimate goal is to strengthen already strong relationships and to convert indifferent customers into loyal ones (Berry, 1995). Palmatier *et al*. (2006) stress the fact that relationship quality conceptualizes as a composite or multidimensional construct capturing the different but related facets of a relationship.

Although, previous researches (e.g. Bejou, Wray, & Ingram, 1996; Hennig-Thurau & Klee, 1997; Walter *et al.*, 2003; Lages, Lages, & Lages, 2005; Rauyruen & Miller, 2006; Sun, Zhang, & Xiao, 2007; Chakrabarty, Whitten, & Green, 2007) discuss the concept of relationship quality in various research contexts, the definition of relationship quality differs from research project to research project. These authors also agree that the concept of relationship quality is a higher-order construct consisting of several distinct but related components or dimensions. An investigation of the extant literature indicates trust, commitment, communication, cultural, and user participation all positively impact the quality of the relationship (Mohr & Spekman, 1994; Morgan & Hunt, 1994; Kern, 1997; Dorsch, Swanson, & Kelley, 1998; Goles & Chin, 2005; Rauyruen & Miller, 2006; Sun *et al.*, 2007; Chakrabarty *et al.*, 2007; Wu, 2007). Various factors or dimensions are used to study relationship quality within IS research.

Chang and Ku (2009) 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 or unsuccessful encounters. They used three variables (trust, commitment, and satisfaction) to measure relationship quality for customer relationship management (CRM) performance. Sun *et al*. (2007) acknowledge that the relationship quality is a key factor that connects IS factors and business profitability factors (such as commitment and retention). Carr (2006) mentions that the quality of relationship is the glue that binds IS users to IS departments through the success and failure of IS project. Carr also states satisfaction, trust, and commitment as a measurement variables for relationship quality between the IS users and IS department. According to Chakrabarty *et al*. (2007), high relationship quality implies high levels of commitment, trust, cultural similarity, communication, and balanced interdependence between IS outsourcing parties.

Organizations realize that the intangible aspects of a relationship may not be easily duplicated by the competition, and therefore may provide a unique competitive advantage (Roberts, Varki, & Brodie, 2003). Increasingly, companies are recognizing the value of establishing close relationships with customers as a means of increasing retention. Morgan and Hunt (1994) explain the relationship quality in terms of trust, commitment, and component. Lee and Kim (1999) present five relationship quality components affecting IS outsourcing success: commitment, trust, conflict, benefit and risk share, and business understanding. Roberts *et al*. (2003) state four variables to measure relationship quality (trust, commitment, satisfaction and affective conflict). Table 2.7 explains the definitions of relationship quality dimensions.

Table 2.7: Relationship Quality Dimensions (Lee and Kim, 1999)

Dimensions	**Definitions**
Commitment	Degree of the pledge of relationship continuity between parties.
Communication	Degree of share or exchange of meaningful and timely information between parties.
Trust	Degree of confidence and willingness between parties.
Conflict	Degree of incompatibility of activities, resource share and goals between parties.
Cooperation	Degree of working together by parties on complementary activities with the objective of achieving mutual benefits.
Coordination	Degree of coordinating action directed at mutual objectives to maintain stability between parties in a dynamic environment.

The relationship between business objectives and technology has surfaced in the data warehouse implementation. It becomes a fact that there are no studies examine the relationship quality in the context of data warehouse. In this research, the researcher revise the traditional definition of relationship quality by including affective trust, commitment, communication, conflict, cooperation, and coordination as a components of measuring relationship quality in data warehouse success area.

An investigation of the relationship quality literature shows a common theme cataloging commitment as a key factor in successful relationships (Morgan & Hunt, 1994). Commitment reflects the parties view in order to sustain the relationship over time (Henderson, 1990), and describes as "*an enduring desire to remain in a valued relationship*" (Simpson & Mayo, 1997: p. 211). According to recent studies about relationship quality, commitment considers to be a major contributor to a successful relationship (Carr, 2006; Sun *et al.*, 2007; Chang & Ku, 2009). In the context of data warehouse, Porter and Rome (1995) contend that

> "*building a data warehouse is extremely complex and takes commitment from both the information technology department and the business analysts of the organization*" (p. 43).

The amount of data available in companies is often overwhelming, and collecting, maintaining and analyzing the data requires significant organizational commitment (Mathew *et al.*, 2006). In addition, consider the more sophisticated tools for developing data warehouse system need a long-term commitment to utilize this technology. There is often an erosion of strong corporate commitment to mandate the use of these tools throughout the entire organization, and once this occurs, it is very difficult to justify the costs versus benefits (Solomon, 2005).

Furthermore, the commitment of top management support is very important to pass over sudden barriers and complexities in a data warehouse project, as highlights by (Wixom & Watson, 2001; Watson *et al.*, 2002; Mukherjee & Souza, 2003; Hwang *et al.*, 2004). Bhansali (2007) argues that high level of commitment of senior managers and data warehouse managers is critical to successful alignment and adoption of data warehouse. Obtaining commitment to the data warehouse initiative at the right level and at the right time is vital during the initial step of the project. The use of metadata encourages developers and end-users to cooperate in the planning and to encourage commitment to all of the stakeholders of the data warehouse (Ganczarski, 2006).

Zaheer, McEvily, and Perrone (1998) define trust as the expectation that parties fulfill its obligations, act predictably, and behave fairly even when the possibility for opportunism is present. Findings at previous researches indicate the importance of trust in the success of relationships (Lee & Kim, 1999; Voss, 2000; Daffy, 2001; Goles & Chin, 2005; Carr, 2006; Chang & Ku, 2009). According to Carr (2006), trust provide the glue holding together the relationship between IS users and the IS department. In addition, Voss (2000) and Daffy (2001) emphasize the importance of the trust in developing a sustainable relationship among an organization, its users, and its business needs. Morgan and Hunt (1994), argue that trust is a confidence in an exchange partner's reliability and integrity. The construct of trust particularly associates with the development of interest in relationship marketing in general (Rauyruen & Miller, 2006) and particularly in the context of IS (Goles & Chin, 2005; Carr, 2006). The lack of the trust in the IS context identifies as one of the major obstacles in the adoption and success of IS technologies (Hoffman, Novak, & Peralta, 1999).

Similar results are reported in data warehouse research. Perkins (2001) states the fact a data warehouse that contains trusted strategic information becomes a valuable enterprise resource for the decision makers' at all organizational levels. If its users discover that it contains bad data, the data warehouse will ignore and will fail. In the implementation of data warehouse, executive sponsorship is characterized by the ability to build trust and consensus between the data warehouse parties (Debasish Mukherjee & Souza, 2003). Data driven decision-making involves collaborating and an assortment of skills of the organization; Data analysis is one of the most important benefits of using data warehouses. The capability to transform data from transactional to customer focused data is immeasurable. Business users need to trust the results of the data warehouse when they produce their reports (Garner, 2007). According to (Bandyo-padhyay, 2002), trust is an important factor since users need to have trust in providers in terms of the service as well as the confidentiality of data. As noted earlier, the data in data warehouse collects from transactional systems in different departments or firms.

Anderson and Narus (1990) define the communication as the proactive formal and informal exchange or sharing of useful and timely information between firms. This definition focuses on the effectiveness of information exchange, rather than amount or quantity. According to Kanar and Oz (2002), communication is the number of people in the IT organization who have communicate to on any given warehouse subject. These subjects may include architecture, strategy, techniques, standards and guidelines, methodology, and tools (Kanar & Oz, 2002).

Moreover, communication is an important aspect in the development and success of data warehouse. Bhansali (2007) acknowledges that "communication of the strategic direction between the business and data warehouse managers is important for the strategic alignment of the data warehouse". In order to make sure that the business rules of data warehouse are correct, there must be communication between all development groups that supply data to the warehouse (Rudra & Yeo, 2000). Further, Shin (2003) outlines that the data warehouse architecture is a specification of formal processing and communication of a data warehousing environment. As mentioned by Mukherjee and Souza (2003), top management needs to keep communication strong between data warehouse parties and to continue supporting the concerns of those who now have a stake in the data warehouse system. As states recently, better communication capability between data warehouse team will cause a positive impact on the successful implementation of data warehouse (AbuAli & AbuAddose, 2010).

In previous studies, coordination is considered to be an important factor in relationship success (Mohr & Spekman, 1994; Lee & Kim, 1999; Goles & Chin, 2005). Goles and Chin (2005) define coordination as "*the process of managing interdependencies between entities to accomplish agreed-upon tasks*" (p. 67). In the context of data warehouse, coordination of organizational resources should affect the successful adoption of data warehouse technology (Hwang *et al*., 2004). In addition to this, the coordination of organizational resources can reduce unnecessary obstacles during the implementation process of data warehouse by investing requested labors and capitals in the project (Haley, 1997). According to AbuAli and AbuAddose (2010), coordination and proper allocation of resources can help data warehouse project teams to meet their project milestones and overcome organizational barriers.

Cooperation is a concept similar to coordination, but is a higher-level abstraction that more closely captures the nature of a relationship quality. Coordination describes the management of interdependent activities: cooperation indicates the participants' agreement and acknowledgement of what those activities are (Goles & Chin, 2005). Cooperation is defined as the complementary activities undertaking by organizations in an interdependent relationship with the goal of achieving mutual benefits (Anderson & Narus, 1990). Generally, data warehouse research has shown cooperation to have positive impacts on implementation success. Quaddus and Intrapairot (2001) argue that cooperation between IT departments and users will increase the diffusion of data warehouse technology. Data warehouse literature also suggests that cooperation between departments in an organization has a large effect on the smooth flow of the required information and expertise among departments, which strongly influences the successful adoption and implementation of data warehouse technology (AbuSaleem, 2005; Hwang *et al*., 2004). Ganczarski (2006) stated that, the process of designing and implementing a data warehouse demands new levels of cooperation among various business units. Moreover, cross-functional team cooperation and coordination is especially important in data warehouse projects (Agosta, 1999).

2.7.5 User Quality

User quality views the quality of IS products and processes from the perspective of users (Eriksson & Törn, 1991). Salmela (1997) identifies various attributes of IS user quality criteria such as ease of learning, ease of use, security, and flexibility in use. He states that: "Poor user quality increases the costs of learning and using the system". In addition to this, user quality considers as an important factor for IS quality improvement (Andersson & Eriksson, 1996; Salmela, 1997). The importance of user related factors like user training, user participation, and user acceptance in the success of a system also recognizes by Guimaraes, Staples, and McKeen (2003). They recognize the importance of user training as a significant factor for user participation and promote user/developer communication during the system development process to reduce user conflict.

Most of the literature available in data warehouse area indicates that the availability of skilled users is an important factor to determine successful data warehouse implementation in competing firm. For instance, Sakaguchi and Frolick (1997) outlined that data warehouse projects in particular require highly skilled teams who can overcome issues that arise during the project implementation. Moreover, it is necessary to select the members from different departments, to add diverse values to data warehouse project, as well as educate them in different aspects, as shown by (Hwang *et al.*, 2004; Watson *et al.*, 2002; Wixom & Watson, 2001). The skills of the data warehouse development team can have a major influence on the outcome of the project (Cooper *et al.*, 2000; Wixom & Watson, 2001; Hwang *et al.*, 2004). Other authors acknowledge that a highly skilled project team is better equipped to manage and solve technical problems (Avery & Watson, 2004; Watson *et al.*, 2004). Hwang *et al*. (2004) point out that the selection and inclusion of appropriate users in the data warehouse project team is also important.

The competences of project team have an endless impact on the success of a data warehouse project. The knowledge, skills, abilities, and experiences of the project manager as well as the selection of the right team members, which should not only be technologically competent but also understand the company and its business requirements (Somers & Nelson, 2001). The team should consist of a mix of consultants and internal staff so the internal staff can develop the necessary technical skills for design and implementation (Sumner, 1999). The members must be proficient in data warehousing matters. Possessing strong background and knowledge of new technology adoption, coupled with better communication capability positively influences data warehouse implementation (Hwang *et al*., 2004; AbuAli & AbuAddose, 2010).

Realizing the importance of good, solid data warehouse systems is just a first step. The second crucial step is employing experts to collect the intelligence that lies behind data warehouse (Rustmann, 1997). Data warehouse can only deliver value if the users are capable of utilizing information gained and turn them into sound business decisions (Avery & Watson, 2004). Business users must have in-depth knowledge of business processes and operations in order to act on the results of the analysis (Barrett & Barton, 2006). Besides that, business users also must understand how the business should use and how the business operates data. Many users simply don't have time, inclination or required skills to use data warehouse systems.

Therefore, quality users with different set of skill such as technical, business and analytical are needed in order to perform necessary tasks (Barrett & Barton, 2006).

Furthermore, the growth of the user base is perceived as a key indicator of the success or failure of a data warehouse (Armstrong, 1997). If the data warehouse is seen as providing timely access to valuable information, then the user base grows rapidly. In addition, data warehouse users need to understand how to use tools to handle large volumes of data in order to implement the data warehouse successfully (Haley, 1997; Little & Gibson, 2003). This is why Avery and Watson (2004) suggest the need to train the data warehouse users to gain knowledge and skills. Trainings would include basic technical skills such data warehouse concepts, the use of data-access tools and applications, the data in the warehouse and how to access them and the applications related to business intelligence (Avery & Watson, 2004).

Strange and Hostman (2003) acknowledge that choosing and implementing the right data warehouse applications is only part of the formula for data warehouse success. They also posit that data warehouse projects integrate requirements, data and priorities of the IS organization and its multiple business units. These tasks require people with unique skills in order to deliver the right outcome. According to them, most enterprises have difficulty finding people with the right skills. Most organizations lack the skills and organizational commitment for managing, implementing and supporting significant cross-functional data warehouse projects. Other authors argue that productivity of data warehouse implementation depends on the presence of experienced team members on the technical side and on the business side (Barrett & Barton, 2006). They also point out that:

"*having a team of experienced developers and business users can make the difference between a successful data warehouse deployment and a failure*" (p. 8).

Researchers categorize data warehouse users according to their business functions. Avery and Watson (2004) defined 4 types of data warehouse users, they are: (1) power users, (2) business users, (3) technical users, and (4) executives. According to them, these users have different needs and tasks that are categorized into strategic, tactical and operational. On the other hand, Brownin and Mundy (2001) classified the data warehouse users as: (1) statisticians, (2) knowledge workers, (3) information consumers, and (4) executives. They also argued that the success of data warehouse is measured by its acceptance by users. Additionally, SunMicrosystems and NCRTeradata (2004) divided the data warehouse user population into three groups as follows:

- Casual users, who makes infrequent use of the data warehouse and prefer parameterized or static reports.
- Analytic users, who makes frequent use of standard and statistical reports.
- Power users, who creates their own ad-hoc queries and prefer interactive reporting.

2.7.6 Business Quality

The construct business quality defines as "*the net value of an information system for the user organization*" (Salmela, 1997: p. 819). The author also argued that business quality views IS processes and products from a business perspective as well as requires the ability to define critical IS requirements, ability to support IS implementation with business changes, and ability to identify beneficial uses of IS. In the context of IS, other authors also stated that business quality is the concern of management, both managers and chief executive officers at the departmental level (Andersson & Eriksson, 1996; Andersson & Hellens, 1997). According to Salmela (1997), business quality affects by both the cost of implementing and using the system, and by the benefits acquired through systems use. Salmela study also shows that user quality and work quality as important components for business quality.

In the data warehouse environment, business quality indicated as important factor of improving the success of data warehouse systems (Thomann & Wells, 1999; Gosain & Singh, 2008). For instance, Thomann and Wells (1999) acknowledge that business quality is directly related to economic success. They add:

> "*business quality is the ability of the data warehouse to provide information to those who need it, in order to have a positive impact on the business*" (p. 2).

They also conclude that business quality refers to the concept of business strategy. Furthermore, Gosain and Singh (2008) consider two aspects of business quality relates to changing economic factors and environmental concerns.

The IT strategic planning literature identifies alignment of business or organizational strategy and IT strategy as a key factor in the success or failure of any IT project, data warehouse included. This means that the success implementation of data warehouse is directly related to the way in which the implementation is articulated in terms of business strategy and of the characteristics of each industry (Reich & Benbasat, 2000). The information definition phase should be linked to corporate strategic planning since data warehouse systems are supposed to link operational and strategic dimensions of an organization through the flow of information (Bhansali, 2007).

Previous studies recognize the need for business strategy to be integrated with technology in the overall data warehouse deployment (Bhansali, 2007; Garner, 2007). Moreover, implementing a data warehouse in response to a business strategy, and using the corresponding choices to define the required data warehouse infrastructure and processes, should bring about closer alignment. It would seek to exploit the emerging data warehouse capabilities to impact business scope and influence key attributes of strategy. Building a data warehouse that answers the needs of the business user and provides a high return on investment would be more likely to bring it into alignment with the business (Bhansali, 2007).

Moreover, to implement a data warehouse successful, it needs to be responsive to changes over time. The key findings from the case studies conducted by Bhansali (2007) shows that the flexibility in data warehouse planning and flexibility in responding to changes in business needs are critical to successful adoption of the data warehouse. Other authors (Armstrong, 1997; Moody & Kortink, 2000) also acknowledge that a flexible data warehouse would be more resistant to changes in analysis requirements over time and accordingly better aligned to business needs and strategies.

A change in the business requirements of the data warehouse is the result of progressive change in the business plan. In essence, a data warehouse is a database that is continually changing to satisfy new business requirements (Stephen, 1998).

Therefore, managing day-to-day data warehouse system is quite different from managing an operational database system (Chaudhuri & Dayal, 1997). The huge amount of data requires effective management processes such as adding summaries, or rolling data off/on the archive (Stephen, 1998). As a result, the organization should clearly define the business requirements of data warehouse at all stages of the change in business plans.

IT can use to enhance business performance in conjunction with vertical diversification and disintegration. Although IT is an essential component (it facilitates better coordination and productivity) it is not sufficient in itself and should be coupled with organizational changes. Similarly Davis, Dehning, and Stratopoulos (2003) in their studies on competitive advantage, find that payoffs from investments in information technology are difficult to recognize and a sustained competitive advantage from IT-enabled strategies is difficult to distinguish from temporary competitive advantage. Shin (2001) finds that by improving scope economies and coordination, IT can shape appropriate business strategies and at the same time the economic benefits of IT can be leveraged by such business strategies.

However, the factors mentioned above are not empirically tested in the data warehouse literature. These call for further empirical study to assess the factors evaluating the success of data warehouse. It is argued that knowledge generated from successful data warehouse deployment can be used to improve the business quality of a firm (Thomann & Wells, 1999; Bhansali, 2007; Gosain & Singh, 2008). Unfortunately, in the area of data warehouse, most of the research available focused on the technological and operational aspects (Chung, Chen, & Nunamaker, 2005), and there is very little research to consider the factors in the business and managerial levels.

2.8 Information Systems Success Models

The study of IS appeals to both scholars and practitioners for decades. Success factors of IS measure by researchers in various ways, including management support (Sabherwal *et al.*, 2006; Biehl, 2007; Fowler & Horan, 2007), information quality (DeLone & McLean, 2003; Hussein, Karim, & Selamat, 2007b), system quality (DeLone & McLean, 2003; Iivari, 2005; Sabherwal *et al.*, 2006; Hussein *et al.*, 2007b), user satisfaction (DeLone & McLean, 1992,; 2003; Hussein *et al.*, 2007b; Iivari, 2005; Sabherwal *et al.*, 2006), perceived usefulness (Chen *et al*., 2000; DeLone & McLean, 1992; Hussein *et al*., 2007; Sabherwal *et al*., 2006), and user attitude (Sabherwal *et al.*, 2006; Biehl, 2007).

In 1992, DeLone and McLean presented a “taxonomy” and “interactive” model, which was to “conceptualize” and “operationalize” information system success, (Figure 2.4). This model synthesized and incorporate previous IS research finding, and its primary goal is to provide a comprehensive framework and guidance for future IS success research. They combined several empirical measures of system quality, information quality, information system use, user satisfaction, individual impact, and organizational impact. They used these measures to create their six dimension IS success model. All of the empirical measures that DeLone and McLean used focused on the context of the organization.

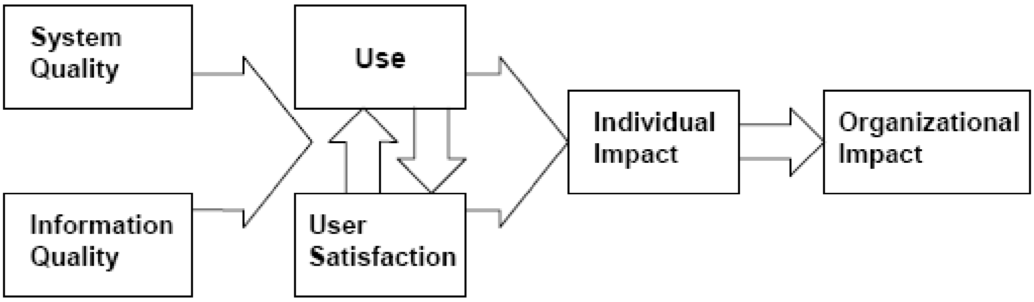


Figure 2.4: IS Success Model (DeLone & McLean, 1992)

In the following ten years, the original DeLone and McLean model investigates in hundreds of research articles. Many researchers validate the dimensions and confirmed the interrelationship between the dimensions of the model (Guimaraes & Igbaria, 1997; Rai, Lang, & Welker, 2002). Some researchers suggested modifications such as Seddon (1997) and Molla and Licker (2001).

Subsequently, Seddon (1997) extends the work of DeLone and McLean (1992). He reforms the original IS model into two partial variance models and he argues for the removal of “system use” as a success measure, claiming that use is a behavior that is appropriate for inclusion in the process model but not the variance model. Furthermore, Segars and Grover (1998) use the DeLone and McLean IS success model 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 focus on IS success within the context of the organization. Wixom and Watson (2001) follow the work of DeLone and McLean (1992) and Sedan (1997) and developed a three-dimensional model of system success with data warehouse:

data quality, system quality, and perceived net benefits. They use a cross-sectional survey to investigate their data warehouse success model.

In 2003, DeLone and McLean conclude the research findings of over 100 DeLone and McLean model studies, and present by the updated DeLone and McLean model (Figure 2.5). The major revision is the addition of a new dimension "Service Quality". According to the authors, as information technology evolved and the environment changed, new challenges emerged; thus the original model needs to adjust in order to perform more accurate measurement tasks.

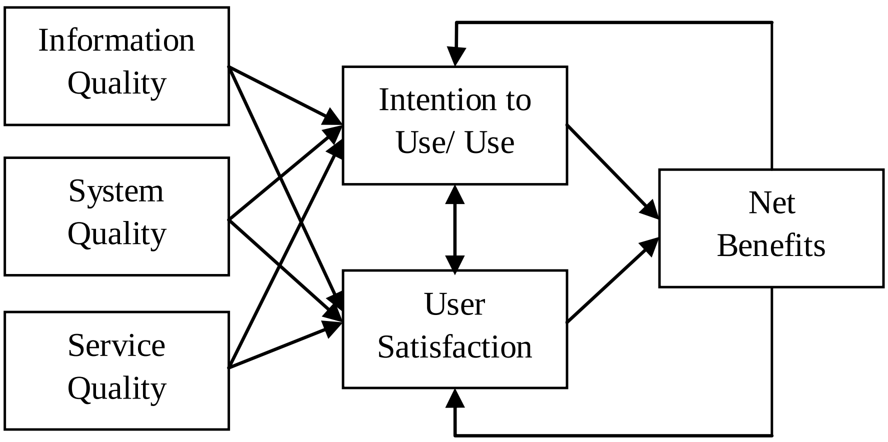


Figure 2.5: Updated IS Success Model (DeLone & McLean, 2003)

According to DeLone and McLean (2003), as the impacts of information systems evolve beyond the immediate user, researchers suggest additional IS impact measures, such as working impacts (Myers, Kappelman, & Prybutok, 1998), inter-organizational and industry impacts (Clemons & Row, 1993), consumer impacts (Brynjolfsson & Hitt, 2000), and societal impacts (Seddon 1997). Therefore, DeLone and McLean decide to replace the "Individual Impacts" and "Organizational Impacts" in their original 1992 IS success model with a new "Net Benefits" measure. This new measure is contingent and depends on the system being evaluated or measured. DeLone and McLean (2003) also decide that rather than complicating their model with more success measures, they refer to move in the opposite direction and group all the impact measures into a single impact or benefit category called "Net Benefits".

According to DeLone and McLean (2003), several researchers comment on the difficulty of applying their success model in order to define and operationalize IS success in specific research contexts. DeLone and McLean (2003) indicate that this is not unexpected, and that their original 1992 article clearly suggests that their model needs future developments and validation before it can serve as a basis for the selection of appropriate IS measures. In their 2003 article, DeLone and McLean also suggest that their new model be future tested and validated, and encouraged others to join this effort. Testing the DeLone and McLean (2003) model in a context other than their original organizational context would be very beneficial.

Other authors developed alternative IS success models. Grover *et al*. (1996) created six effectiveness categories based on unit of analysis and evaluation type context dimensions. The six effectiveness classes are infusion measures, market measures, economic measures, usage measures, perceptual measures, and productivity measures. Smithson and Hirschheim (1998) also propose a framework that consists of three zones of measures: namely, efficiency, effectiveness, and understanding. These models were also discussed in the context of the organization. The DeLone and McLean model is more accepted and use in IS literature than these other models. In addition, DeLone and McLean (2003) state that IS success model become a standard for the specification and justification of the measurement of the dependent variable in information system research. A citation search in the fall of 1999 by DeLone and McLean yield 144 refereed journal articles and 15 papers from the International Conference on Information system (ICIS) that refer to the IS success model during the period of 1993 to mid-1999. Thus, this new model measures IS success in terms of more up-to-date dimensions, and become more robust for information system success evaluation.

In recent studies, Jennex and Olfman (2006) adapt the updated DeLone and McLean 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*. (2008) 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 (2008) re-specifies and validates the updated DeLone and McLean IS success model for assessing the e-commerce systems success using structural equation modeling techniques. Wang's study reforms the updated DeLone and McLean 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 (2009) empirically evaluate the relationships for the updated DeLone and McLean IS success model using the quantitative method of meta-analysis. They state that the majority of the relationships posited in the updated DeLone and McLean IS success model are supported. The next chapter discusses the proposed research model and its justifications.

2.9 Summary

The literature review reveals data warehouse has unique features that make them different from other decision support applications. Data warehouse also differs from traditional operational systems. The data warehouse architecture and implementation process described in this review shows that the data warehouse has an enterprise wide impact on the infrastructure of the organization. Furthermore, the difficulties of data warehouse implementations have been widely cited in the literature. Moreover, the literature review reveals that researchers have investigated some factors that affect data warehouse implementation. In addition, the literature review contends that more studies in factors that influence the data warehouse success need to be conducted. It also describes the important of the quality factors in the success of data warehouse systems. The literature also discusses the DeLone and McLean IS success model which is the basis of this study. The proposed model and planned methodology for conducting this study explains in the following chapters.

CHAPTER Three

RESEARCH MODEL AND HYPOTHESES

This chapter presents the research concepts used in this study. The chapter then proposes the research model. The first section describes the conceptual model of the research, and then followed by a presentation of the construction of hypotheses. A broad review of relevant literature in data warehouse success dimensions and measurements are presented. This allows for a broad outline of the underlying theoretical concepts used in this research.

3.1 Research Model

According Sekaran and Bougie (2010), a theoretical framework is a conceptual model of how one theorized or makes logical sense of the relationship among the several factors that have been identified as important to the problem. From the theoretical framework, testable hypotheses can be developed to examine whether the theory formulated is valid or not. The hypothesized relationship can thereafter be tested through appropriate statistical analysis, so to be sure of the firmness of this research. Since the theoretical framework offers the network of relationships among the variables considered important to the study, it is essential to understand what variables are involved in the study of conceptual model.

As noted before (Section 1.2), the theoretical framework selected for this study, is the updated DeLone and McLean IS Success Model (2003). Researchers investigates the success of information systems in numerous ways (Garrity & Sanders, 2001), by measuring the system quality, information quality, service quality, and the perceived usefulness of specific applications. Moreover, researchers treat IS success as a multi-faceted construct and select several appropriate success measures based on the research objectives and the phenomena under investigations (Hayen *et al.*, 2007; Thomas & Fernandez, 2008; Petter *et al.*, 2008). This provides possible relationships among the success dimensions when constructing a research model. That model establishes a framework for metrics that can be used to manage the data warehouse implementation project to insure the success of data warehouse (Hayen *et al*., 2007). The IS success model (DeLone & McLean, 2003) emerges as a dominant model in the selection of dependent variables by the researchers. This model classifies all success measures into six categories: system quality, information quality, service quality, use, user satisfaction, and net benefits.

The difficulties of data warehouse implementation and evaluation are widely cited in the literature, but research on the factors for initial and on-going data warehouse success is rare and fragmented. However, chapter two (Section 2.7) explained in details the importance of quality factors in evaluating the success of data warehouse systems. Furthermore, previous studies shows that there is a need to study new factors such as relationship quality (Hwang *et al.*, 2004; Carr, 2006; Bhansali, 2007), user quality (Avery & Watson, 2004; Barrett & Barton, 2006), and business quality (Gosain & Singh, 2008) that could help firms to assess the success of their data warehouse systems.

Basically, most of the previous empirical studies related to data warehouse success model are associated with the original DeLone and McLean IS success model (such as: Hwang & Xu, 2008; Wixom & Watson, 2001). According to the studies reviewed in chapter Two (section 2.5), it found that there is no intensive examination of the interrelationships among the system quality, the information quality, the service quality, the relationship quality, the user quality, and the business quality and its individual or combined effects on the net benefits in the data warehouse success environment.

This study suggests a primary research model based on the underlying models as well as the review on the applications of those models in the IS fields that have been discussed in the previous chapters. Various factors identified in studies on IS-related fields were also taken into considerations. The model development is done by combining the IS success model by DeLone and McLean (2003) and other models on IS/DW-related fields. Four factors, they are: information quality, system quality, service quality, and net benefits were selected from DeLone and McLean IS success model (2003). Relationship quality factor was adapted from other IS success studies by Goles and Chin (2005) and Chakrabarty *et al*. (2007). Business quality factor adapted from model developed by Salmela (1997) and study conducted by Thomann and Wells (1999). While user quality factor was adapted from data warehouse literature. This combination of models was adapted in this study in order to develop a specific research model of data warehouse success.

DeLone and McLean (2003) recommend that researchers can select proper measures for the success model based on the research context. This prompted Shin (2003) to consider IS success model that introduced by DeLone and McLean (2003) as a good framework in understanding the success of data warehouse. Therefore, this study identifies the appropriate variables and measures for the data warehouse success.

The research model of this study has seven constructs as shown in Figure 3.1. 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.

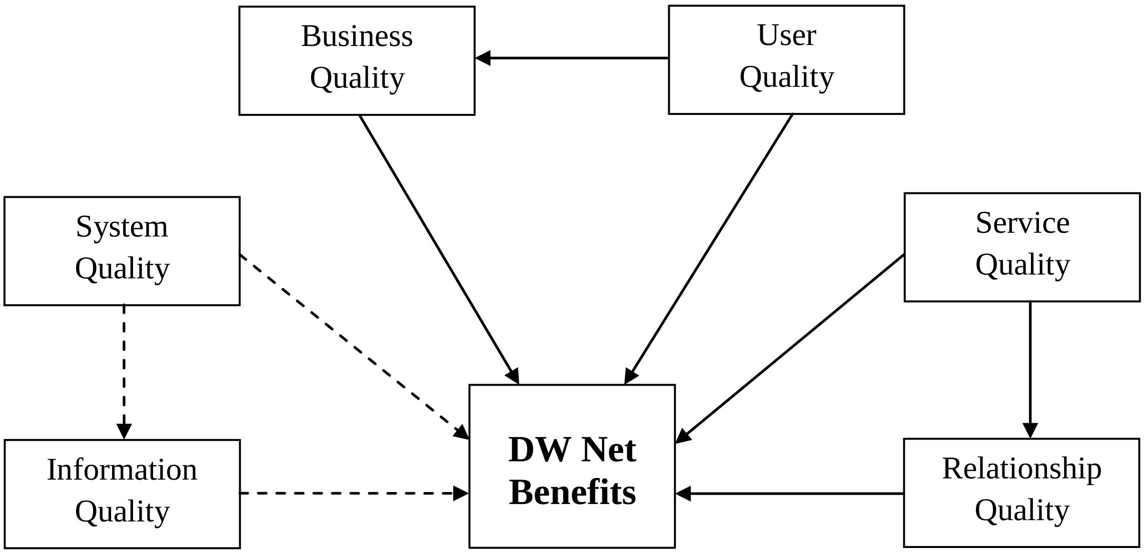


Figure 3.1: The Proposed Research Model of the Data Warehouse Systems Success

Legend: - - - - - - → Has been tested
——→ Has not been tested

3.2 The Success Measurements

The data warehouse literature emphasizes that the purpose of data warehouse is to provide quality data that is flexible and accessible. This purpose reflects facets of two success measures - information quality and system quality. Firstly, information quality is the measure of information systems output, and it is used to measure success in many studies (Lee *et al.*, 2002; DeLone & McLean, 2003; Shin, 2003;Nelson *et al.*, 2005; Hwang & Xu, 2008; Gorla *et al.*, 2010; among many others). In the instrument of Gorla *et al.* (2010), the information quality includes perceptions of information accuracy, completeness, usefulness, relevance, format, and consistency.

Systems quality addresses the information system itself. In addition, the system quality measures are straightforward and tap into the flexibility and accessibility of the system. The instrument of Gorla *et al*. (2010) defines the system quality in terms of flexibility and sophistication. In particular, an essential attribute of data warehouse is flexibility; it must adapt to changing business priorities and provide for future applications (Nelson *et al*., 2005; Inmon, 2005; Bhansali, 2007). Systems quality has surfaced often in the implementation literature (DeLone & McLean, 2003; Nelson *et al*., 2005; Gorla *et al*., 2010; among many others). Furthermore, data warehouse should well integrate data from various data sources. Ultimately, perceptions of information quality and system quality were deemed appropriate measures of success for this study.

Another quality factor that is proposed in this study is service quality, as mentioned in the chapter 2, data warehouse is the process of creating an infrastructure, and its users are less easily described. For example, data warehouse users who are responsible for the maintenance of decision support applications are different than the person who maintains the executive information system. This change in thinking of a user eliminates service quality as a viable success measure as well. Service quality focuses on the services delivered by IS department to the end user (Kettinger & Lee, 2005). However, in the case of data warehouse, services delivered to the external users (i.e. suppliers) and internal users (i.e. managers and decision makers). Therefore, providing reliable and prompt services by data warehouse specialists to users would better serve user needs. Thus, service quality is more appropriate for this study and would be quite important.

This study also considered effective relationship quality, user quality, and business quality as keys to data warehouse success. Relationship quality refers to 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 or unsuccessful encounters (Chang & Ku, 2009). As stated previously, the data warehouse systems integrate requirements, data and priorities of the IS organization and its multiple business units. Furthermore, building a data warehouse requires an integration in many tasks, components, and coordination of efforts of many people (Kimball, 2006). Therefore, the existences of better quality of relationship between the data warehouse parties are absolutely necessary for achieving the business goals and reach success (Bhansali, 2007).

Moreover, the underlying objective of user quality is to ensure an effective use of software. According to several researchers (Chen *et al.*, 2000; Cooper *et al.*, 2000; Payton & Zahay, 2003; Hwang *et al.*, 2004), there is additional risk in the form of the data warehouse users in terms of their needs to strong analytical and technical skills in order to properly setup and interpret oftentimes unexpected results. The true value of data warehouse will only be realized if the users are capable of utilizing information gained and turn them into sound business decisions (Avery & Watson, 2004). Thus, the quality of user is considered as an appropriate success measure for this study. Finally, business quality in the data warehouse context defined as the ability of the data warehouse systems to provide information to those who need it, in order to have a positive impact on the business (Thomann & Wells, 1999). This prompted several authors (Thomann & Wells, 1999; Gosain & Singh, 2008) to consider that business quality as an important aspect to measure the success of the data warehouse systems. Ultimately, adding business quality to this study adds great value.

The researcher excluded the intermediate variables *use* and *user satisfaction* from the research model for the following reasons: (1) while *use* and *user satisfaction* were well researched in the past, the value of these variables in IS and data warehouse success models provide for little variability in mandatory systems and hence can be eliminated (Seddon, 1997; Wixom & Watson, 2001; Gable, Sedera, & Chan, 2003; Bradley, Pridmore, & Byrd, 2006; Hwang & Xu, 2008; Petter *et al*., 2008), (2) also IS use is excluded from the study model because it's utility in general and in data warehouse studies in particular (Wixom & Watson, 2001; Hwang & Xu, 2008), and (3) IS use does not play a role in data warehouse success measures because it is not the use of data warehouse itself that is important; rather, it is the impact of that use on organizations that is important and represents a success measure (Hwang & Xu, 2008).

Several researchers have developed instruments to measure user's satisfaction. However, many of the items (i.e. ease of use, ease of learn, user requirements) in the satisfaction instruments readily map to items measuring system quality, service quality, and information quality (Gable *et al*., 2003). Rai *et al*. (2002) state that user's satisfaction can be measured indirectly through the information quality and the system quality. In a study of the enterprise systems success model, Sedera and

Gable (2004) observe that satisfaction items loaded with system quality in the factor analysis. In a study relating to data warehouse success, Hwang and Xu (2008); Wixom and Watson (2001) excludes user satisfaction because it is not considered a good indicator of success for multiple-user applications such as data warehouse. As user satisfaction items are thus already included in information quality or system quality, we chose not to include user's satisfaction in the study model.

3.3 Hypotheses of the Study

According Sekaran and Bougie (2010), 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 (Sekaran & Bougie, 2010). All the hypotheses in this study are directional in stating the positive relationship between two variables or comparing two groups' terms.

Conceptualization of the data warehouse success model in this study involved three key activities: problem analysis, related dimensions identification, and construction of hypotheses. The analysis of the problem area was mainly established through a comprehensive literature review reported in chapter two. The main aspect of deriving a research model in this study is the identification of related dimensions. Review of literature revealed that existing data warehouse success models and their measures are insufficient and perhaps obsolete to assess the success of data warehouse (Solomon, 2005; Chenoweth *et al.*, 2006; Garner, 2007; Hayen *et al.*, 2007). Therefore, identification of dimensions and measures of data warehouse success was given the highest priority in deriving the research model. The third aspect of model derivation relates to the hypotheses construction. Hence, the following section discusses the hypotheses and variables of the research model in detail.

3.3.1 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 (Gorla *et al.*, 2010). 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 (Bradley *et al.*, 2006). 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 (Swanson, 1997; Gorla *et al.*, 2010).

Previous studies (Seddon, 1997; DeLone & McLean, 2003) 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 described as an important success factor (Petter *et al*., 2008), as it is believed that higher information systems quality should be considered as easier to use and essentially have higher levels of success (Seddon, 1997; Nelson *et al*., 2005). Nelson *et al*. (2005) on the other hand regards the system quality construct that produces the information output, which can be expressed 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 data warehouse on decision performance and indicate the evidence that support the effects of quality data warehouse systems on decision performance through system use (Seddon, 1997; Park, 2006).

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 (Yang & Yoo, 2004; Wixom & Todd, 2005; Hsieh & Wang, 2007). 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 (Bharati & Chaudhury, 2006). Seddon and Kiew (1996) and Shih (2004) indicate a significant relationship between system quality and perceived usefulness as measured by productivity and decision-making quality. Moreover, Prybutok, Zhang, and Ryan (2008) identify a significant relationship between system quality and net benefits in e-government environment. Furthermore, the quality of the data warehouse system is significantly associated with net benefits in the study conducted by Wixom and Watson (2001). They also state that system quality of a data warehouse is positively related to decreased effort and time for decision making. In addition, Petter *et al*. (2008) stress that further research is required to assess the relationship between system quality and net benefits.

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

Hypothesis 1 (H1): System quality is positively associated with data warehouse net benefits.

On the other hand, system quality can be used to signify the quality of information. Overall, lower quality of system results in high costs due to software's not serving its intended purpose, are not designed as planned, be subject to errors, having few safety measures, and not being robust (Gorla *et al.*, 2010). Thus, low-quality system results in low information quality (with respect to the information content dimension) because of irrelevant and incomplete/inaccurate information. Furthermore, a data warehouse system that is flexible can update easily and quickly, thus meeting changed user information needs quickly and efficiently, which leads to relevant and up-to-date information outputs to users, implying high information quality. As a result, high flexibility of the data warehouse system (i.e., maintainability, useful features of system) leads to high information accuracy and completeness (Hwang & Xu, 2008).

A data warehouse system that takes advantage of user-friendly and modern technologies (such as GUI - graphical user interfaces) can provide information to users in an easy to understand format, allowing them to effectively use data warehouse systems. In addition, a well-integrated data warehouse system provides accurate and complete information so that its outputs will be useful information for users' daily jobs and relevant for decision-making aims. Yet, few studies investigate the relationship between system quality and information quality. Gorla *et al*., (2010) examine the relationship between system quality and information quality on IS success model as a whole. They indicate that system quality is significantly related to information quality, when information quality is measure by information content and format. For data warehouse systems, one study concludes that the system quality is positively associated with information quality, measured by better quality information and improved productivity (Hwang & Xu, 2008).

The above arguments stated that high data warehouse system sophistication (i.e., user friendly, well integrated, modern technology) leads to high information format and high information content (i.e., complete, accurate, relevant to decision making). Thus, we proposed the following hypothesis:

Hypothesis 2 (H2): System quality is positively associated with information quality.

3.3.2 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 (DeLone & McLean, 2003). Researchers use a variety of attributes for information quality. For instance, Nelson *et al*. (2005) use the constructs of currency, completeness, accuracy, and format to measure the information quality factor. Huh *et al*. (1990) define four dimensions of information quality: completeness, accuracy, consistency, and currency. In the context of data warehouse systems, information quality indicates as an important aspect influence in data warehouse success (Haley, 1997; Thomann & Wells, 1999; Rudra & Yeo, 2000; Wixom & Watson, 2001; Shin, 2003; Nelson *et al*., 2005; Hwang & Xu, 2008; among many others).

Data quality in the data warehouse systems is generally poor and there are many foreseeable setbacks such as economic failure and ineffective planning of business strategies (Rudra & Yeo, 2000). However, the growth of data warehouses systems and the direct access of information from various sources by managers and information users increase the need of high quality information in organizations (Lee *et al*., 2002). Additionally, data warehouse is anticipated to enable the production of information of higher quality as well as the new information for innovative use. For instance, Sakaguchi and Frolick (1997) discuss one of the data warehouse 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 (1994) argues that information quality is related to decision-making efficiency. The quality of the information considered in this study is also significantly associated with quality of work and time savings (Shih, 2004) and decision-making support (Bharati & Chaudhury, 2006). Moreover, the perceived information quality is positively associated with net benefits (Seddon & Kiew, 1996; Rai *et al.*, 2002; Shih, 2004; Wu & Wang, 2006). Prybutok *et al*. (2008) also study the impact of information quality on net benefits in e-government environment and found largely significant results. However, in the context of data warehouse systems, information quality is directly related to individual benefits (Hwang & Xu, 2008). Additionally, a study of data warehouse success conducted by Wixom and Watson (2001) 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 (Farhoomand & Drury, 1999) and to better perceptions of the work environment (i.e., interesting work, job content, morale) (Teo & Wong, 1998). Moreover, data quality is significantly related to perceived decrease in effort and time for decision making (Wixom & Watson, 2001). In addition, Petter *et al*. (2008) conclude that further research is required to investigate the relationship between information quality and net benefits.

As a result, high information quality in terms of information content and usefulness can lead to high benefits of data warehouse 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 following hypothesis.

Hypothesis 3 (H3): Information quality is positively associated with data warehouse net benefits.

3.3.3 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 (2005) 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 data warehouse 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), data warehouse 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 (Gorla *et al*., 2010).

According to Gorla *et al*. (2010) "*the impact of IS service quality can be understood from the impact of a firm's service quality on the firm performance*" (p. 9). Delivering quality service is a very important aspect for business success that leads to lower cost, higher profitability (Reich & Benbasat, 2000), long-term economic returns for the firm, and increased customer satisfaction (Andersson & Eriksson, 1996). In the data warehouse 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 data warehouse 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 data warehouse specialists can ensure the success of business operations and take benefit of them. As a result, service quality of data warehouse 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 (Petter *et al*., 2008). A study conducted by Prybutok *et al*. (2008) 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 (Gefen & Keil, 1998). Leonard-Barton and Sinha (1993) also indicate that the developers' technical performance, based on their ability to respond to problems, is significantly associated with improving efficiency. Gorla *et al*. (2010) identify a significant relationship between system quality and organizational impact as measured by organizational performance enhancement. In the data warehouse environment, Ramamurthy *et al*., (2008) suggest that the examination of responsiveness for both current and future data warehouse projects can increase the chances of success. In addition, Petter *et al*. (2008) indicate that further research is required to assess the relationship between service quality and net benefits.

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

Hypothesis 4 (H4): Service quality is positively associated with data warehouse net benefits.

The service quality components (such as reliability and responsiveness) are relatively more controllable in terms of a managerial perspective (Chakrabarty *et al.*, 2007). When the user sees that the data warehouse system is providing high service quality, it would develop a positive impression of the data warehouse system, and could lead to a growth in relationship among data warehouse users and data warehouse parties. In the interests of data warehouse system success, users who perceive their system as not providing the expected service quality or the desired outcomes will not give attention or serious cooperation with data warehouse parties. At the same time, it is important for the data warehouse parties to realize that it should make sincere efforts to cooperative and communicating with each other by providing well thought out and realistic project plans, schedules, and requirements (Bhansali, 2007). Therefore, the quality of services provided by data warehouse system to its users would positively impact the quality of the relationship between data warehouse parties within the organization.

In contrast, there are few studies that examine the relationship between service quality and relationship quality. However, in the context of outsourcing systems, Chakrabarty *et al*. (2007) conclude that service quality is significantly and positively related to relationship quality. Another study (Paravastu, 2007) argues that, better service quality leads to a better relationship quality with a better commitment between the parties, better coordination of joint efforts of the parties, and better cooperation between the parties. Furthermore, a study of e-commerce system (Sun *et al.*, 2007) stresses that service quality is significantly associated with perceived relationship quality as measured by trust, commitment, retention, and satisfaction.

Hence, from the evidence provided, the author strongly believes that the quality of services provided by data warehouse system can positively impact the quality of the relationship between the data warehouse parties. Thus, this research posits the following hypothesis:

Hypothesis 5 (H5): Service quality is positively associated with relationship quality.

3.3.4 Relationship Quality

Lee and Kim (1999) 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 data warehouse 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*. (2007) 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 data warehouse parties is critical for success of data warehouse system in terms of commitment, trust, cooperation, coordination, and communication (Haley, 1997; Hwang *et al.*, 2004; Ganczarski, 2006; Bhansali, 2007; Garner, 2007; AbuAli & AbuAddose, 2010). Moreover, a good relationship between data warehouse 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 (Bhansali, 2007). Generalizing the above discussion, relationship quality is described in terms of the user's expectation of benefit from the relationship. Additionally, a data warehouse 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 a data warehouse 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*. (2007) indicates that relationship quality is significantly associated with user satisfaction in IS outsourcing success. In the context of e-commerce systems, Wu (2007) 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 (2009) 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 data warehouse net benefits. Thus, the corresponding study develops the following hypothesis:

Hypothesis 6 (H6): Relationship quality is positively associated with data warehouse net benefits.

3.3.5 User Quality

According to Andersson and Hellens (1997), 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 the data warehouse environment, user quality factor also performs an essential role in identifying the success of data warehouse systems in a competing company (Wixom & Watson, 2001; Avery & Watson, 2004; Hwang *et al*., 2004). Particularly, the skills of the users have an important effect on the outcome of the data warehouse success. In addition, quality users equips with business, analytical and technical skills are essentials as data warehouse benefits can be only utilized by these users who are competent of analyzing information and turn them into proper business decisions (Avery and Watson, 2004).

As a result, quality of the user reflects the level of benefits resulting from the use of the data warehouse system. Therefore, it can obtain more realistic estimate of the data warehouse benefits when the user consider other skills such as business, analytical, and technical. More important aspects of data warehouse which regards to integrating organization's requirements and priorities require people with unique skills in order to provide the right outcome. Unfortunately, Avery and Watson (2004) state that most enterprises have difficulty finding people with the right skills to deliver these important tasks. Thus, the success adoption of data warehouse requires provision of adequate and sufficient training for the data warehouse parties to acquire necessary skills such as concepts of data warehouse and the use of data-access tools (Hwang *et al*., 2004).

Overall, few studies investigate the relationship among user quality and net benefits. One study analyzes the influence of IS user quality on business benefits (Salmela, 1997). The author indicates that the quality of IS user is positively associated with organizational benefits. Furthermore, a study of data warehouse systems concludes that a high level of user skills is significantly related to project implementation success (Wixom & Watson, 2001). Another study shows similar results when examining the relationship between skills of project team and the adoption of data warehouse technology (Hwang *et al*., 2004).

Therefore, it can conclude that the capability of data warehouse 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:

Hypothesis 7 (H7): User quality is positively associated with data warehouse net benefits.

According to Salmela (1997), high business quality requires high quality of IS user. Salmela also stresses the fact that IS user quality is an important predictor of business quality. Andersson and Hellens (1997) also discuss the influence of user support quality on business quality. They acknowledge that user quality is significantly related to business quality. In the context of data warehouse, user quality in terms of business, analytical, and technical skills is needed in order to ensure that the data warehouse systems are actually developed and used in the way that produces the business benefits.

Hence, with the argument discussed above, the following hypothesis related to user quality is proposed:

Hypothesis 8 (H8): User quality is positively associated with business quality.

3.3.6 Business Quality

According to Salmela (1997), 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 (Andersson & Eriksson, 1996) 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 the data warehouse systems success (Thomann & Wells, 1999; Gosain & Singh, 2008). 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 (2001) contend that business strategy is significantly related to organizational performance. In the data warehouse environment, Hwang *et al*. (2004) identify a significant relationship between business competition and data warehouse success adoption. Moreover, Bhansali (2007) stresses that the data warehouse success affected by business plans and business strategies.

Previous studies (Thomann & Wells, 1999; Bhansali, 2007; Gosain & Singh, 2008) suggest the need of business quality to be integrated with technology in the overall data warehouse deployment. Therefore, the researcher believes that the quality of business offered by data warehouse system would significantly influence the net benefits of data warehouse. Hence, this study postulates the following hypotheses that relate to business quality:

Hypothesis 9 (H9): Business quality is positively associated with data warehouse net benefits.

3.4 Summary

It is evident that there is dearth of research that addresses the applicability of the quality factors to data warehouse success. This chapter details the foundation for this research conceptual model. This chapter also summarizes the sources of the factors with their associated relationships. In addition, this chapter provides an understanding of the quality factors that should be taken into account when implementing data warehouse systems.

From the analysis of the literature, the researcher has developed the data warehouse systems success model that is based on IS success model for DeLone and McLean (2003). The model proposes and formulates 12 hypotheses (Figure 3.2) in trying to answer to the research questions. There are seven constructs involved which include six quality constructs (i.e. system quality, information quality, service quality, relationship quality, user quality, and business quality) that are concerned with the net benefits construct. The system quality construct is concerned with information quality construct. The service quality construct is concerned with relationship quality construct while the user quality construct is concerned with business quality construct. The next chapter discusses the methodology to be used in this research.

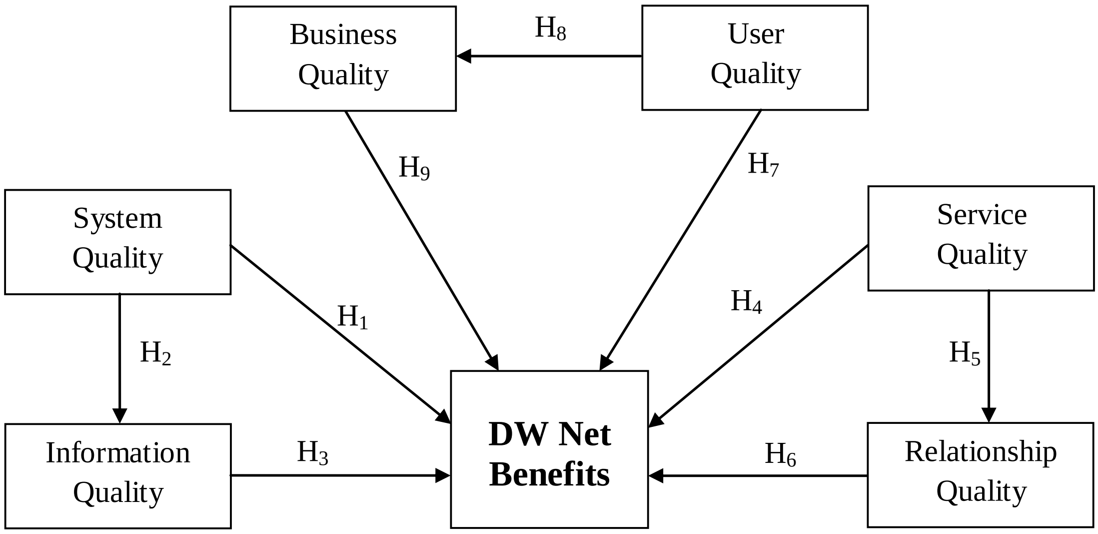


Figure 3.2: Hypotheses Research Model

CHAPTER Four

METHODOLOGY

4.1 Introduction

This chapter presents the methodology of research and the theoretical basis behind the approaches and their definitions. The research methodology is an operational plan derived from the research design. It is the way in which the analysis of the principles of methods, postulates, and rules employed by a discipline (Hair *et al.*, 2007). The main objective of this study is to develop and test a model for evaluating the success of data warehouse. The study conducts by using the Information System (IS) success model through the examination of the influences of information quality, system quality, service quality, relationship quality, user quality, and business quality on the net benefits of data warehouse. To do so, the first part of this chapter explains the research design and methods used to address the research objectives as outlined in chapter one. The following sections discuss the measures specification, creation of survey instrument, proposed data collection method, and statistical methods to analyze the data.

4.2 Research Design

According to Yin (2009), the purpose of research is to state what should be accomplished by conducting research and how the results from the research can be used. Moreover, research design or research strategy is a plan that researcher should follow in order to ensure that the objective of the research is achieved. Selecting an appropriate design is critical to make sure that research questions could be answered correctly (Creswell, 1994; Robert K Yin, 2009). Nachmias and Nachmias (1996) also defined research design as a plan that guided the investigator in a process of collecting, analyzing, and interpreting observations. It is a logical proof that allows the researcher to draw inferences concerning causal relations among variables under investigation (Nachmias & Nachmias, 1996).

There are two types of research methods, qualitative and quantitative, based on the data types. The qualitative research is characterized by the opportunity to explore a subject in a manner as real as possible (Saunders, Lewis, & Thornhill, 2003). The quantitative research involves numerical data or contains data that usually can be quantified (Saunders *et al.*, 2003). By quantitative method, researchers have come to mean the techniques of quasi-experiments, randomized experiments, sample surveys, multivariate statistical analyses and the like (Blaikie, 2000). This study uses a quantitative instrument method to determine relationships and also explore new variables that may be useful in developing a better model for similar studies in the future. The reason of taken this method is its ability in capturing the advantages in generalizing the findings to the population (Hair *et al*., 2007). A field questionnaire-based survey is conducted to examine the relationship between the quality factors and net benefits in data warehouse context. The related secondary data was collected and analyzed from other literature and previous research to verify the hypothesis and results as well. The following sections describe the population, sample size, and data collection method used in this study.

4.3 Population

According Sekaran and Bougie (2010) "*a population refers to the entire group of people, events, or things of interest that the researcher wishes to investigate*" (p. 262). A population considers as a complete group that divides the set of common elements relevant to the research project (Hair *et al.*, 2007). The population of interest is identified the target population. The research project can only be designed to collect data from objects or elements in the population of interest. Hair *et al.* (2007) argue that the target population is an important step in the design of research project.

The population in this study is the members of The Data Warehouse Institution (TDWI). This institution is the premier provider of in-depth, high-quality education and research in the business intelligence and data warehousing industry. Starting in 1995 with a single conference, TDWI is now a comprehensive resource for industry information and professional development opportunities (MeritDirect, 2010). The total number of TDWI members is 29,209 for the mid-year 2010 (MeritDirect, 2010). These members are working in variety industries around the world and they are different in terms of their experience levels (MeritDirect, 2010). TDWI provides a wide variety of benefits, including robust online resources, printed publications and research reports, and discounts on TDWI education events and merchandise for members. Registration for TDWI is not available for free, who wants to join TDWI should be relevant to the subjects of data warehouse and business intelligent, and also must pay fees ranging from $1200 to $6000 for enterprise, $275 for individual, and $50 for student.

Generally, TDWI members categorized into seven groups based on their job levels (Table 4.1): IT/DW specialist/staff, developers, IT/DW management, non-IT specialist/staff, non-IT management, executive/corporate management, and consultant (MeritDirect, 2010: 25/7/2010). The target population selected for this research considered three groups of TDWI members: IT/DW management, IT/DW specialists/staff, and executive/corporate management. This is to make sure that the appropriate person provided perceptions for this study. In other words, the target population considered TDWI members who are most familiar with using the data warehouse and who are only able to assess the success or failure of data warehouse systems. This suggestion was also made by a convenience sample of people who checked the content validity of the questionnaire during the pre-test stage (see section 4.6.1). Thus, the total number of the target population is about 20,499.

Table 4.1: Job Specifications for the Target Population (MeritDirect, 2010: 25/7/2010)

Job Specifications	**Total Members**
IT/DW Specialist/Staff	5915
Developer	2274
IT/DW Management	9764
Specialist/Staff (NON-IT)	982
Management (NON-IT)	2460
Executive/Corporate Management	4820
Consultant	2994

4.4 Sample and Data Collection

Sampling is the process of selecting a sufficient number of elements from the target population. Hair *et al.* (2007) referred sample as a small subset of the population to derive conclusions about the population characteristics. Sekaran and Bougie (2010) outlined that the sample and an understanding of its characteristics or properties would make it possible for making generalization towards such characteristics or properties of the population elements. Sekaran and Bougie (2010) acknowledged that sampling is required due to:

- It would be practically impossible to investigate or collect data on every element if examinations involved thousands of elements. Even if it is possible, it implies a higher cost in term of time and effort.
- A higher overall credible and reliable accuracy than a census due to reducing fatigues, which produces less error in data collection.

There are two ways argued by several authors to select a sample: probability sampling and non-probability sampling (Saunders, *et al*., 2003; Yin, 2009; Hair *et al*., 2007; Sekaran & Bougie, 2010). Probability sampling is typically a process where elements are selected randomly and it's used in quantitative studies. The elements possess similar opportunity of being selected. As opposed, non-probability sampling is usually used in qualitative research and it's done without chance selection procedures.

According to Sekaran and Bougie (2010), probability sampling is most typically associated with survey-based studies, as it needs the researcher to make inferences from the sample about the population to achieve the research objectives and to answer the research questions. It may be unrestricted or limited (simple random sampling) in nature. Researchers added that simple random sampling has the least bias and offers the most generalizability where every element has an equal chance of being selected as subject from the population. Other limited probability sampling (complex probability sampling) designs are often chosen instead because this type of sampling process could be more expensive while updates must be made to have the latest, most recent information of what is being focused or looked at.

The most common complex probability sampling design is stratified random sampling. Stratification provides more information with certain sample size which is in line appropriate to the research questions. Hair *et al*. (2007) state that the researchers requires to partition the population into relatively homogeneous subgroups that are distinct on the basis of some specific characteristics, called strata such as gender, job level, and academic level followed by using sample from each subgroup of the population (e.g. female and male, developer and manager, bachelor / master / PhD) through simple random sampling in stratified sampling.

As mentioned in previous section, the target population of this study considered three groups of TDWI members (e.g. IT/DW managers, IT/DW specialists/users, and executive/corporate management). Therefore, the sampling procedure used in this study was a stratified sampling. It serves as the most appropriate sampling technique where a subgroup of sampling could be chosen from the target population. Elements for the stratified sample could be selected by drawing simple random samples of the specified size from the strata of the target population. When done properly, stratified sampling increases the accuracy of the sample information but does not necessarily increase the cost (Hair *et al*., 2007). In this study, the 3,000 members of TDWI were selected randomly from the three groups considered in the previous section (Section 4.3) of the total target population of 20,499 members. The administrator of TDWI member list selected 3000 active members based on the standards of the institution. Of these criteria: the number of times members login to TDWI website, participating in events, and publishing articles and papers. The reason for choosing 3,000 members was that TDWI does not allow accessing of members information for free. Therefore, the researcher used the cheaper offer provided by them which have an average of $2,300 for accessing 3,000 members.

In order to collect the data from the sample of TDWI members, a web-based questionnaire was developed using VB.NET and ASP.NET programming and SQL Server 2008 database. A web-based questionnaire was hosted on UUM domain and it was available at http://dwsurvey.uum.edu.my/as on 30/10/2010. A questionnaire web form was divided over eight pages in order to not confuse the respondent, to reduce any potential data loss, and to be able to track the progress of each participant. Furthermore, to introduce the questionnaire and thank the respondent for their participation, welcome and thank you pages were used. In addition, “Next Page” and “Previous Page” buttons also allowed the respondent to switch between pages, with the state of the form controls being saved per session. A copy of a web-based survey is available in Appendix 3. This method of data collection simplified the process of gathering the participants' responses, reduced manual data entry errors, and provided an efficient way to analyze the raw data and export it to Statistical Package for Social Science (SPSS v.17).

A memo (Appendix 1) that includes a direct link to an online survey was mailed to the 3,000 members selected based on the approach mentioned above. A reminder email was sent to non-respondents four weeks after the initial mailing. The source of the sampling frame (TDWI members list) was owned by 1105 MEDIA Inc. Therefore, TDWI email list rental agreement was conducted between the researcher and 1105 MEDIA (list owner) through MERIT DIRECT (list manager). The agreement is attached in Appendix 4. The e-mail was sent by MERIT DIRECT to the selected members. However, the mailing resulted in a total response of 244 usable questionnaires, representing approximately an 8.1% response rate. Of the 276 members who participated to the survey, 32 members were removed due to the non-completed answers. To encourage the members to join the questionnaire, they informed that the name of each member completed the questionnaire will be entered into a drawing for a $100 Amazon gift card. Also, they will receive a copy of the completed research when published. Since the survey was unsolicited, fairly complex, quite long, and resource constraints, researcher expects a low response rate.

Nevertheless, compared with previous data warehousing and other studies that used a web-based survey as a data collection method, the total number of respondents is at the high end of their sample sizes (Table 4.2). In addition, many authors (Manfreda, Bosnjak, Berzelak, Haas, & Vehovar, 2008) stress that response rate of web surveys yield lower than other modes (i.e., telephone and mail). Moreover, a study conducted by Dillman *et al*. (2009) to evaluate response rate across different survey modes found that rates varied greatly, from lows of 13% for the web, to 28% for interactive voice response (IVR), 44% by telephone and 75% for mail.

Table 4.2: Prior Survey Studies

Authors	**Fields of study**	**Sample Size**	**Number of Respondents**	**%**
Hwang & Cappel (2002)	Data warehouse	1000	27	2.7
Hwang & Xu (2007; 2008)	Data warehouse	6000	98	1.6
Ramamurthy *et al*. (2008)	Data warehouse	2498	198	8
Palmer (2006)	Data warehouse	1200	32	2.6
Mathew (2008)	Data warehouse	96	8	8.3
Kanooni (2009)	Information technology	2505	126	5
Gonzalez *et al.* (2005)	Information systems outsourcing	4416	357	8
Li *et al.* (2006)	Supply chain management	3137	196	6.2

The next section presents the operationalization of all the constructs used in this study as well as some demographic information of the respondents.

4.5 Instrument Development

A questionnaire was developed to measure the factors of the combined model described in Chapter 3. The measurement items were based on previous works from various data warehouse and IS literatures and findings from field study, and were then reworded to suit with data warehouse context. The survey contained demographic information, as well as forty-five instrument items that were measured on a seven-point Likert type scale, ranging from 'Strongly Disagree' to 'Strongly Agree'. Dawes (2008) in his study found that a 5- or 7- point scale may produce slightly higher mean scores relative to the highest possible attainable score, compared to those produced from a 10-point scale. Extensive literature reviews on measurements used and consultation with supervisor and expert in data warehouse were done to ensure that the instrument served the intended purpose of the study.

The survey instrument contains eight sections. In the first section (Section 1), the respondents are asked to fill-in some personal details such as: the respondents' location, position in the organization, experience in data warehouse projects, status of data warehouse project, and details about their organizations such as organization's primary industry. The remaining sections were concerned with statements relating to data warehouse systems. In section 2, respondents are asked to provide their ideas on the statements relating to information quality of data warehouse systems. In section 3, respondents are asked to provide their perspectives on the statements regarding system quality of data warehouse systems. In section 4, respondents are asked to rate their opinions on the statements relating to quality of services provided by the data warehouse system and IT department. This is followed by section 5 where the respondents are asked to provide their ideas on the statements regarding relationship quality between the data warehouse parties. In section 6, respondents are asked to rate their opinions on the statements relating to quality of the data warehouse users. In section 7, the respondents are asked to rate their opinions on the statements regarding business quality of data warehouse systems.

The last section which is section 8, respondents are asked to provide their opinions on the statements relating to the net benefits of data warehouse systems.

The details of the characteristics measuring individual constructs and their sources are presented in the following sections.

4.5.1 Information Quality

Information quality factor reflects the information possess internally by competing firms that has an impact on data warehouse success. Eight items are developed to measure the information quality factor, they are: accuracy/correct, usefulness, relevance, format, completeness/adequacy, timeliness, and integrity.

The measurement items are comparable to those used by previous researchers. Some items used in this research are also present in some form in the data quality instrument developed by Wixom and Watson (2001). Table 4.3 details the measurement items and their related references for the information quality construct.

Table 4.3: Information Quality Measurements

Characteristic Measured	**Questions**	**References**
Accuracy/ Correct	DW system provides more accurate and correct information.	Haley (1997); Wixom & Watson (2001); Shin (2003); Dijcks (2004); Nelson *et al*.(2005); Ganczarski (2006); Watson & Ariyachandra (2006); Gorla *et al*. (2010).
Usefulness	The information from DW system is useful and makes me more productive.	Kahn *et al*. (2002); Lee *et al*. (2002); Shin (2003); Gorla *et al*. (2010).
Relevant	DW system produces relevant information that meets organization’s requirements.	Doll *et al*. (1994); Lee *et al*. (2002); Yang *et al*. (2004a); Gorla *et al*. (2010).
Format	DW system produces information in a presentable format and easily to understand.	Gorla *et al*. (2010); Nelson *et al*. (2005); Dijcks (2004); Wang & Strong (1996); Ganczarski (2006)
Completeness/ Adequacy	DW system provides complete and adequate information.	Kahn *et al*. (2002); Dijcks (2004); Yang *et al*. (2004a); Nelson *et al*. (2005); Watson & Ariyachandra (2006); Gorla *et al*. (2010).
Timeliness	DW system always provides current and up to date information.	Haley (1997); Lee *et al*. (2002); Nelson *et al*. (2005); Ganczarski (2006); Hussein *et al*. (2007b).
Integrity	DW system provides high integrity information.	Shin (2003); Evans (2005); Solomon (2005); Palmer (2006); Bhansali (2007).
Security	Information from DW system is secure and free from threats.	Porter & Rome (1995); Wang & Strong (1996); Vassiliadis (2000b); Lee *et al*. (2002); Shin (2003).

4.5.2 System Quality

The construct of system quality impacts the data warehouse system performance in terms of ease of use, easy to learn, easy to manage, response time, flexibility, accessible,integration, and other system characteristics, which in turn can have impact on net benefits of data warehouse systems. This construct is measured by seven items as shown in Table 4.4:

Table 4.4: System Quality Measurements

Characteristic Measured	**Questions**	**References**
Easy to use	DW system is convenient and easy to use.	Rudra & Yeo (2000); Shin (2003); Ganczarski (2006); Hussein *et al*. (2007b); Gorla *et al*. (2010).
Easy to learn	DW system is easy to learn.	Rudra & Yeo (2000); Hussein *et al*. (2007b); Gorla *et al*. (2010).
Easy to manage	DW system is easy to manage.	Hwang & Xu (2007).
Response time	DW system returns answers to my requests quickly and in a timely manner.	Iivari (2005); Nelson *et al*. (2005); Gorla *et al*. (2010).
Flexible	DW system is flexible enough to meet my organization's current and future needs.	Wixom & Watson (2001); Iivari (2005); Nelson *et al*. (2005); Watson & Ariyachandra (2006); Gorla *et al*. (2010).
Accessible	DW system allows information to be readily accessible to me.	Lee *et al*. (2002); Nelson *et al*. (2005).
Integration	DW system effectively combines data from different areas of the organization.	Wixom & Watson (2001); Iivari (2005); Nelson *et al*. (2005); Watson & Ariyachandra (2006); Gorla *et al*. (2010).

4.5.3 Service Quality

Service quality construct deals with the support of users by the IS department, often measured by the reliability, responsiveness, assurance, and empathy of the support organization, which can in turn impact the net benefits of data warehouse systems. This construct is measured based on six variables. Table 4.5 shows the measurement items and their references that are devised to measure this construct in the questionnaire.

Table 4.5: Service Quality Measurements

Characteristic Measured	**Questions**	**References**
Reliability	When DW system promises to do something, it does so.	Jiang, Klein, and Discenza (2002);Yang *et al.* (2004b); Yoon & Suh (2004); Carr (2006); Gorla *et al*. (2010).
Responsiveness	DW system is always willing to help me.	Jiang *et al.* (2002);Yang *et al.* (2004b) ; Yoon & Suh (2004) ; Carr (2006); Gorla *et al*. (2010).
Assurance	DW team has the knowledge to do their job well.	Jiang *et al.* (2002); Yoon & Suh (2004); Carr (2006); Gorla *et al*. (2010).
Empathy	DW team understands the specific needs of its users.	Jiang *et al.* (2002); Yoon & Suh (2004); Carr (2006); Gorla *et al*. (2010).
Customization	DW system provides customization for the services it provides.	Joseph *et al*. (1999); Madu & Madu (2002).
User Training	Our organization provides extensive training on how to understand, access, or use DW system.	Shin (2003); Yoon & Suh (2004).

4.5.4 Relationship Quality

The construct of relationship quality refers to the overall assessment of the strength of a relationship between the data warehouse parties. This construct is measured by the communication, coordination, cooperation, trust, conflict, and commitment between the data warehouse parties. This can in turn impact the net benefits of data warehouse systems. Six items are used to measure this construct and Table 4.6 details the variable, measurements and related references used in the questionnaire.

Table 4.6: Relationship Quality Measurements

Characteristic Measured	**Questions**	**References**
Communication	DW parties effectively communicate well with each other.	Goles & Chin (2005); Ganczarski (2006); Chakrabarty *et al.* (2007).
Coordination	DW parties are highly coordinate resources and activities well with each other.	Goles & Chin (2005); Paravastu (2007).
Cooperation	DW parties cooperate well and willing to help out each other.	Goles & Chin (2005); Paravastu (2007).
Conflict	The process of resolving conflicts between DW parties is effective.	Roberts *et al.* (2003); Goles & Chin (2005).
Trust	DW parties should be trusted to behave fairly.	Goles & Chin (2005); Chakrabarty *et al.* (2007).
Commitment	DW parties are willing to commit resources to sustain the relationship.	Goles & Chin (2005); Chakrabarty *et al.* (2007); Paravastu (2007).

4.5.5 User Quality

The construct of user quality refers to the influence of data warehouse users' capabilities on the data warehouse success. This construct is measured by six variables and Table 4.7 details the six measurements and the related references used in the questionnaire.

Table 4.7: User Quality Measurements

Characteristic Measured	**Questions**	**References**
Technical skills	DW users should posses' technical knowledge of how to use DW in their organization.	Haley (1997); Wixom & Watson (2001); Biere (2003); Avery & Watson (2004); Hwang *et al*. (2004).
Business skills	DW users should be knowledgeable in their business or working environment.	Haley (1997); Wixom & Watson (2001); Biere (2003); Avery & Watson (2004); Hwang *et al*. (2004).
Analyze skills	DW users should have an ability to analyze data from DW systems in their organization.	Haley (1997); Wixom & Watson (2001); Biere (2003); Avery & Watson (2004); Hwang *et al*. (2004).
Competence	DW users should be competence in carrying out their tasks and responsibilities.	Haley (1997); Shin (2003); Imhoff and Pettit (2004).
Understand requirements	DW users should understand the organization's unique requirements.	Rudra & Yeo (2000); Imhoff and Pettit (2004); Bhansali (2007).
Determine to use data	DW users should have the determination to use and make action based on available data.	McFadden (1996); Imhoff and Pettit (2004).

4.5.6 Business Quality

Business quality refers to the net value of the data warehouse system for the user organization. This value could be in terms of supports business strategy, business plan, business needs, business requirements, business scope, and achieve competitive advantage. Six items are used to measure this construct. Table 4.8 details the items, measurements and related references used in the questionnaire.

Table 4.8: Business Quality Measurements

Characteristic Measured	**Questions**	**References**
Business strategy	DW system strongly supports the business strategy of my organization.	Watson& Ariyachandra (2006); Bhansali (2007).
Business plan	My organization's business plan makes reference to DW.	Haley (1997); Bhansali (2007).
Business needs	DW system is responsive to a change in business needs.	Ganczarski (2006); Bhansali (2007); Ramamurthy *et al*. (2008).
Business requirements	DW system addresses several critical business requirements of my organization.	Watson& Ariyachandra (2006); Ganczarski (2006); Ramamurthy *et al*. (2008).
Business scope	My organization seeks to exploit the emerging DW capabilities to impact business scope.	Bhansali (2007); Garner (2007).
Competitive advantage	My organization understands how to use DW in order to achieve greater competitive advantage.	Bhansali (2007); Garner (2007).

4.5.7 Net Benefits

The net benefits construct refers to the extent in which data warehouse system are contributing to the success of group, individual, organization, industry, society, etc. Net benefits are often measured in terms of improved decision-making, improved productivity, improved profits, increased sales, market efficiency, organizational performance, and economic development. In this study, the net benefits construct only measuring operational benefits but not include financial performance values. Table 4.9 details the items that are developed to measure this construct in the questionnaire.

Table 4.9: Net Benefits Measurements

Characteristic Measured	Questions	References
Better decisions	DW improves decision making capabilities.	Wixom & Watson (2001); Watson *et al*. (2002); Watson& Ariyachandra (2006); Heise (2005); Palmer (2006).
Time savings	DW reduces the time it takes to support decision.	Wixom & Watson (2001); Watson *et al*. (2002); Heise (2005).
Effort savings	DW reduces the effort it takes to support decision.	Wixom & Watson (2001); Watson *et al*. (2002).
Improvement of business processes	DW improves my organization business processes.	Watson *et al*. (2002); Watson& Ariyachandra (2006).
Improvement of planning processes	DW improves my organization planning processes.	Heise (2005); Bhansali (2007); Garner (2007).
Improvement of operational control processes	DW improves my organization operational control processes.	Heise (2005); Bhansali (2007); Garner (2007).

4.5.8 Demographics

The demographic and background information used in this study are presented in Table 4.10.

Table 4.10: Demographics Information

1.	**Where are you located?**			
	USA	Canada	Europe	Australia
	Asia	Africa	Central or South America	Middle East
2.	**What is the current status of your DW project?**			
	Live	Planned	In development	Don't know
3.	**Which best describes your current position?**			
	DW Business Analyst	DW Manager	DW DBA	IT Specialist/Staff
	DW User	DW Specialist	IT Manager	Others
4.	**How long have you been in your current position?**			
	Less than 1 year	1 to 3 years	3 to 6 years	More than 6 years
5.	**How long have you worked for this organization?**			
	Less than 2 years	2 to 5 years	5 to 10 years	More than 10 years
6.	**How long has DW in your organization been in existence?**			
	Less than 2 years	2 to 5 years	5 to 10 years	More than 10 years
7.	**Which best describes your organization's primary industry?**			
	Aerospace	Advertising/Marketing / PR	Agriculture	Computer Manufacturing
	Chemical/petroleum	Construction/architecture/engineering	Consulting/professional services	Education
	Financial services	Food/beverage	Government: Federal	Healthcare
	Insurance	Manufacturing (non-computers)	Media	Software/ Internet
	Telecommunications	Transportation/ Logistics	Utilities	Others

4.6 Instrument Validation

According to Hair *et al*. (2007) validity is "*the extent to which a construct measures what it is supposed to measure*" (p 246). Therefore, one can infer that instrument validation must make sure that the instrument measures what it claims to measure (Sekaran & Bougie, 2010; Hair *et al*., 2007; Saunders *et al.*, 2003; Nachmias & Nachmias, 1996). Differenttypes of validity have been proposed. This study used four types of validity, namely: content validity, construct validity, convergent validity, and discriminant validity.

4.6.1 Content Validity

Content validity is how well the instrument adequately measures the subject domain (Hair *et al*., 2007; Sekaran & Bougie, 2010). A measure has content validity if there is a general consensus among judges that the instrument of the study includes items that cover all aspects of the variable being measured (Uma Sekaran, 2006; Hair *et al.*, 2007; Uma Sekaran & Bougie, 2010). In this study, a pre-test of the research instrument was conducted to assess the content validity. According to Alreck and Settle (1995), a pre-test can be used as a means of validating the content of the research instrument. Other authors suggested that a pre-test is a fair degree of initial content validity to the survey instrument (Creswell, 1994; D. R. Cooper & Emory, 1995; Hoyle, Harris, & Judd, 2002; Patton, 2002).

The basis of pre-testing is to evaluate the survey instrument before it is administered to the whole target population. The objective is to identify any potential weaknesses and to confirm the clarity and validity of the instrument. The pre-test is conducted mainly to ascertain that all the items used are suitable for the intended audience. This is to minimize risk that the instrument is not included particular important items, or on the other hand, had included items that may not belong in the domain. The pre-test is also used to confirm the required time needed by the respondents to complete the survey.

During the pre-test stage, a sample of three UUM academic staff, two UUM PhD students, and three data warehouse experts (two DW managers and one DW consultant) were used. Those participants are experienced of data warehousing, research methodology, and systems analysis. The survey instrument was sent via e-mail attachments to the participants. They were given time to read and examine the survey instrument drafts. This was followed by telephone call with non-respondents participants. Finally, all participants posed the important suggestions and comments. Accordingly, the feedback obtained from the participants was used to further refine the research instrument.

4.6.2 Construct Validity

According to Hair *et al*. (2007), construct validity is the extent to which a measurement corresponds to theoretical concepts (constructs) concerning the phenomenon under study. Moreover, construct validity is defined by Sekaran and Bougie (2010) as the degree to which operationalization of a construct adequately represents what is meant by theoretical account of the construct being measured. In this study, the construct validity examined how well the theoretical rationale underlying the measurements obtained by using factor analyses test (see section 5.6).

4.6.2.1 Convergent Validity

Convergent validity is defined by Hair *et al*. (2011) as "*the extent to which the construct is positively correlated with other measures of the same construct*" (p. 239). In this study, convergent validity was used to establish construct validity. It evaluated the degree to which two measures of the same concept are correlated. In addition, convergent validity was conducted through factor analysis in order to obtain a more in-depth judgment of the dimensionality of the construct under study (Hair *et al.*, 2009). The researcher has conducted an exploratory factor analysis to deeply examine the factor structure of 45 items instrument (see section 5.6.1). The results shown that the items selected in this study have achieved convergent validity.

4.6.2.2 Discriminant Validity

According to Hair *et al*. (2011), discriminant validity is "*the extent to which the construct does not correlate with other measures that are different from it*" (p. 239). Therefore, high discriminant validity is evidenced by a uniqueness of statistical construct and captures some phenomenon that other measures do not. According to Kline (1998), discriminant validity is presented when cross-correlations between indicators measuring different factors are moderately strong (see section 5.6.1).

4.7 Pilot study

It is important to conduct a pilot study in order to test the techniques and instrument in advance before running the actual or full-scale study (Sekaran & Bougie, 2010). Hambleton and Patsula (1999) argue that a pilot test should be carried out using a smaller group of subjects or respondents who have similar characteristics to those of the subjects who will be used in the actual study and data collection. The objective of the pilot study is to ensure the understanding of the instructions, the questions asked, and that the instrument used is reliable and appropriate to the area being researched.

During pilot study, the invitation to participate the questionnaire of this study was posted on TDWI Facebook page on July 2, 2010. Two weeks after, 34 usable questionnaires were extracted and used for pilot testing. The data were analyzed with reliability analysis using Cronbach's alpha, 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 alpha can be interpreted as a correlation coefficient, it ranges in value from 0 to 1. Table 4.11 and Table 4.12 detail an SPSS output for reliability test.

Table 4.11: Testing Alpha Item- Reliability Statistics

Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.944	0.946	8

An investigation of the items comprising the scale of information quality factor indicates that Cronbach's alpha for the overall scale is equal to 0.944, so the reliability of this construct is good.

Table 4.12: Testing Alpha Item-Total Statistics

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Inf Quality 1	38.18	55.483	0.700	0.813	0.943
Inf Quality 2	37.68	56.225	0.767	0.758	0.938
Inf Quality 3	38.09	51.234	0.910	0.901	0.928
Inf Quality 4	38.47	52.923	0.843	0.824	0.933
Inf Quality 5	38.91	51.113	0.790	0.727	0.938
Inf Quality 6	38.12	54.046	0.929	0.901	0.929
Inf Quality 7	38.26	55.594	0.712	0.817	0.942
Inf Quality 8	38.24	55.034	0.765	0.729	0.938

In addition, as shown in Table 4.12, no removal of the items would enhance this reliability measure. This is to be expected for such a well-established scale. The Cronbach’s alpha values for the other factors are included with the reliability test in Appendix 2. Also the data were analyzed with exploratory factor analysis to determine how well the items loaded and to determine if items factored as predicted. The pilot test indicates that, in general, the questions are valid and that most items factored according to the theorized dimensions. The initial analysis seemed to support content and face validity for the survey items.

4.8 Data Analysis

The hypotheses were tested using descriptive statistic, factor analysis, correlation, and multiple regressions to analyze the relationship between quality factors with net benefits of data warehouse. SPSS software for windows, version 17.0 is used. The analyses conducted in this study are as follows:

4.8.1 Descriptive Analysis

After going through the validity and reliability procedure successfully, retained items were then aggregated into a collective sum. Descriptive statistics such as percentage, frequency and standard deviation were used to understand the profile of respondents and to emphasize any error of data entry process. Mean scores and standard deviations were used to determine central tendency and variance from the mean. Mean scores were computed by equally weighting the mean of all items in each construct.

4.8.2 Normality and Linearity

Normality refers to the error in distribution and used to describe the normal distribution of the sample. The assumption of normality was diagnosed using the residual plots and skewness and kurtosis, where no violation of this assumption was found. In normal probability plot the points are lie in a reasonably straight diagonal line from bottom left to top right and this would suggest no major deviations from normality (Pallant, 2007).

Linearity is the phenomenon that measures the degree to which the change in independent variable is associated with the dependent variable. For a strong relationship the points form a vague cigar shape with a define clumping of scores a round an imaginary straight line (Pallant, 2007). In order to examine linearity in this study the residual has oval-shapes and scattered around zero points. In this study, the researcher explored normality analysis including linearity by using normal probability plots (P-P plots). The results of P-P plots test are discussed in section 5.3.3.

4.8.3 Factor Analysis

Factor analysis is used to analyze the interrelationships among a large number of variables and to interpret these variables in terms of their common underlying factors by applying data reduction (Hair *et al*., 2009). According to Sekaran and Bougie (2010) factor analysis decreases the number of variables to a meaningful, interpretable and manageable set of factors. Indeed, factor analysis is considered as important statistics technique in data analysis. This type of analysis was usually conducted in order to understand the dimensionality of the variables in the proposed framework or to realize the relationship in empirical research. The factor loading reveals the strength of relationship between the item and the factor or construct. The factor loading was obtained for each item in order to recapitulate the patterns of correlation among variables and therefore reduce the large number of variables (Pallant, 2007). The most recommended measure of internal consistency is provided through the Coefficient Alpha which provides a good reliability estimate in most situations. At the same time the rule in assessing the suitability of factor analysis, the minimum requirement is to have at least five times as many interpretations as there are variables to be analyzed. The more acceptable size would have a ten-to-one ratio (Hair *et al*., 2009).

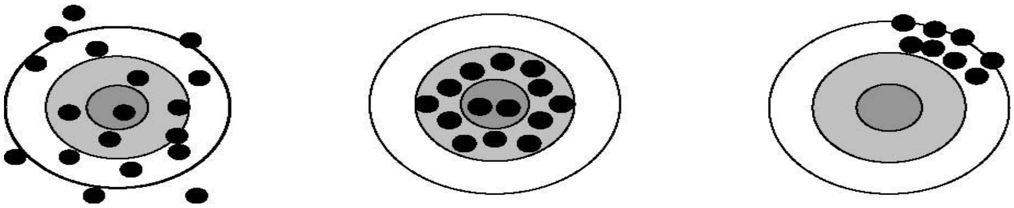
4.8.4 Reliability

Reliability refers to the consistency of results when the research object is repeatedly measured (Sekaran, 2006). Reliability can be defined as the degree to which measures are free from error and therefore yield consistent results. Thus, reliability is obtained when similar results are presented over time and across situations (Zikmund, 2000). It involves the accuracy of the chosen research methods and techniques, i.e., how reliable and accurate the process data is. A measurement tool should give reliable results. Reliability is concerned with whether alternative researches would reveal similar information conducting a similar study (Saunders *et al.*, 2003). The reliability of a measure indicates the extent to which the measure is without biased and hence offers consistent measurement across time (Hair *et al*., 2007).

The reliability of this questionnaire is measured by using Cronbach's Coefficient Alpha (α) on the inter-item consistency reliability of the multipoint-scaled items of the survey instrument. Sekaran and Bougie (2010) explains the internal consistency as follows:

> *"The internal consistency of measure is indicative of the homogeneity of the items in the measure that tap the construct. In other words, the item should be "hang together as a set': and be capable of independently measuring the same concept such that the respondents attach the same overall meaning to each of the item".*

In order to illustrate the differences between validity and reliability, Zikmund (2000) uses three rifle targets, Figure 4.1.



Low Reliability High Reliability Reliable but not Valid

Figure 4.1: An illustration of differences between Reliability and Validity (Zikmund, 2000)

In this study, values of the Cronbach's alpha for every section are stated in chapter 5 (section 5.5).

4.8.5 Correlation Analysis

Correlation analysis is used to study the relationship and direction between two variables (Hair *et al.*, 2009). The values of correlation coefficients (r) show the strength of the relationship between the variables under investigation. A positive correlation indicates that as one variable increase, the other variables are also increase. On the other hand, a negative correlation indicates as one variable increases the other variables decrease (Sekaran & Bougie, 2010). A perfect correlation of 1 or -1 indicates that the variable show a straight line (Pallant, 2007). According to Hair *et al*. (2009), Multicollinearity normally represents the degree to which a variable can be explained by other variables in the analysis. Thus it is important to verify the degree of Multicollinearity before running regression analysis because it may complicate the interpretation of the variation as it is more difficult to determine the effect of any single variable (Hair *et al.*, 2009). Specifically, as Multicollinearity increase, it may complicate the interpretation of the variation as it is difficult to ensure the effect of any single variable (Hair *et al.*, 2007). Thus, Multicollinearity exists whenever the correlation (r) exceeds 0.80 (Berry & Feldman., 1985). The researcher examines the correlation analysis to test the research hypotheses to indicate a significant positive relationship (section 5.7 in chapter 5).

4.8.6 Regression Analysis

This is a technique used to find out the relationship between one continuous dependent variable and a number of independent variables (Pallant, 2007). Regressions normally are used to explain when several independent variables are theorized to concurrently influence it. According to Hair *et al*. (2009), regression analysis appears to be the most extensively used multivariate technique to answer two main research problems; to predict and/or explain. In fact, before the recommencement of regression analysis, preliminary analyses were conducted in order to ensure no violation of the underlying assumptions of normality, linearity, and outliers. In this study, a regression analysis was performed to examine the combined influences of quality factors on the net benefits of data warehouse (section 5.8 in chapter 5).

4.9 Summary

In this chapter, the research design, population, sample and data collection procedures are established. The development and validation of the new instrument are conducted as they are required by quantitative analysis type of study. The instrument is prepared as questionnaire and used to identify the quality factors that could lead to the success of data warehouse systems. Series of tests such as instrument validity, reliability analysis, descriptive statistics, factor analysis, correlation, multiple regressions, and mediator test are described. In addition, this chapter detailed out the research methodology that is followed and adopted. This includes all the procedures, process, and guidelines that according to research literature are suitable for this kind of research. The following chapter discusses the data analysis and results.

CHAPTER Five

DATA ANALYSIS AND FINDINGS

5.1 Introduction

In this chapter data analysis and results of the relationship between the quality factors and net benefits as well as mediator factors are presented based on the data gathered from the survey. The first section contains descriptive analysis of respondents. Exploratory factor analysis performs in the secondsection. Section three investigates the reliability and validity of the items. Section four explains the use of multivariate analysis to test the stated hypotheses.

5.2 Sample Characteristics

This section describes background information of the respondents participated in the survey and other relevant information about their organizations, which is helpful to understand the data segmentation. The examined characteristics include location, current position, period in current position, period in current organization, status of data warehouse project, period of using data warehouse, and organization's industry. The descriptive analysis results for the demographic profile of respondents shows in Table 5.1 whereas the full SPSS results are presented in Appendix 5.

Table 5.1: Respondents Characteristics Summary

Variables	Descriptions	%
Business Location	USA	33.6
	Canada	27
	Europe	13.9
	Australia	12.3
	Asia	5.7
	Middle East	3.3
	Africa	2

	Central or South America	2
Current position	DW Specialist	16.8
	IT Specialist/Staff	16.8
	IT Manager	15.2
	DW Business Analyst	12.7
	DW User	11.5
	DW DBA	11.5
	DW Manager	10.2
	Other	5.3
Period in current position	1 to 3 years	27.5
	3 to 6 years	26.6
	More than 6 years	24.6
	Less than 1 year	21.3
Period in current organization	More than 10 years	26.6
	5 to 10 years	25.4
	2 to 5 years	25
	Less than 2 years	23
Status of data warehouse project	Live	51.2
	In development	30.3
	Planned	17.2
	Don't know	1.2
Scope of data warehouse implementation	Enterprise-wide	50.4
	Departmental in one or more multiple locations	24.6
	Pilot only in a single department or location	23
	Don't know	2
Organization’s industry	Financial services	13.9
	Healthcare	9
	Government: Federal	8.6
	Consulting/professional services	7
	Education	6.1
	Manufacturing (non-computers)	5.3
	Software/Internet	5.3
	Insurance	4.9
	Computer Manufacturing	4.9
	Telecommunications	4.1
	Chemical/petroleum	3.3
	Retail/Wholesale/Distribution	3.3
	Utilities	3.3
	Media	2.9
	Hospitality/travel	2.9
	Non-profit/Trade association	2.9
	Real Estate	2
	Construction/architecture/engineering	2
	Pharmaceuticals	2
	Transportation/Logistics	1.6
	Government: State/local	1.6
	Other	1.2
	Agriculture	0.8
	Advertising/Marketing/PR	0.8

As shown in Table 5.1, the majority of respondents comes from USA, representing 33.6% (82 respondents), the second largest number of respondents comes from Canada which formed 27.0% (66 respondents), followed by Europe, 34 respondents (13.9%), Australia obtains 30 respondents (12.3%), Asia covered 14 respondents (5.7%), Middle East acquired 8 respondents (3.3%) and the smallest number of respondents comes from Africa and Central or South America of 2% (5 respondents for each). This confirms the robustness of the study results, where the majority of the respondents are from the developed countries in data warehouse implementation.

In terms of job specification, the respondents were drawn from a broad range of job functions. Of 244 respondents, 16.8% of the respondents were DW specialist, 16.8% were IT specialist/staff, 15.2% were IT manager, 12.7% were DW business analyst, 11.5% were in DW user, 11.5% were in DW DBA, 10.2 were in DW manager and 5.3% were in other IT/DW related positions.

Meanwhile, it is observed that 51% of the respondents have been in their current position for more than 3 years, with approximately 27% had 3 years' experience. The number of respondents who were relatively new to their current positions with less than 1-year experience is approximately 21% of the total responses. This gives the indication that the majority of respondents have sufficient experience to give their opinion about the study questionnaire.

In terms of data warehouse project status, almost (51.2%) of respondents have at least one DW application either live, while close to 30.3% are still in development stage, 17.2% are still in planning stage and finally 1.2% of respondents have no any efforts made in their organizations to implement the data warehouse. This result shows that more than 80% of respondents have implemented data warehouse applications, meaning that they are able to assess the success or failure of data warehouse applications.

In terms of data warehouse implementation scope, 50.4% of the respondents reported that the implementations are enterprise-wide, 24.6% departmental or multiple locations, 23.0% pilot only in a single department or location and 2.0% don't know about the data warehouse scope in their organizations. In terms of organization's industry, the respondents represented wide range industries with largest participation (13.9%) drawn from financial services sector, 9.0% comes from healthcare sector, 8.6% comes from government/federal sectors, 7.0% comes from consulting/professional services sectors, 6.1% comes from education sector and the remaining (55.3%) comes from the other industries. This result shows that the respondents are involved from several industries, which in turn help to generalize the findings of this research.

5.3 The Data

5.3.1 Data Inspection

Data analysis began with an inspection and review of the data to assure that it was suitable for analysis. For this purpose the guidelines suggested by Hair *et al*. (2009) are followed which included examining for missing data patterns, adherence to statistical assumptions, identification of outliers, and a review of skewness and kurtosis.

5.3.2 Missing Data

Missing data in any research undertaking is a common phenomenon. According to Hair *et al*. (2009), missing data implies a situation where valid values on one or more variables are not available for data analysis, especially in a multivariate analysis. Sekaran and Bougie (2010) notes that a situation of this nature occurs when respondents fail to answer some items in the questionnaire, thus leaving the items blank. Also this scenario on the part of the respondents could be as a result of lack of understanding of the question, ignorant of the answer, unwilling to answer etc. However, it is always important to take note of the missing data because of their unavoidable impact on the analysis. In order to handle missing data phenomenon, Hair *et al*. (2009) observe that the primary concern is to identify the patterns and relationships underlying the occurrence, although, the extent of missing data is a secondary issue in most instances.

Therefore, the practical impacts of missing data are reduction of the sample size available for analysis. However, Sekaran and Bougie (2010) believes that the best way to handle the problem irrespective of its characteristics is to omit the case, especially if the sample is big, for instance, if only two or three items are left unanswered in a questionnaire of 30 items or more this case can be dropped. Furthermore, Hair *et al*. (2009) equally note that the issue of missing data could be frustrating and damaging if not properly handle. Thus, they identified a four step process of identifying and remedying this problem. These steps are: determine the type of missing data; determine the extent of missing data; diagnose the randomness of the missing data processes; and select the imputation method. However, the general rule of the thumb on missing data as enumerated by Hair *et al*. (2009) includes that missing data under 10 percent for an individual case or observation can generally be ignored but the number of cases with no missing data must be sufficient for the selected analysis technique. Variables with as little as 15 percent missing data are candidates for deletion, but higher levels of missing data for instance 20 percent to 30 percent can often be remedied.

In this study, two types of missing data patterns are examined. The first type has to do with the number of items that have missing data for each case. It found that 32 cases have data missing for 15 - 35 items, which was 33.3% - 77.7% above the 30% cutoff, which is 13 items (where cases should be deleted). The other type of missing data pattern required reviewing the number of cases that had missing data for each item. Six items had missing data for 32 cases, which was 11.6% of all cases (28 / 276). Thus, 32 incomplete cases are deleted due to missing data.

5.3.3 Normality Assessment

Normality is an assumption for many multivariate techniques such as multiple regressions (Hair *et al*., 2009). For factor analysis, the main concerns are outliers and linearity. Kurtosis and skewness are the two main tests normally conducted for univariate normality, which refers to the shape of the distribution are used with interval and ratio scale data. Values for kurtosis and skewness are zero if the observed distribution is exactly normal. However, normal distribution is not critical for the factor analysis. Many multivariate statistical techniques measure of central tendency and variability can also be used to determine the normality of the distribution (Hair *et al*. 2009; Pallant, 2007). In this study, the researcher explores normality analysis using normal probability plots (P-P plots) as shown in Figure 5.1. The data was inspected based on the above guidelines and was considered acceptable.

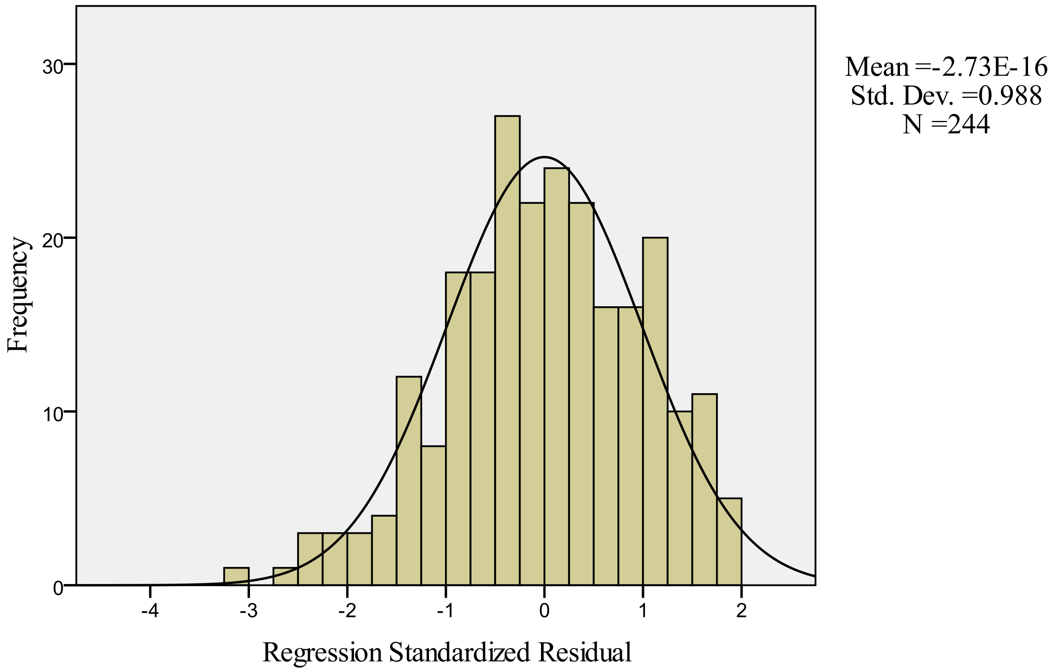


Figure 5.1: Normal probability plots (P-P plots)

5.4 Factor Analysis

Hair *et al*. (2009) describe two types of factor analysis: (1) Exploratory Factor Analysis (EFA) which attempts to identify the nature of the constructs influencing a set of responses in a specific content area and (2) Confirmatory Factor Analysis (CFA) which determines whether a specific set of constructs is affecting responses in a predicted way. In this research, exploratory factor analysis is conducted to reduce a number of variables and to summarize the structure of asset among the variables to be manageable. The factor analysis was conducted on all variables of this study which included the independent variables namely quality factors and the dependent variable namely net benefits. An exploratory factor analysis was held for data reduction purpose using 39 items for quality factors and 6 items for net benefits.

The instrument items are analyzed to access dimensionality. Initial analysis was performed with exploratory factor analysis using the principal components method. Principal Components Analysis (PCA) is a factor extraction method used to form uncorrelated linear combinations of the observed variables. The first component has maximum variance. Successive components explain progressively smaller portions of the variance and are all uncorrelated with each other. Principal components analysis is used to obtain the initial factor solution. It can be used when a correlation matrix is singular (Coakes, 2009).

This procedure is taken to remove items where there was a lack of evidence indicating that the items were part of a hypothesized dimension. Items were removed one at a time using the following procedure, as recommended by most researchers (Hair *et al*. 2009; Sekaran & Bougie, 2010; Coakes, 2009; Pallant, 2007). Appendix 6 explains, with examples every step of the following procedure.

1. Items with a MSA (measure of sampling adequacy) < 0.500 in the anti-image matrix were removed. The anti-image correlation matrix contains the negatives of the partial correlation coefficients, and the anti-image covariance matrix contains the negatives of the partial covariances. In a good factor model, most of the off-diagonal elements are small. The measure of sampling adequacy for a variable is displayed on the diagonal of the anti-image correlation matrix; the acceptable level is above 0.5.

2. Items that did not load with any other item were removed. For this purpose this study uses the factor matrix of loadings, or correlation between the items and factors.
3. Items that had loadings < 0.3 were removed. Pure items have loadings of 0.3 or greater on only one factor.
4. Items that double loaded were removed (complex items), as they make interpretation of output difficult. Double loading occurs when the factor score >=0.500 on more than one factor.
5. Items were removed if an item loaded on a factor where it seemed unreasonable for that item to be associated with the other items in the factor.
6. The Bartlett test of sphericity is significant and the Kaiser-Meyer-Olkin measure of sampling adequacy is far greater than 0.6. The Kaiser-Meyer-Olkin measure of sampling adequacy tests whether the partial correlations among variables are small. Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate.

The above process, which is explained fully in Appendix 6, is repeated if an item was removed. Thus the final solution was the result of several iterations of item analysis and evaluation. Performing Principal Component factor analysis with varimax rotation supported initial construct and discriminant validities. The items dropped during the process described above are shown in Table 5.2 along with reason why they were dropped.

Table 5.2: Items Dropped During Exploratory Factor Analysis

Dimensions	**Items Dropped**	**Reasons**
Information Quality	Information from DW system is secure and free from threats.	Double loaded
	DW system produces relevant information that meets organization's requirements.	Double loaded
User Quality	DW users should posses' technical knowledge of how to use DW in their organization.	Loaded in wrong factor
	DW users should be knowledgeable in their business or working environment.	Loaded in wrong factor
	DW users should have the determination to use and make action based on available data.	Loaded in wrong factor
	DW users should understand the organization's unique requirements.	Double loaded
Business Quality	DW team is aware of the business plan.	Double loaded

All items loaded on the appropriate factor with loading typically above 0.500 (greater than the recommended 0.500 minimum). Based on the recommendations by Hair *et al*. (2009), the minimum requirements for factor loading range between 0.30 and 0.40, and loadings of 0.50 or above are considered more significant. The detailed of factor analysis for all variables in this study are concluded inTable 5.3.

Table 5.3: Exploratory Factor Loadings

	Component						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Information Quality 1		.755					
Information Quality 2		.746					
Information Quality 3		.756					
Information Quality 4		.799					
Information Quality 5		.802					
Information Quality 6		.771					
System Quality 1	.704						
System Quality 2	.696						
System Quality 3	.645						
System Quality 4	.746						
System Quality 5	.754						
System Quality 6	.689						
System Quality 7	.736						
Service Quality 1			.707				
Service Quality 2			.776				
Service Quality 3			.743				
Service Quality 4			.683				
Service Quality 5			.705				
Service Quality 6			.630				
Relationship Quality 1						.625	
Relationship Quality 2						.754	
Relationship Quality 3						.644	
Relationship Quality 4						.622	
Relationship Quality 5						.602	
Relationship Quality 6						.615	
User Quality 3							.727
User Quality 4							.771

Business Quality 1		.676
Business Quality 3		.753
Business Quality 4		.710
Business Quality 5		.820
Business Quality 6		.754
Net Benefits 1	.631	
Net Benefits 2	.631	
Net Benefits 3	.750	
Net Benefits 4	.734	
Net Benefits 5	.719	
Net Benefits 6	.626	

Table 5.3 presents the factor loading of seven dimensions after deleting the items that show double loading and wrong loading, and the results indicated that the loadings of the remaining items were from 0.602 to 0.820. The factor analysis for 45 items provided four dimensions with six items, one dimension with seven items, one dimension with five items, and one dimension having only two items (7 items were deleted). Thus, the reliabilities were considered acceptable, as Principal component factor analysis was performed and seven constructs were extracted. Moreover, Table 5.3 shows that there were no cross-loading items. Additionally, items intended to measure the same construct exhibited prominently and distinctly higher factor loadings on a single construct than on other constructs, suggesting adequate convergent and discriminant validity (Hair *et al*., 2009) jointly, the observed reliability and construct validity suggested adequacy of the measurements used in the study.

Furthermore, as shown in Table 5.3, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MAS) for all items was 0.939 which is ranged within the acceptable level, i.e. between 0.51 and 0.90. In other words, if the MAS value is above 0.50 it indicates a certain level of appropriateness (Hair *et al*., 2009).The Bartlett's Test of Sphericity was significant, which indicates that there is sufficient number of significant inter-correlations for factor analysis and the assumptions of factor analysis were met. In fact, if the KMO measure is greater than 0.60 and the Bartlett's test of Sphericity is large and significant, then factorability is assumed (Coakes, 2009; Pallant, 2007). Also, the dimensions cumulatively captured 69.438% of variance in the data (Table 5.3).

5.5 Reliability Analysis and Descriptive Statistics

Table 5.4 shows the original number of items and final number of items after the factor analysis. It also shows the reliability based on the Cronbach's alpha and descriptive statistics of the constructs.

Table 5.4: Reliability Alpha and descriptive statistics for constructs

Constructs	Original No. of Items	Final No. of Items	Cronbach's Alpha	Mean	Standard Deviation
Information Quality	8	6	.916	5.188	1.227
System Quality	7	7	.918	5.277	1.116
Service Quality	6	6	.919	5.182	1.168
Relationship Quality	6	6	.887	5.312	1.208
User Quality	6	2	.791	5.256	1.181
Business Quality	6	5	.872	5.172	1.169
Net Benefits	6	6	.889	5.421	1.233

The Cronbach's alpha (α) of items is reliable (Table 5.4). The data were analyzed with reliability analysis using Cronbach's 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. According to Pallant (2007), new measure scales should have reliabilities of at least 0.60. 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 (Hair *et al*., 2009). Table 5.4 indicates that Cronbach's α value ranged from 0.791 to 0.919, so the reliability of this study is acceptable.

From the table above, it indicates that the net benefits construct has the highest mean, followed by relationship quality, system quality, user quality, information quality, service quality, and business quality. It also shows that the net benefits construct has the largest standard deviation, followed by information quality, relationship quality, user quality, business quality, service quality, and system quality

5.6 Construct Validity

The reliabilities of the scales are considered acceptable, as the reliabilities calculated using Cronbach's alpha (Table 5.4). The validity and reliability of the revised concept are examined. Content validity was addressed in Chapter 4, while construct validity is described in next section.

According to Hair *et al*. (2007), the support for construct validity exists if there are relatively high correlations between measures of the same construct using different methods (convergent validity) and low correlations between measures of different constructs (Straub, 1989). Upon this the next sections will answer and discusses construct validity using convergent and discriminant validity.

5.6.1 Convergent Validity

Convergent validity of items is used to assess whether individual scale items are related. Principal components for factor analysis are used to test convergent validity. Convergent validity is demonstrated as the data from Table 5.3, shows that all loadings from principal component factor analysis were >= 0.600 as recommended by Hair *et al*. (2009). Hence the items selected in this study have achieved convergent validity.

5.6.2 Discriminant Validity

In this study, correlation matrix approach and factor analysis were applied to examine construct validity in terms of convergent and discriminant validity. After examining the EFA correlation matrix, the results revealed that the 0.034 is the lowest within-factor correlations. These correlations are higher than zero ($P < 0.000$) and large enough to proceed with discriminant tests as supported by (Hair *et al*., 2009). Discriminant validity was examined by counting the number of times an item correlates higher with items of other variables than with items of its own variable (Aladwani & Palvia, 2002). For example, the lowest result within-factor correlation for relationship quality is 0.602, and none of the correlations of relationship quality with items of other factors are > 0.614, i.e. number of violations is zero. The results show a zero violation for potential comparisons. Which conclude that this study achieved discriminant validity, as parts of answering construct validity.

5.7 Hypothesis Testing

A Pearson product-moment correlation coefficient describes the relationship between two continuous variables or when the researcher is interested in defining the important variables that are associated with the problem (Sekaran & Bougie, 2010). Correlation is appropriate for interval and ratio-scale variables and it is the most common measure of linear relationship. This coefficient has a range of possible values from -1 to +1. The value indicates the strength of the relationship, while the sign (- or +) indicates positive or negative correlation. It has been proposed that the lower limit of substantive regression coefficients is 0.05 (Hair *et al*., 2009; Pallant, 2007), although the researcher preferred a critical value of 0.10 and higher ($r > 0.10$) for substantive correlations. Also, a significance of $\rho=0.05$ is a generally accepted. This indicates that 95 times out of 100. The researcher can be sure that there is a true or significant correlation between the two variables, and there is an only 5 percent chance that the relationship does not truly exists. Thus in this study, the researcher examined the correlation between two variables to test a hypothesis to indicate a significance positive relationship.

The study proposed nine hypotheses. A list of proposed hypotheses is given in Table 5.5.In order to test the hypotheses, the mean values of the items measuring each construct was calculatedand stored as a separate item in SPSS representing the construct. The average response of quality factors toward net benefits of data warehouse was considered. If the net benefits mean value rating correlated positively and significantly with the six quality factors, the nine hypotheses could be supported. The means of the Inter-Item Correlations, maximum of correlation coefficient, minimum of correlation coefficient, range and variance among the seven research constructs are presented next.

Table 5.5: List of Hypotheses

H#	Description
H1	System quality is positively associated with data warehouse net benefits.
H2	System quality is positively associated with information quality.
H3	Information quality is positively associated with data warehouse net benefits.
H4	Service quality is positively associated with data warehouse net benefits.
H5	Service quality is positively associated with relationship quality.
H6	Relationship quality is positively associated with data warehouse net benefits.
H7	User quality is positively associated with data warehouse net benefits.
H8	User quality is positively associated with business quality.
H9	Business quality is positively associated with data warehouse net benefits.

The first hypothesis (H1) stated that system quality is positively related to net benefits of data warehouse system. Relationship of system quality and net benefits was significant. H1 was supported at the 0.000 level of significance. The standardized correlation coefficient is 0.532 (Table 5.6). This finding implies that factors such as: easy to use, easy to learn, easy to manage, flexibility, accessibility, and quick response time of system are very essential for the success of the data warehouse systems.

Table 5.6: Hypothesis (H1) Correlations

		Net Benefits
System Quality	Pearson Correlation	**0.532****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The second hypothesis stated that system quality is positively associated with information quality. Relationship of system quality and information quality was significant. H2 was supported at the 0.000 level of significance. The standardized correlation coefficient is .598 (Table 5.7).This finding supports the perspective adopted by this study that a poor system quality will most likely result in poor information quality.

Table 5.7: Hypothesis (H2) Correlations

		Information Quality
System Quality	Pearson Correlation	**0.598****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The third hypothesis posited that the information quality is positively associated with the net benefits of data warehouse. This hypothesis was supported at the 0.000 level of significance. The correlation coefficient is 0.455 as shown in Table 5.8. The results supported the hypothesis that providing a good quality of information would contributes to the success of data warehouse system by improveing decision making capabilities and by reducing the time and effort needed to support decision. This indicates that accuracy, usefulness, relevant, format, timeliness, and adequacy of information could help in successful execution of data warehouse system.

Table 5.8: Hypothesis (H3) Correlations

		Net Benefits
Information Quality	Pearson Correlation	**0.455****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The fourth hypothesis stated that service quality is positively associated with the net benefits. This relationship is expected to be significant in the context of data warehouse also. As shown in Table 5.9, H4 was supported at the 0.000 level of significance. Also, the correlation coefficient is .650.

Table 5.9: Hypothesis (H4) Correlations

		Net Benefits
Service Quality	Pearson Correlation	**0.650****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The fifth hypothesis stated that service quality is positively related to relationship quality in the context of data warehouse success. As shown in Table 5.10, this hypothesis (H5) was supported at the 0.000 level of significance. The standardized correlation coefficient is .732. In addition, the results supported that service quality was significantly related to the relationship quality between the data warehouse parties in terms of enhancing communication, coordination, and cooperation; creating commitment; increasing trust; and reducing conflicts.

Table 5.10: Hypothesis (H5) Correlations

		Relationship Quality
Service Quality	Pearson Correlation	**0.732****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The sixth hypothesis stated that relationship quality is positively correlated with the net benefits of data warehouse systems. The correlation coefficient is 0.698. As the results in Table 5.11 suggests, a significant positive relationship exists; therefore, there is a support for this hypothesis. H6 was supported at the 0.000 level of significance. The results supported the hypothesis that providing a good quality of relationship between the data warehouse parties would contributes to the success of data warehouse system. This indicates that a good communication, coordination, cooperation, commitment, and trustbetween the data warehouse parties could help in successful execution of data warehouse system.

Table 5.11: Hypothesis (H6) Correlations

		Net Benefits
Relationship Quality	Pearson Correlation	**0.698****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The seventh hypothesis posited that user quality is positively associated with the net benefits of data warehouse systems. Relationship of user quality and net benefits was significant. H7 was supported at the 0.000 level of significance. The standardized correlation coefficient is 0.342 (Table 5.12). This finding implies that the user skills in analyzing the data provided by the data warehouse system as well as the competence in carrying out their tasks and responsibilities are very essential for the success of the data warehouse systems.

Table 5.12: Hypothesis (H7) Correlations

		Net Benefits
User Quality	Pearson Correlation	**0.342****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The eighth hypothesis stated that user quality is positively correlated with business quality in the context of data warehouse success. As shown in Table 5.13, this hypothesis (H8) was supported at the 0.000 level of significance. The standardized correlation coefficient is .608. In addition, the results supported that the quality of users in terms of thier business knowledge of how to use the data warehouse in their organizations and the ability of understand their organization's requirements would strongly supports the business strategy and plan as well as achieves greater competitive advantage of their organizations.

Table 5.13: Hypothesis (H8) Correlations

		Business Quality
User Quality	Pearson Correlation	**0.608****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

The ninth hypothesis posited that business quality is positively related to the net benefits of data warehouse systems. Relationship of business quality and net benefits was significant. H9 was supported at the 0.000 level of significance. The standardized correlation coefficient is 0.444 (Table 5.14). This finding implies that makes a good business strategy and plan, and clearly defines the business requirements, needs and scope are very essential for the success of data warehouse systems.

Table 5.14: Hypothesis (H9) Correlations

		Net Benefits
Business Quality	Pearson Correlation	**0.444****
	Sig. (2-tailed)	**0.000**

** Correlation is significant at the 0.01 level (2-tailed).

Table 5.15 provides a summary of correlation analysis for the all hypotheses. All the hypotheses in this study are supported. Correlation alpha ranges in value from 0.342 to 0.732. A support for a direct relationship hypothesis of information quality, system quality, service quality, relationship quality, user quality, and business quality on net benefits of data warehouse were found. Of these, relationship quality had the maximum impact (0.698) on net benefits, followed by service quality, system quality, information quality, business quality, and user quality. Table 5.15 also shows that a direct relationship hypothesis of system quality on information quality, a direct relationship hypothesis of service quality on relationship quality, and finally a direct relationship hypothesis of user quality on business quality were found.

The correlations between the constructs (represented by the mean of all items measuring the construct) are presented in Appendix 7. The next section discusses the findings regarding multipleregression analysis.

Table 5.15: Hypothesis Testing Results

Hypothesis	**Supported**	**Correlation Alpha**	**Direction**
System Quality → Net Benefits	Yes	0.532(**)	Positive
System Quality → Information Quality	Yes	0.598(**)	Positive
Information Quality → Net Benefits	Yes	0.455(**)	Positive
Service Quality → Net Benefits	Yes	0.650(**)	Positive
Service Quality → Relationship Quality	Yes	0.732(**)	Positive
Relationship Quality → Net Benefits	Yes	0.698(**)	Positive
User Quality → Net Benefits	Yes	0.342(**)	Positive
User Quality → Business Quality	Yes	0.608(**)	Positive
Business Quality → Net Benefits	Yes	0.444(**)	Positive

(**) Correlation is significant at the 0.01 level (2-tailed)

→ Correlation direct

5.8 Regression Analysis

In order to examine the combined influences of quality factors on the net benefits of data warehouse, a multiple regression analysis was performed. As shown in Table 5.16 the adjusted coefficient of determination (R^2) indicates that 0.561 percent of the variation in the dependent variable is explained by variations in the independent variables. In other words, 56.1% of the variance (R^2) in the net benefits of data warehouse has been significantly explained by the quality factors. Therefore, the six (6) predictor dimensions were observed to positively correlate to the net benefits of data warehouse.

Table 5.16: Multiple Regression Results of Quality Factors with Net Benefits

Model Summary[b]				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.749[a]	.561	.549	.66487

a. Predictors: (Constant), information quality, system quality, service quality, relationship quality, user quality, business quality

b. Dependent Variable: Mean_NetB

The regression analysis also used to examine the impact of system quality on information quality. As shown in Table 5.17 the adjusted coefficient of determination (R^2) indicates that 0.357 percent of the variation in the dependent variable is explained by variations in the independent variable. In other words, 35.7% of the variance (R^2) in the information quality is significantly explained by the system quality factor.

Table 5.17: Regression Results of System Quality with Information Quality

Variables	**Unstandardized Coefficients**		**Standardized Coefficients**		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.640	0.311		5.281	0.000
System Quality	0.672	0.059	0.598	11.599	0.000
R		0.598[a]			
R2		**0.357**			
Std. Error of the Estimate		0.82747			

Dependent Variable: information quality.
a. Predictors: (Constant), system quality

Another regression analysis used to examine the impact of service quality on relationship quality. As shown in Table 5.18, the adjusted coefficient of determination (R^2) indicates that 0.536 percent of the variation in the dependent variable is explained by variations in the independent variable. In other words, 53.6% of the variance (R^2) in the relationship quality is significantly explained by the service quality factor.

Table 5.18: Regression Results of Service Quality with Relationship Quality

Variables	**Unstandardized Coefficients**		**Standardized Coefficients**		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	1.657	0.223		7.436	0.000
Service Quality	0.706	0.042	0.732	16.718	0.000
R		0.732[a]			
R2		**0.536**			
Std. Error of the Estimate		0.65138			

Dependent Variable: relationship quality.
a. Predictors: (Constant), service quality

Finally, regression analysis used to examine the impact of user quality on business quality. As shown in Table 5.19, the adjusted coefficient of determination (R^2) indicates that 0.370 percent of the variation in the dependent variable is explained by variations in the independent variable. In other words, 37.0% of the variance (R^2) in the business quality is significantly explained by the user quality factor.

Table 5.19: Regression Results of User Quality with Business Quality

Variables	**Unstandardized Coefficients**		**Standardized Coefficients**		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	2.401	0.238		10.075	0.000
User Quality	0.530	0.044	0.608	11.927	0.000
R		0.608[a]			
R2		**0.370**			
Std. Error of the Estimate		0.74217			

Dependent Variable: business quality.
a. Predictors: (Constant), user quality

The full SPSS results for regressions analysis are presented in Appendix 8. The next section discusses the findings regarding mediator factors (i.e. indirect effects).

5.9 Additional Results

In statistics, a mediation model is one that seeks to identify and explicate the mechanism that underlies an observed relationship between an independent variable and a dependent variable via the inclusion of a third explanatory variable, known as a mediator variable (Preacher, Rucker, & Hayes, 2007; Hayes, 2009; Pearl, 2011). Rather than hypothesizing a direct causal relationship between the independent variable and the dependent variable, a mediational model hypothesizes that the independent variable affects the mediator variable, which in turn affects the dependent variable. The mediator variable, then, serves to clarify the nature of the relationship between the independent and dependent variables (MacKinnon, 2008).

To test the mediation hypothesis, the multipleregression analysis was performed according to the steps and method suggested by Baron and Kenny (1986), Frazier *et al.* (2004), and MacKinnon (2008). According to MacKinnon (2008), mediation is generally present when:

1. the independent variable (IV) significantly affects the mediator variable (MV) (a path),
2. the MV significantly affects the dependent variable (DV) (b path),
3. the IV significantly affects the DV in the absence of the MV (c path), and
4. the effect of IV on the DV shrinks upon the addition of the MV to the model (c` path).

To test whether a full or partial mediator in the relationship exists, the researcher utilizes the steps suggested by Baron and Kenny (1986). According to Baron and

Kenny (1986), full mediation holds if $a \neq 0$, $b \neq 0$, $c \neq 0$, $c`=0$; partial mediation holds if $a \neq 0$, $b \neq 0$, $c \neq 0$, $c` \neq 0$ ($|c|>|c`|$); no mediation holds if a=0 or b=0.

This study found that the information quality mediates the relationship between the system quality and the net benefits. To establish this mediation hypothesis, first, system quality (IV) must be shown to affect information quality (MV). Second, system quality (IV) must be shown to affect net benefits (DV). Thirdly, the information quality (MV) must affect net benefits (DV). If these conditions all hold in the predicted direction, in order for these results to support the hypothesized mediation, then the effect of the independent variable on the dependent variable must be less in the third analysis, than in the second. Table 5.20 provides the summary of beta value for the system quality (IV) on net benefits (DV) before and after including the information quality variable (MV) in the multiple regression analysis. The results indicated that information quality is partially mediating the relationship between system quality and net benefits. The full SPSS results are presented in Appendix 9.

Table 5.20: Summary of Beta Value on the Relationship of Information Quality between System Quality and Net Benefits

	Criterion Dimension Net Benefits		
Dimension	Without	With	Result
System Quality	0.532**	0.405**	P

Note: F = Full mediator

P = Partial mediator

**p<0.01

This study hypothesized that relationship quality mediates the relationship between service quality and net benefits. To establish this mediation hypothesis, first, service quality (IV) must be shown to affect relationship quality (MV). Second, service quality (IV) must be shown to affect net benefits (DV). Thirdly, the relationship quality (MV) must affect net benefits (DV). If these conditions all hold in the predicted direction, in order for these results to support the hypothesized mediation, then the effect of the independent variable on the dependent variable must be less in the third analysis, than in the second. Table 5.21 provides the summary of beta value for the service quality (IV) on net benefits (DV) before and after including the relationship quality variable (MV) in the multiple regression analysis. The results indicated that relationship quality is partially mediated the relationship between service quality and net benefits.

Table 5.21: Summary of Beta Value on the Relationship of Relationship Quality between Service Quality and Net Benefits

	Criterion Dimension Net Benefits		
Dimension	Without	With	Result
Service Quality	0.650**	0.299**	P

Note: F = Full mediator

P = Partial mediator

**p<0.01

This study hypothesized that business quality mediates the relationship between user quality and net benefits. To establish this mediation hypothesis, first, user quality (IV) must be shown to affect business quality (MV). Second, user quality (IV) must be shown to affect net benefits (DV). Thirdly, the business quality (MV) must affect net benefits (DV). If these conditions all hold in the predicted direction, in order for these results to support the hypothesized mediation, then the effect of the independent variable on the dependent variable must be less in the third analysis, than in the second. Table 5.22 provides the summary of beta value for the user quality (IV) on net benefits (DV) before and after including the business quality variable (MV) in the multiple regression analysis. The results indicated that business quality is fully mediated the relationship between user quality and net benefits.

Table 5.22: Summary of Beta Value on the Relationship of Business Quality between User Quality and Net Benefits

	Criterion Dimension Net Benefits		
Dimension	Without	With	Result
User Quality	0.342**	0.114	F

Note: F = Full mediator, P = Partial mediator

**p<0.01

5.10 Research Model with Results

In Figure 5.2 the path coefficients for the hypothesized model with the supported hypothesis are shown. Represent standardized regression weights (r), or coefficients of correlation, between two variables; r is a number between -1.00 and 1.00 that indicates both the direction and the strength of the linear relationship between two variables. In Figure 5.2, estimates of squared multiple correlations (R^2) are shown. Once the proposed measurement model was consistent with the data, the hypothesized structural paths were estimated. After analyzing data, the hypothesized model fits the data well and all significant relationships are in the hypothesized direction.

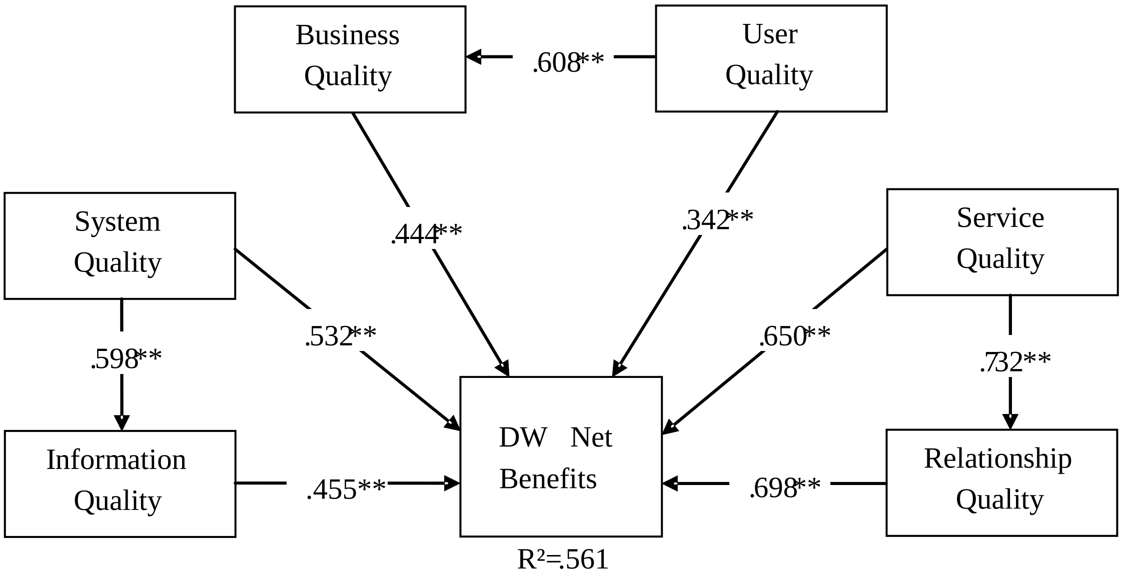


Figure 5.2: Research Model with Correlation Coefficients and Squared Multiple Correlations

5.11 Summary

This chapter discusses the data analysis and findings of the study through the results of demographic profile of respondents, goodness of measures including factor analysis and reliability analysis, descriptive analysis and hypotheses testing including correlation analysis, multiple regression analysis, a summary of the hypotheses testing results, and finally presents the final research model. Next chapter covers the discussion and conclusion of the whole study.

CHAPTER Six
DISCUSSION AND CONCLUSIONS

6.1 Introduction

This chapter summarizes the results of data analysis from chapter 5 and provides the discussion to support the findings of this study. This chapter starts with the holistic finding, then reflection on research questions and hypotheses, implications of the study, contributions, limitations, future studies and finally the conclusion.

6.2 Holistic Findings

This empirical study attempts at finding plausible answers to several questionspertaining to the success of data warehouse systems. Literature revealed that there is lack of consistency inthe outcomes available particularly in respect of quality factors contributed to the success of data warehouse systems.The literature also suggests that more studies are needed not only forbetter understanding of the role and contributions of quality factors but also for clearer insight into the manner in whichit affects the success of data warehouse systems. This study hasmoved towards this direction. This study has investigated the theoretical linkagesbetween qualityfactors and the net benefits of data warehouse systems.The aim of quality factors study was to add optimal value to evaluate the success of the data warehouse systems. The model developed in this study had seven main concepts namely information quality, system quality, service quality, relationship quality, user quality, business quality, and net benefits. Analysis using descriptive analysis, factor analysis, correlation analysis and multiple regression analysis resulted in the support of all hypotheses. Moreover, the research results indicated that there are statistically positive causal relationship between each quality factors and the net benefits of the data warehouse systems. These results imply that the net benefits of the data warehouse systems increases when the overall qualities were increased. In addition, the results indicated that the direct causal effect of information quality on system quality was statistically significant and positive. The results also indicated that the direct causal effect of service quality on relationship quality was statistically significant and positive. Furthermore, the results indicated that the direct causal effect of user quality on business quality was statistically significant and positive. Finally, regarding the mediation relationships, the results indicated that information quality was partially mediated the relationship between system quality and net benefits, relationship quality was partially mediated the relationship between service quality and net benefits, and business quality was fully mediated the relationship between user quality and net benefits.

6.3 Reflection on Research Questions

In this study, researcher developed a model of data warehouse systems success and postulated twelve hypotheses (chapter 3). The hypothesized model was then empirically validated using data collected from a field survey of TDWI members. The implications of the findings in the context of the research questions addressed by the study were discussed in the following sections.

6.3.1 Research Question 1

This study postulated five research questions that were addressed by the problem statement of this research. The first question is:

> *What are the quality factors that influence the success of data warehouse systems?*

To answer this question, detail literature and research were conducted on the data warehouse and IS success. An initial study was conducted to obtain information on the existing studies concerning data warehouse success, to illustrate issues and gaps, and the extent of which quality factors are most useful to the success of data warehouse systems. In addition, the study provided an understanding of the specific quality factors to be considered in evaluating the success of data warehouse systems. The initial study resulted in six quality factors that influence the success of data warehouse systems, they are: system quality, information quality, service quality, relationship quality, user quality, and business quality.

6.3.2 Research Question 2

Concerning the second research question:

> *What is the effect of the quality factors (system, information, service, relationship, user, and business) on the net benefits of the data warehouse systems?*

To answer this question, hypothesized model was developed against reasonable alternative model. The hypothesized model of data warehouse success was determined by seven constructs: information quality, system quality, service quality, relationship quality, user quality, business quality, and net benefits, (figure 6.1). This question involved two parts, the first part was to examine the individual impacts of quality factors on net benefits. Thus, six hypotheses were posited in this regards as follows:

H1: System quality is positively associated with data warehouse net benefits.

H3: Information quality is positively associated with data warehouse net benefits.

H4: Service quality is positively associated with data warehouse net benefits.

H6: Relationship quality is positively associated with data warehouse net benefits.

H7: User quality is positively associated with data warehouse net benefits.

H9: Business quality is positively associated with data warehouse net benefits.

A Pearson correlation analysis was used to test the above mentioned hypotheses. The findings about perceptions addressed by research question 2 have important implications which are discussed below.

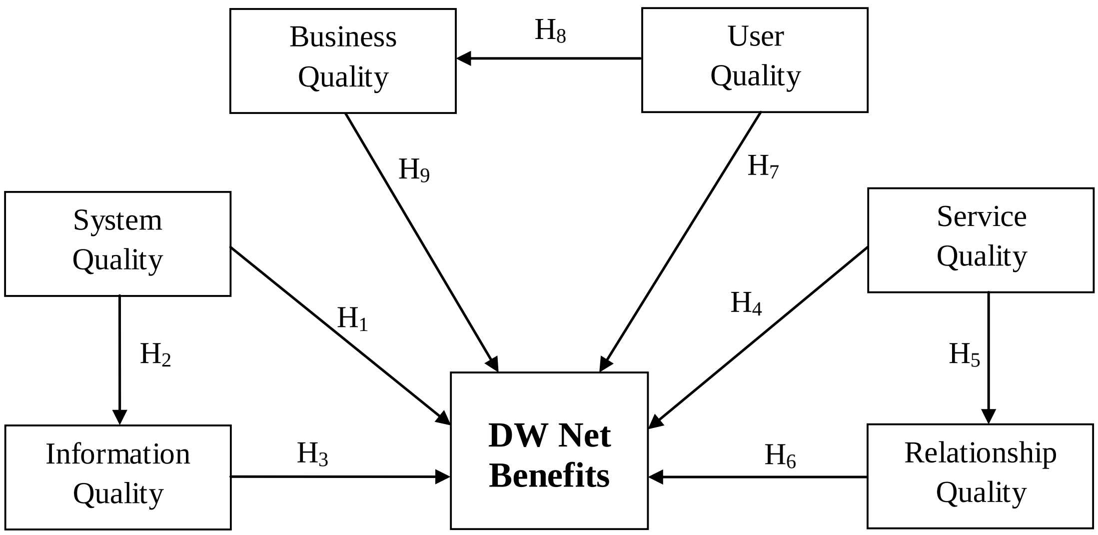


Figure 6.1: Final Hypotheses Research Model

Reflection on findings regarding information quality

The finding of this study evident that information quality factor had positive and significant impact on the net benefits construct at the 0.000 level of confidence with the 0.455 of correlation coefficient. It also found that information quality is partially mediating the relationship between system quality and net benefits. It meant that a good quality of information would contribute to the success of data warehouse systems. Therefore, it is improving decision making capabilities and reducing the time and effort needed to support decision. This finding lends support to the finding in research literature and to the research model.

This result is supported by previous researches such as Prybutok *et al*., (2008) who found a positive relationship between information quality and net benefits in an e-government context. Bharati and Chaudhury (2006) also mentioned the information quality strongly and positively impact on decision making (which is one of the net benefits measures) in an e-commerce environment. In addition, Kositanurit, Ngwenyama, & Osei-Bryson (2006) stated that information quality have positive effect on performance among ERP systems users. In the context of data warehouse systems, Hwang and Xu (2008) found that information quality is significantly related to individual benefits. Further to this, Wixom and Watson (2001) concluded that data quality greatly and positively influences perceived net benefits. Likewise, Hayen *et al*. (2007) found that data quality is positively correlated with perceived net benefits of the data warehouse systems. Moreover, findings from the two case studies conducted by Bhansali (2007) showed that data quality is strongly and positively impacts the successful adoption of the data warehouse.

Organizations require data warehouse system 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, the data warehouse system should, therefore, not only provide depth and width in information, but also enables competitive advantage and business effectiveness. Consequently, in order to simultaneously achieve high levels of information quality, everyone in the organization should have a stewardship role for information quality. Furthermore, effective business decision-making depends on good quality information, and poor information quality can be costly and sometimes disastrous. Without quality information the data warehouse systems will fail to achieve the highest benefits for the organization. Besides that poor quality information of the data warehouse systems can impact an organization in many ways. It can causes process failure and information scrap and rework that wastes people, materials, money, and facilities resources. Another possible explanation could be for the positive result is the data warehouse with good information quality improves the way information is provided for enabling better decision making, delivering insight, and driving enterprise performance.

Reflection on findings regarding system quality

The finding of this study revealed that system quality factor had positive and significant impact on the net benefits construct at the 0.000 level of confidence with the 0.532 of correlation coefficient. This finding implied that easy to use, easy to learn, easy to manage, flexibility, accessibility, and quick response time of system are very essential for the success of the data warehouse systems. The findings from this study and research literature support the research model. This provided evidence for the importance of system quality to obtain the net benefits from the data warehouse systems.

This finding was found with the findings of previous studies such as Prybutok*et al*., (2008) who found that there is a significant relationship between system quality and net benefits in an e-government context. Bharati and Chaudhury (2006) also indicated that system quality is significantly and positively related to decision making satisfaction in an e-commerce context. Similarly, Seddon and Kiew (1996) and Shih (2004) found a significant relationship between system quality and perceived usefulness as measured by productivity and decision-making quality. In the data warehouse context, Wixom and Watson (2001) found that system quality is strongly and positively impacts perceived net benefits. In addition to this, findings from the case study conducted by Hayen *et al*. (2007) showed that system quality is greatly and positively associated with perceived net benefits of the data warehouse systems.

The reasons of this positive influence of system quality state as follows: firstly, the data warehouse 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, a data warehouse system 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, the data warehouse 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 data warehouse system is a necessary prerequisite to deriving the potential benefits include increased revenues, cost reduction, and improved decision making process. Finally, a data warehouse 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.

Reflection on findings regarding service quality

The finding of this study indicated that service quality factor had positive and significant impact on the net benefits construct at the 0.000 level of confidence with the 0.650 of correlation coefficient. This means that the better services that provided by the data warehouse system and the more productive users' leads to better organizational performance. Thus, through a combination of the study findings and research literature, support is found for the research model.

However, this research is not alone in providing evidence of a significant relationship between service quality and net benefits. For example, in some previous studies byPrybutok *et al*., (2008), also found that service quality dimension is strongly and positively associated with net benefits in an e-government context. Gefen and Keil (1998) also found that responsiveness of perceived developer and user training provided by the computing department has significant impact on system usefulness. Leonard-Barton and Sinha (1993) added that the ability to respond to problems by the IS users has a positive effect on improving organizational efficiency. In the data warehouse context, Ramamurthy *et al*., (2008) found that responsiveness for current and future data warehouse projects would increase the chances of success.

The conclusion was reached having in mind 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 data warehouse specialists who are able to maintain communication well through interactions with business units could results to better services aligned with organizational goals. In addition to this, 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 data warehouse systems would enable rapid responses to new business opportunities. Ultimately, organizations need data warehouse systems to have the ability to provide adequate solutions for decisions making, reliable service, and promise accomplishment.

Reflection on findings regarding relationship quality

The finding of this study revealed that relationship quality factor had positive and significant impact on the net benefits construct at the 0.000 level of confidence with the 0.698 of correlation coefficient. It also found that relationship quality factor is partially mediating the relationship between service quality and net benefits. This indicates that a good communication, coordination, cooperation, commitment, and trustbetween the data warehouse parties could help in successful execution of data warehouse systems.

This result was supported by previous studies such as Wu (2007) who found that relationship quality dimension is significantly associated with net benefits through its impact on use and user satisfaction in e-commerce systems. Chakrabarty *et al*. (2007) also found that relationship quality is greatly and significantly associated with user satisfaction in IS outsourcing context. Besides that, Chang and Ku (2009) found that relationship quality is strongly and positively associated with organizational performance in context of the implementation of CRM. In the context of data warehouse, Bhansali (2007) indicated that commitment, communication, and cooperation between the business users and data warehouse managers are greatly associated with the success of the data warehouse systems.

This finding is justified by the fact that quality of the relationship between data warehouse parties could potentially reduce the time and effort, which in turn leads to make decisions in a timely manner and with high accuracy. Likewise, data warehouse 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 the data warehouse parties will facilitates the identification of areas for development in the data warehouse with the best return on investments. Another possible explanation could be for the positive result is the successful communication, coordination, and cooperation between the data warehouse managers and business are absolutely help in avoiding paradoxical decisions.

Reflection on findings regarding user quality

The finding of this study indicated that user quality factor had positive and significant impact on the net benefits construct at the 0.000 level of confidence with the 0.342 of correlation coefficient. This meant that the user skills in terms of analyzing the data provided by the data warehouse systems and the competence in carrying out their tasks and responsibilities are very essential for the success of the data warehouse systems. The finding mentioned above and research literature support the research model.

Relatively similar finding was found with the findings of previous studies such as Salmela (1997) who found that the quality of IS user is greatly and positively associated with organizational benefits. To corroborate further, a study of data warehouse conducted by Wixom and Watson (2001) found that a high level of user skills is significantly related to the data warehouse systems success. Further to this, Hwang *et al*. (2004) found similar results when examining the relationship between skills of the data warehouse users and the adoption of data warehouse technology in the banking industry in Taiwan.

The reasons of this positive finding are most likely because, the capability of data warehouse 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 data warehouse 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.

Reflection on findings regarding business quality

The finding of this study evident that business quality factor had positive and significant impact on the net benefits construct at the 0.000 level of confidence with the 0.444 of correlation coefficient. It also found that business quality is fully mediating the relationship between user quality and net benefits. This makes that implies a good business strategy and plan, clearly define the business requirements, and identify the scope of the data warehouse systems are very essential for the success of it. The finding mentioned above and research literature support the research model.

Relatively similar finding was found with the findings of previous studies such asCroteau and Bergeron (2001) who found that business strategy is significantly correlated with organizational performance. In the data warehouse context, Bhansali (2007) found that business plans and business strategies are strongly and significantly associated with the success adoption of the data warehouse.

The reasons of this positive influence of business quality are stated as follows: firstly,the data warehouse 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, the data warehouse 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 data warehouse and business planning process could leads to improve the organization planning processes.

Reflection on findings regarding the combined influences of quality factors on the net benefits

The second part of research question 2 is to examine the combined influences of the quality factors on the net benefits. Thus, a multiple regression analysis was performed. The result of the multiple regression indicated that the quality factors explained the variance in the net benefits of data warehouse. Specifically, the multiple regression analysis found that the 56.1% of the variance (R^2) in the net benefits of data warehouse has been significantly explained by the quality factors. Based on these results, it can be concluded that the net benefits of the data warehouse is a multidimensional construct composed of the six sub-dimensions mentioned above.

6.3.3 Research Question 3

Concerning the third research question:

> *What is the effect of information quality, relationship quality, and business quality on the relationship between system quality, service quality, and user quality and the net benefits of the data warehouse systems?*

Thus, three hypotheses were posited in this regards as follows:

H2: System quality is positively associated with information quality.

H5: Service quality is positively associated with relationship quality.

H8: User quality is positively associated with business quality.

Reflection on findings regarding system quality to information quality

The finding of this study indicated that system quality had positive and significant impact on information quality construct at the 0.000 level of confidence with the 0.598 of correlation coefficient. It also found that the 35.7% of the variance (R^2) in the information quality has been significantly explained by system quality factor. This means that poor system quality could result in poor information quality. The finding mentioned above and research literature support the research model.

However, this research is not alone in providing evidence of a significant relationship between system quality and information quality. For example, in a previous study by Gorla *et al*., (2010),found that quality information directly influence information quality in the context of IS. In the data warehouse context, Hwang and Xu (2008) also found that system quality is greatly and positively impacts information quality.

This finding is justified by the fact that the use of modern technology and formal development methods when developing the data warehouse systems could facilitate to improve the quality of information by provides adequate information and produces relevant and integrity information. 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.

Reflection on findings regarding service quality to relationship quality

The finding of this study indicated that service quality had positive and significant impact on relationship quality construct at the 0.000 level of confidence with the 0.732 of correlation coefficient. It also found that the 53.6% of the variance (R^2) in the relationship quality factor has been significantly explained by system quality factor. This implies that a good services provided by IS/DW departments would enhance the relationship between the data warehouse parties within the organization.

This result was supported by previous studies such as Sun *et al*. (2007) who found that service quality is greatly and significantly correlated with relationship quality in an e-commerce website success. Moreover, Chakrabarty *et al*. (2007) and Paravastu (Paravastu, 2007) found that service quality is positively associated with relationship quality in the context of IS outsourcing success.

The reasons of this positive influence of service quality on relationship quality are stated as follows: firstly, great services delivered by IT unit and data warehouse system could lead to enhances cooperation, coordination, and communication; reduces conflicts; increases trust; and create commitment between the data warehouse parties. Secondly, when the users feels that the data warehouse system is providing high quality of services, it would develop a positive impression for them, which in turn lead to a growth in relationship among data warehouse business users and data warehouse parties. Thirdly, 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 data warehouse parties. Finally, by having knowledgeable data warehouse 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.

Reflection on findings regarding userquality to business quality

The finding of this study indicated that user quality had positive and significant impact on business quality construct at the 0.000 level of confidence with the 0.608 of correlation coefficient. It also found that the 37.0% of the variance (R^2) in the business quality factor has been significantly explained by user quality factor. This means that user quality in terms of business, analytical, and technical skills is needed in order to ensure that the data warehouse systems are actually developed and used in the way that produces the business benefits.

Relatively similar finding was found with the findings of previous studies such as Salmela (1997) who found that IS user quality is positively related to business quality. In addition to this, Andersson and Hellens (1997) found that user quality is significantly associated with business quality in the context of IS.

The conclusion was reached having in mind the following reasons: the quality of users in terms of their business knowledge of how to use the data warehouse would aggressively leads to achieve the best business strategies and plans. Further to this, the ability of data warehouse business users to understand their organization's requirements could strongly results to attain greater competitive advantage. Ultimately, poor user quality increases the cost of learning and using the data warehouse system.

6.4 Contributions of the Study

This study investigated the factors that lead to evaluate the success of data warehouse systems. It explored the causal relationship between quality factors and net benefits, which potentially trigger a new stream of research. The following is a brief discussion of the most important contributions offered by this study.

6.4.1 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 data warehouse. It draws upon IS success model of DeLone and McLean (2003) and other IS/DW success models. In the context of data warehousesuccess, 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 the data warehouse 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.

The comprehensive research model was unique in the sense that it adapted and extended the well-established factors of IS/DW success models to the applications of data warehouse. These models were used as the background and the research model incorporated the quality factors that were specific to the successful implementation of data warehouse. Therefore, this study contributes significantly to the existing literature, as there has been little evidence found in the current literature in explaining the implementation and deployment of data warehouse systems.

The findings of this study strongly support the appropriateness of using DeLone and McLean IS success model attributes to predict the successful data warehouse deployment. Three of DeLone and McLean IS success attributes of information quality, system quality, and service quality were observed to have significant influence on data warehousenet 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 data warehouse net benefits. In addition, a high proportion of the variance (R^2) 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. Generally, the findings of this study showed significant direct and indirect impacts of quality factors on the net benefits of data warehouse. It also expanded the existing research in this area and provided a starting framework for future research.

6.4.2 Implications for Practitioners

Practitioners are highly interested in understanding the success of data warehouse systems. Often, organizations invest millions of dollars and large amounts of corporate resources in data warehouse initiatives. Failed efforts can impact the organization through wasted investments and unrealized needs. This study offers practitioners an empirically tested model of successful data warehouse. Its findings can be used as a basis for guidelines for data warehouse managers who are interested in protecting data warehouse investments.

The guidelines offer an understanding of the quality factors that ultimately impact the success of data warehouse systems. The following is to clarify the implications for practitioners:

First, high information quality is associated with high organizational benefits. Information quality can be improved in several ways, for example:

- By aligning IT strategy with business strategy, using data warehouse techniques to aid business decision making, and using data mining techniques to improve business intelligence.
- By linking IT strategy with business strategy, information outputs can be designed to provide information that enhances organizational effectiveness.
- By providing relevant information to decision makers, which can improve decision making strategies.

Second, information quality plays a mediating role in the relationship between system quality and net benefits. Thus, data warehouse managers should emphasize up-to-date hardware and software, graphical user interfaces, and well-designed and well-documented systems. If system quality is poor, it is unlikely that information quality can be improved dramatically. For instance, concise and easy-to-understand outputs are unlikely without modern information technology features, such as graphical user interfaces and online processing capabilities.

Third, this research also identified the direct effects of system quality on the net benefits of data warehouse. Taking into account the system quality, data warehouse managers could have the preeminent effect on quality if they concentrate on creating an accessible, reliable, flexible, and integrated system. In addition to this, data warehouse 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. On the other hand, the data warehouse systems data is collected across technologies from different environments, it should become clearer to what extent there are dominant system quality characteristics that would guide to successful data warehouse system.

Fourth, the results also identified that system qualityis associated with the net benefits of data warehouse. Therefore, any actions taken to enhance data warehouse service quality can subsequently improve organizational performance. More emphasis should be placed by data warehouse managers on training the data warehouse staff to develop better attitudes toward service orientation. Moreover, data warehouse managers and business managers should be made aware of the importance of services provided by IT unit to increase the chances of data warehouse success. Furthermore, service quality is important for the long-term health of both the data warehouse 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.

Fifth, findings from this study gave high indication to relationship quality on the net benefits of data warehouse. Thus, high relationship quality between data warehouse managers and data warehouse business users can help in the effective management of data warehouse projects. Furthermore, maintaining flexibility and good relationship between data warehouse parties also help in problem-free execution of the projects, avoids cost and time over-runs during implementation of data warehouse projects. In a high quality relationship, it is expected that the data warehouse team makes beneficial decisions for the users, provides assistance when needed, and is always sincere. These actions build trust between data warehouse team and data warehouse users and add to the success of data warehouse system. Additionally, successful execution of data warehouse project requires high commitment from the data warehouse team towards keeping promises. The success of data warehouse 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 the data warehouse system success can improve. Alternatively, poor relationship quality can result due to frequent conflicts and non-cooperation (due to breakdown in trust, commitment, cooperation, and communication); and this poor relationship quality can hamper the data warehouse system success.

Sixth, practitioners can use the model presented in this study to review the potential benefits of high data warehouse system quality in their own organization. They also can establish business goals and strategies for the data warehouse projects that aim at improving decision making. And they can use the model as investigative tools in analyzing the reasons for low business profitability of data warehouse. In addition, the results from 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, practitioners have to make sure that the data warehouse users having the necessary skills such as analysis, technical, and business skills.

Finally, understanding the quality factors should serve as an assist to evaluate the success of data warehouse systems. Data warehouse managers should improve the data warehouse system capabilities so that system quality, information quality, service quality, relationship quality, user quality, and business quality can be improved. Moreover, increasing data warehouse system capabilities in the core data warehouse functional areas (such as planning, system development, system support, and system operations) and developing data warehouse applications to enhance core competencies of the business and decision making could help to improve data warehouse quality and organizational performance.

Furthermore, data warehouse managers should aim at developing valuable, inimitable, and non-substitutable data warehouse system capabilities to increase competitive advantage to the organization. The researcher believe that the findings of this study would be useful for data warehouse 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 the data warehouse systems. In addition, data warehouse managers need to consciously try to allocate time to evaluate these new technologies and develop a vision for the use of the data warehouse in order to remain competitive.

6.5 Limitations

To the researcher's knowledge, this study is the first to examine the essence of the quality factors of the data warehouse systems success. For this reason, the reader is cautioned that this research has some limitations, they are:

1. As indicated above, this is the first study of its type and additional research is needed to confirm the results.
2. This study uses cross-sectional data, thus studying the relationship between the variables at a given point in time. All the variables are measured based on perceptions of the respondents at the time of responding to the survey. Therefore, causality between the variables cannot be established.
3. The reporting scales used by respondents may very across the respondents. The data may also be subject to personal biases and social-desirability biases in responses. Since all the data used for the study were collected using survey techniques, the 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.
4. The professionals responding to this study were actively involved in data warehouse. The sample is not limited to one industry or specific type of data warehouse. The sample is adequately representative of the population of professionals who are involved in data warehouse projects development. However, the generalization of the results must be done with caution.
5. Another limitation of this study is that, 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. 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.

6.6 Directions for Future Research

This empirical study has several limitations that can be addressed in the future research. Some specific ideas are:

1. This study provided a starting point for a new direction for research on an enduring topic. Data warehouse quality is an ongoing process in industry. It is therefore especially appropriate to examine the impacts of data warehouse quality variables on data warehouse systems success over time. The present study only examined one point in time. Perhaps the effects of data warehouse 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 data warehouse quality on corporate performance.
2. 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.
3. The link between system quality and information quality could be incorporated into the IS/DW success models as well as the link between service quality and relationship quality, and between user quality and business quality. In addition, future research to be conducted to re-validate

the success models in different IS context by including the relationship quality, user quality, and business quality constructs.

4. This study explored only three links (system quality-to-information quality, service quality-to-relationship quality, and user quality-to-business quality) of all of the possible associations among the six quality factors. The present research can be extended to explore other links: for example, (1) the effects of service quality on information quality because empathy can lead to better information content, (2) the impacts of relationship quality on service quality because every effort made by data warehouse team to provide maximum support to data warehouse users could deliver high quality service, and (3) the influences of information quality on business quality.
5. Finally, this study attempts to cover all aspects of overall data warehouse systems success, there may be some other aspects that may have been omitted from the research model or over looked. Any future study, therefore, needs to continuously refine the scale of overall data warehouse success proposed and supported in this study. Also, there is a need to incorporate new aspects of overall data warehouse success such as "work quality" variable into the proposed scale to verify the measure of overall data warehouse success.

6.7 Conclusion

Increased organizational dependence on data warehouse systems drive management attention toward data warehouse success improvement. Previous research indicated that "Improve data warehouse 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 data warehouse system improvement strategies with which scarce resources can be allocated more effectively.

This study found that data warehouse 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. Under system quality there are seven measures such as, easy to use, easy to learn, easy to manage, response time, flexibility, accessible, and integration. Under information quality there are eight measures such as, accuracy, usefulness, relevance, format, adequacy, timeliness,integrity, and security. Under service quality there are six measures such as, reliability, responsiveness, assurance, empathy, customization, and user training. Under relationship quality there are six measures such as, communication, coordination, cooperation, trust, conflict, and commitment. Under user quality there are six measures such as, technical skills, business skills, analytical skills, competence, understand requirements, and determine to use data. At the same time, under business quality there are six measures such as, business strategy, business plan, business needs, business requirements, business scope, and competitive advantage. While under net benefits there are six measures such as, better decisions, time savings, effort savings, improvement of business processes, improvement of planning processes, and improvement of operational control processes.

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 the data warehouse systems success. There are reasons to be positive and continue to pursue the success of data warehouse systems. However, the data warehouses' research community is invited to continue these initial investigations about the success of data warehouse systems. The data warehouse systems likely have value although it could cost more than expected. In addition, data warehouse implementation is risky, but offer great rewards for decision makers.

This research in the data warehouse systems success appears promising. Initial results are encouraging. Studies can now look at the success of data warehouse systems with more ideas to couch their dialogue and decisions. If knowledge is power, then the additional knowledge from this research should provide data warehouse 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 data warehouse systems. Yet, little thought seems to have been given to what the data warehouse success is, what is necessary to achieve the success of data warehouse, and what benefits can be realistically expected.

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

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Appendix 1

The Letter of Invitation

We'd like to invite you to complete the data warehouse system success survey in regards to your experiences. We are very interested in hearing from you. The survey should take no longer than 10 minutes to complete.

Your name will be entered into a drawing for a $100 Amazon gift card. Also, you will receive a copy of the completed research when published.

To participate in this survey, simply click here:
http://dwsurvey.uum.edu.my/

Thank you for your valued participation!

Sincerely,

AlaaEddin
PhD Candidate, University Utara Malaysia

Alaaeddin Almabhouh
Jalan Tanmin Permai 1, 43300, Serdang, Selangor, Malaysia

Appendix 2

The Results of Pilot Test

Information Quality

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.944	.946	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Information Quality 1	38.18	55.483	.700	.813	.943
Information Quality 2	37.68	56.225	.767	.758	.938
Information Quality 3	38.09	51.234	.910	.901	.928
Information Quality 4	38.47	52.923	.843	.824	.933
Information Quality 5	38.91	51.113	.790	.727	.938
Information Quality 6	38.12	54.046	.929	.901	.929
Information Quality 7	38.26	55.594	.712	.817	.942
Information Quality 8	38.24	55.034	.765	.729	.938

System Quality

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.909	.910	7

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
System Quality 1	33.32	32.589	.795	.736	.887
System Quality 2	33.88	33.440	.706	.601	.897
System Quality 3	32.59	34.795	.752	.589	.893
System Quality 4	33.29	34.638	.624	.549	.906
System Quality 5	33.26	33.534	.693	.568	.899
System Quality 6	32.82	33.059	.731	.708	.894
System Quality 7	32.88	32.652	.791	.687	.888

Service Quality

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.943	.944	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Service Quality 1	26.62	31.940	.869	.802	.928
Service Quality 2	26.15	30.190	.936	.972	.919
Service Quality 3	26.15	30.978	.931	.973	.920
Service Quality 4	26.32	33.862	.814	.783	.935
Service Quality 5	26.53	32.075	.820	.713	.934
Service Quality 6	27.06	34.299	.625	.486	.958

Relationship Quality

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.916	.919	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Relationship Quality 1	26.85	29.766	.769	.780	.900
Relationship Quality 2	26.85	31.523	.647	.563	.917
Relationship Quality 3	26.76	31.882	.830	.763	.895
Relationship Quality 4	26.74	29.049	.880	.866	.884
Relationship Quality 5	27.21	31.078	.700	.649	.910
Relationship Quality 6	26.91	29.598	.786	.744	.898

User Quality

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.828	.841	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
User Quality 1	27.62	22.425	.518	.693	.816
User Quality 2	27.59	21.522	.445	.674	.840
User Quality 3	27.62	21.152	.709	.720	.779
User Quality 4	27.76	18.246	.735	.667	.768
User Quality 5	27.32	22.892	.690	.714	.791
User Quality 6	27.53	22.378	.596	.572	.801

Business Quality

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.927	.928	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Business Quality 1	27.41	29.886	.864	.763	.903
Business Quality 2	27.50	31.045	.863	.771	.903
Business Quality 3	27.62	34.243	.712	.621	.923
Business Quality 4	27.00	31.152	.823	.704	.908
Business Quality 5	27.56	34.921	.755	.633	.919
Business Quality 6	27.32	31.377	.737	.567	.922

Net Benefits

Reliability Statistics

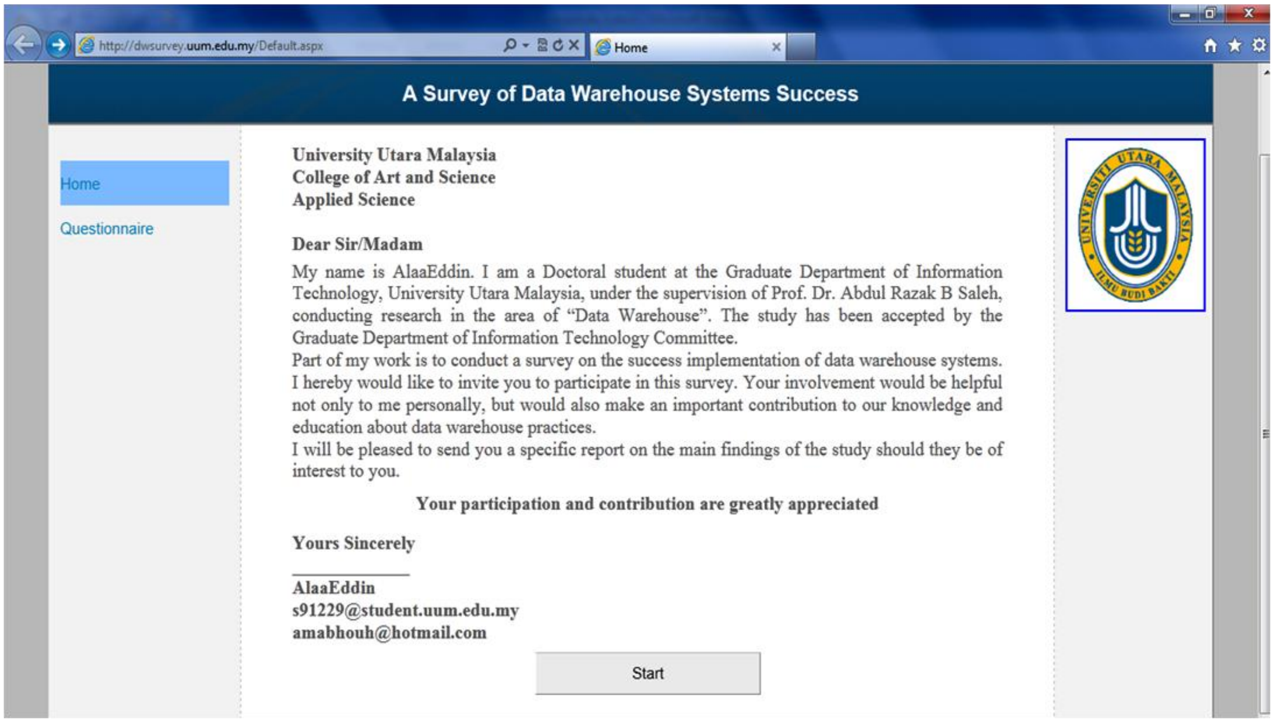
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.936	.937	6

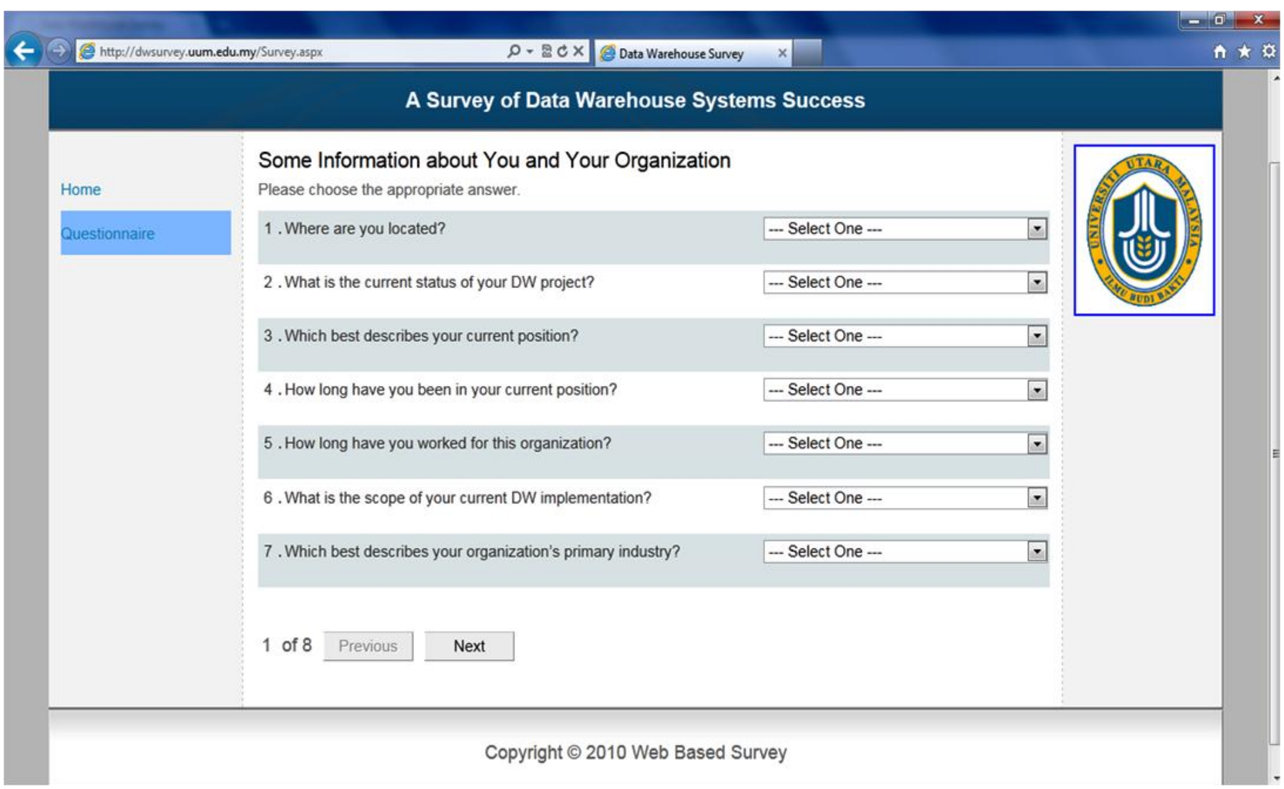
Item-Total Statistics

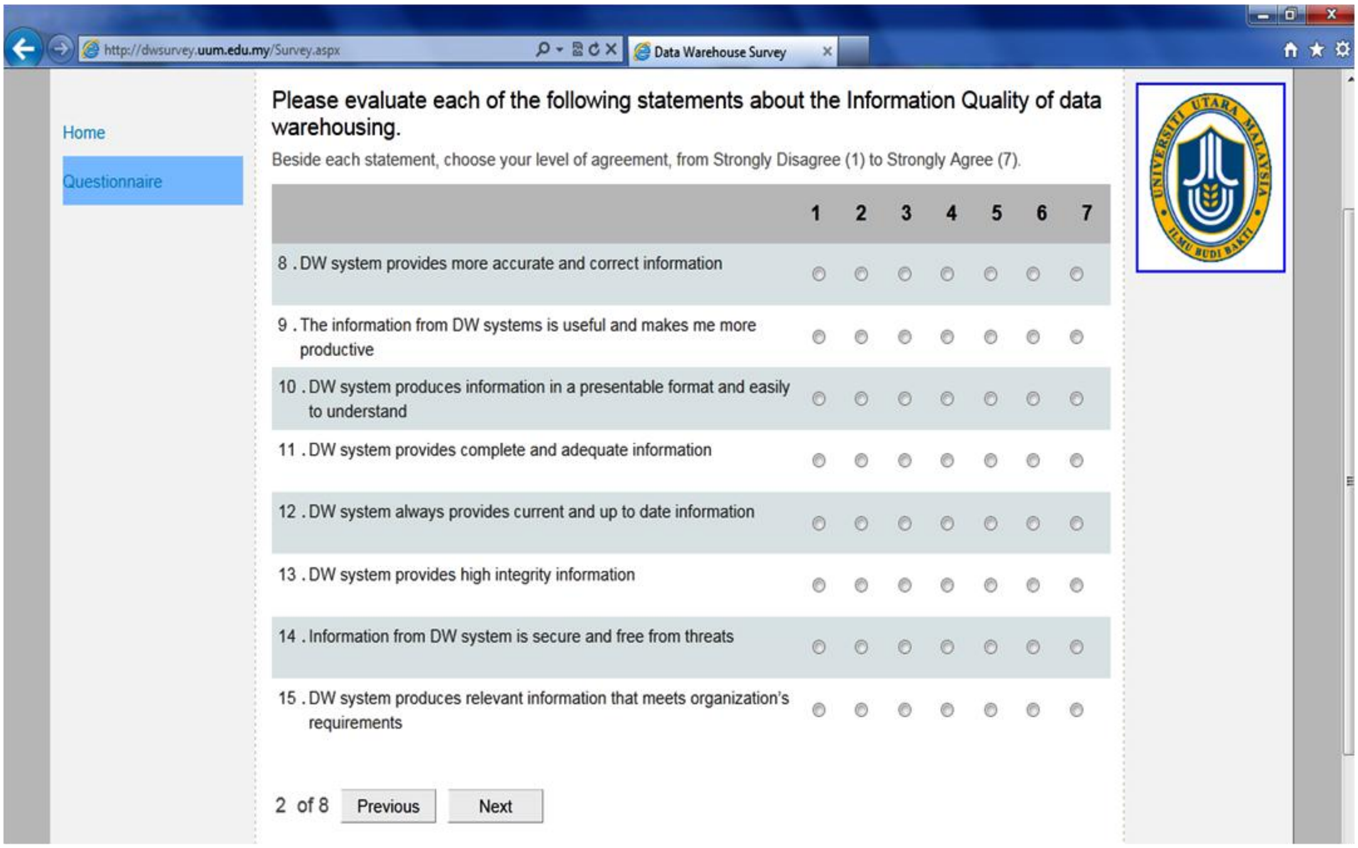
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Net Benefits 1	28.59	26.674	.871	.760	.916
Net Benefits 2	28.53	28.257	.858	.788	.918
Net Benefits 3	28.50	29.470	.797	.770	.926
Net Benefits 4	28.50	29.227	.843	.786	.921
Net Benefits 5	28.47	30.439	.759	.718	.930
Net Benefits 6	28.74	28.140	.754	.617	.933

Appendix 3

Web Based Questionnaire







http://dwsurvey.uum.edu.my/Survey.aspx — Data Warehouse Survey

Home

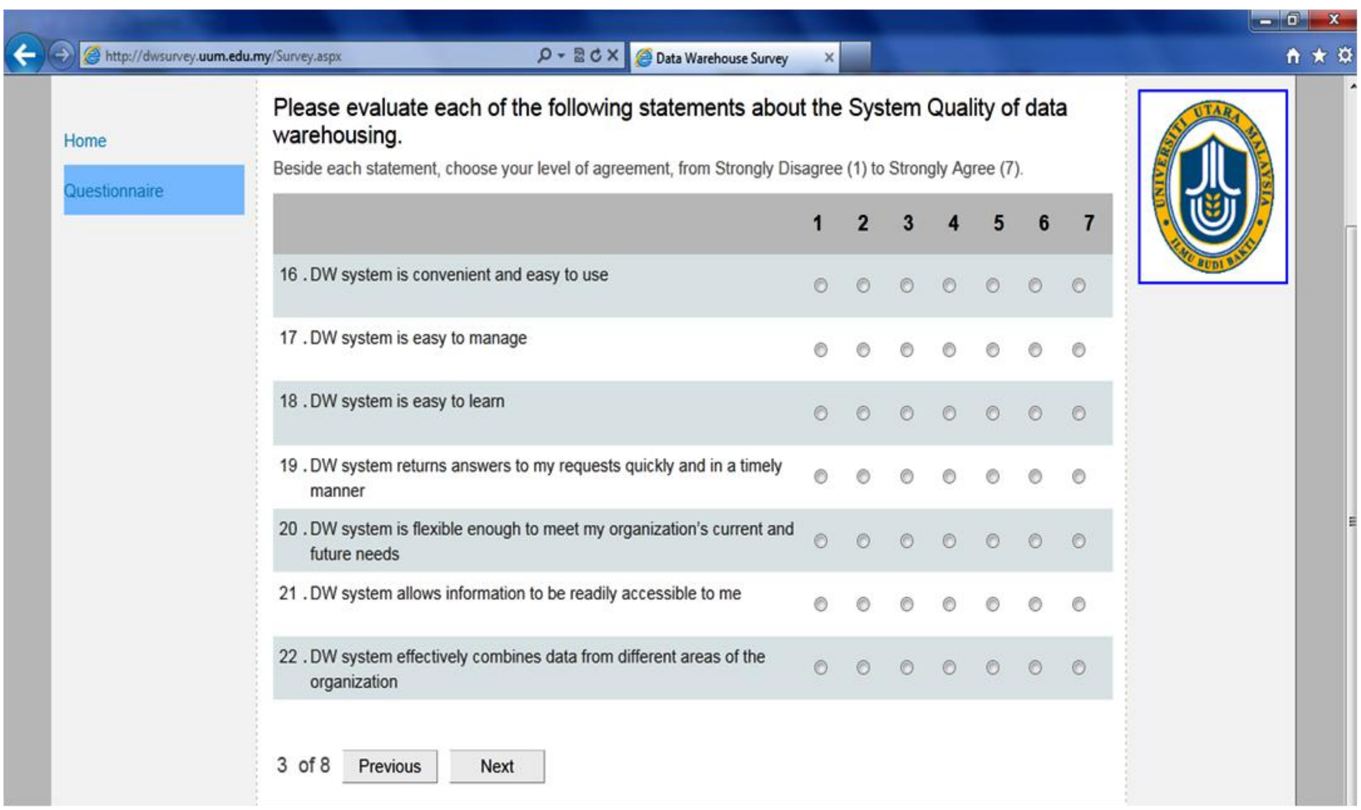
Questionnaire

Please evaluate each of the following statements about the Information Quality of data warehousing.

Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).

	1	2	3	4	5	6	7
8 . DW system provides more accurate and correct information	○	○	○	○	○	○	○
9 . The information from DW systems is useful and makes me more productive	○	○	○	○	○	○	○
10 . DW system produces information in a presentable format and easily to understand	○	○	○	○	○	○	○
11 . DW system provides complete and adequate information	○	○	○	○	○	○	○
12 . DW system always provides current and up to date information	○	○	○	○	○	○	○
13 . DW system provides high integrity information	○	○	○	○	○	○	○
14 . Information from DW system is secure and free from threats	○	○	○	○	○	○	○
15 . DW system produces relevant information that meets organization's requirements	○	○	○	○	○	○	○

2 of 8 Previous Next



http://dwsurvey.uum.edu.my/Survey.aspx — Data Warehouse Survey

Home

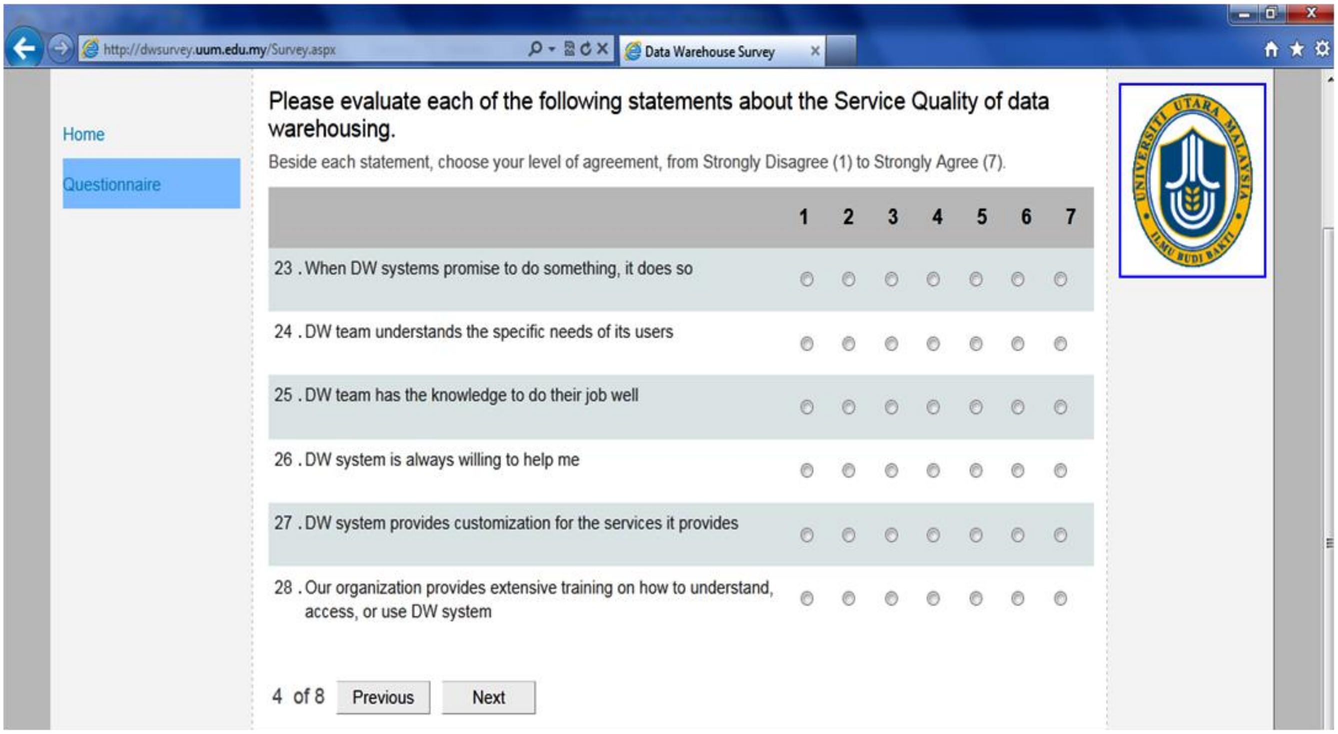
Questionnaire

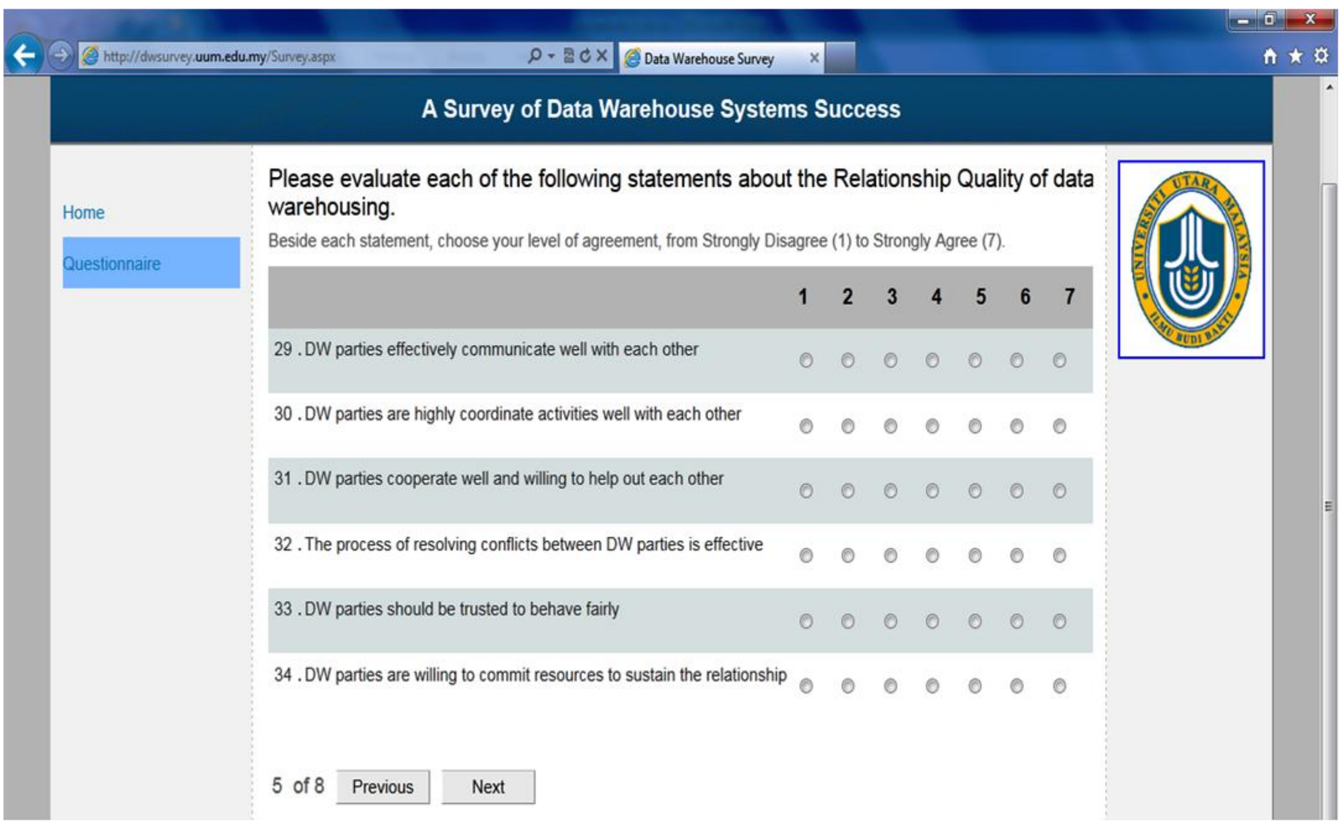
Please evaluate each of the following statements about the System Quality of data warehousing.

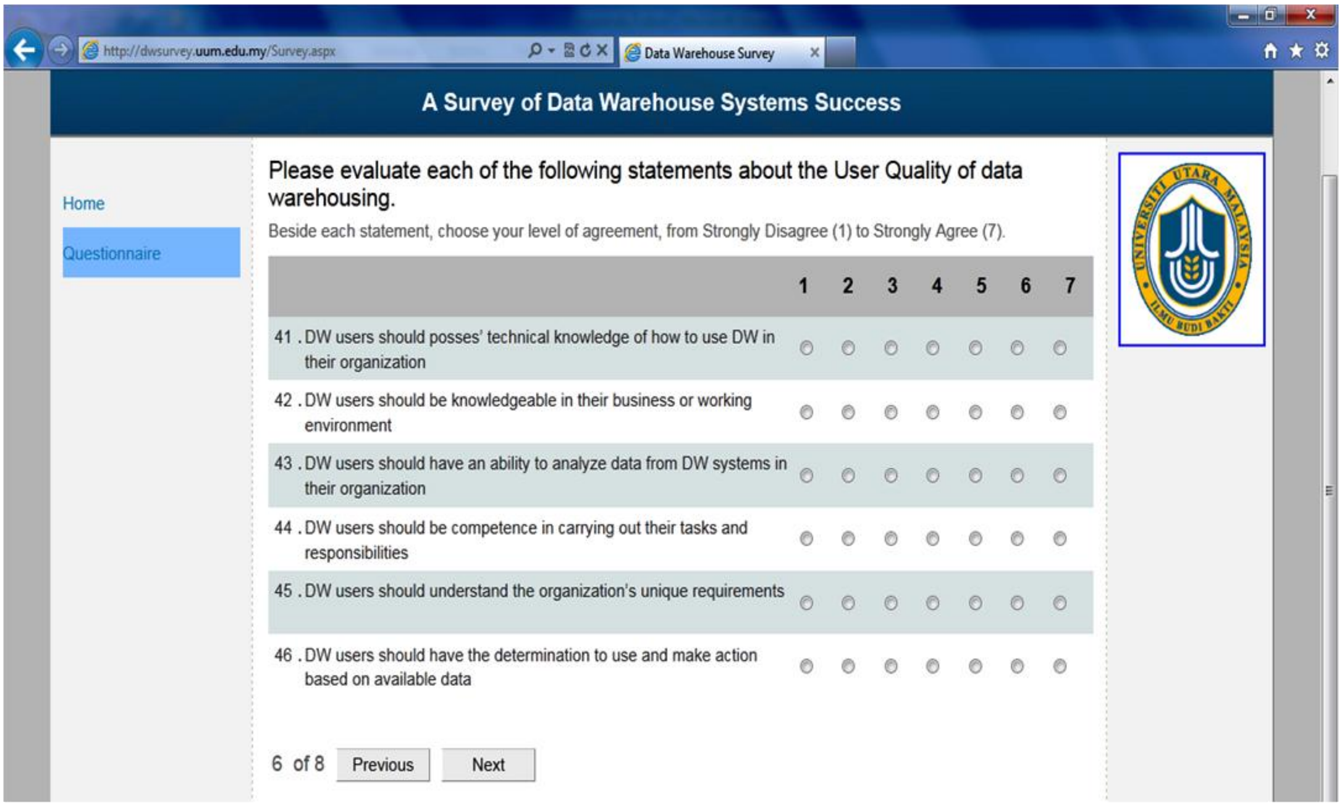
Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).

	1	2	3	4	5	6	7
16 . DW system is convenient and easy to use	○	○	○	○	○	○	○
17 . DW system is easy to manage	○	○	○	○	○	○	○
18 . DW system is easy to learn	○	○	○	○	○	○	○
19 . DW system returns answers to my requests quickly and in a timely manner	○	○	○	○	○	○	○
20 . DW system is flexible enough to meet my organization's current and future needs	○	○	○	○	○	○	○
21 . DW system allows information to be readily accessible to me	○	○	○	○	○	○	○
22 . DW system effectively combines data from different areas of the organization	○	○	○	○	○	○	○

3 of 8 Previous Next


http://dwsurvey.uum.edu.my/Survey.aspx
Data Warehouse Survey
Home
Questionnaire
Please evaluate each of the following statements about the Service Quality of data warehousing.
Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).
1 2 3 4 5 6 7
23 . When DW systems promise to do something, it does so
24 . DW team understands the specific needs of its users
25 . DW team has the knowledge to do their job well
26 . DW system is always willing to help me
27 . DW system provides customization for the services it provides
28 . Our organization provides extensive training on how to understand, access, or use DW system
4 of 8
Previous
Next


http://dwsurvey.uum.edu.my/Survey.aspx
Data Warehouse Survey
A Survey of Data Warehouse Systems Success
Home
Questionnaire
Please evaluate each of the following statements about the Relationship Quality of data warehousing.
Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).
1 2 3 4 5 6 7
29 . DW parties effectively communicate well with each other
30 . DW parties are highly coordinate activities well with each other
31 . DW parties cooperate well and willing to help out each other
32 . The process of resolving conflicts between DW parties is effective
33 . DW parties should be trusted to behave fairly
34 . DW parties are willing to commit resources to sustain the relationship
5 of 8
Previous
Next



http://dwsurvey.uum.edu.my/Survey.aspx — Data Warehouse Survey

A Survey of Data Warehouse Systems Success

Home

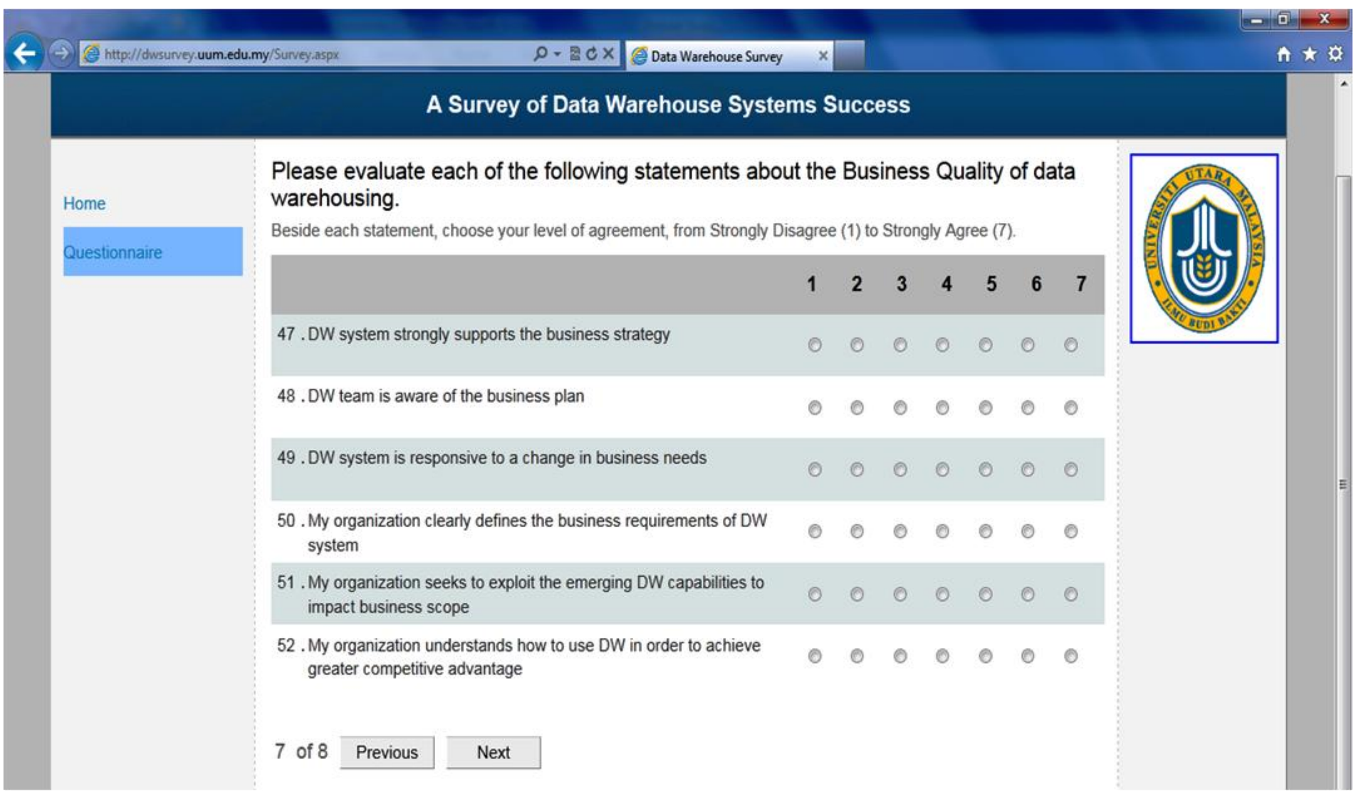
Questionnaire

Please evaluate each of the following statements about the User Quality of data warehousing.

Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).

	1	2	3	4	5	6	7
41 . DW users should posses' technical knowledge of how to use DW in their organization	○	○	○	○	○	○	○
42 . DW users should be knowledgeable in their business or working environment	○	○	○	○	○	○	○
43 . DW users should have an ability to analyze data from DW systems in their organization	○	○	○	○	○	○	○
44 . DW users should be competence in carrying out their tasks and responsibilities	○	○	○	○	○	○	○
45 . DW users should understand the organization's unique requirements	○	○	○	○	○	○	○
46 . DW users should have the determination to use and make action based on available data	○	○	○	○	○	○	○

6 of 8 Previous Next



http://dwsurvey.uum.edu.my/Survey.aspx — Data Warehouse Survey

A Survey of Data Warehouse Systems Success

Home

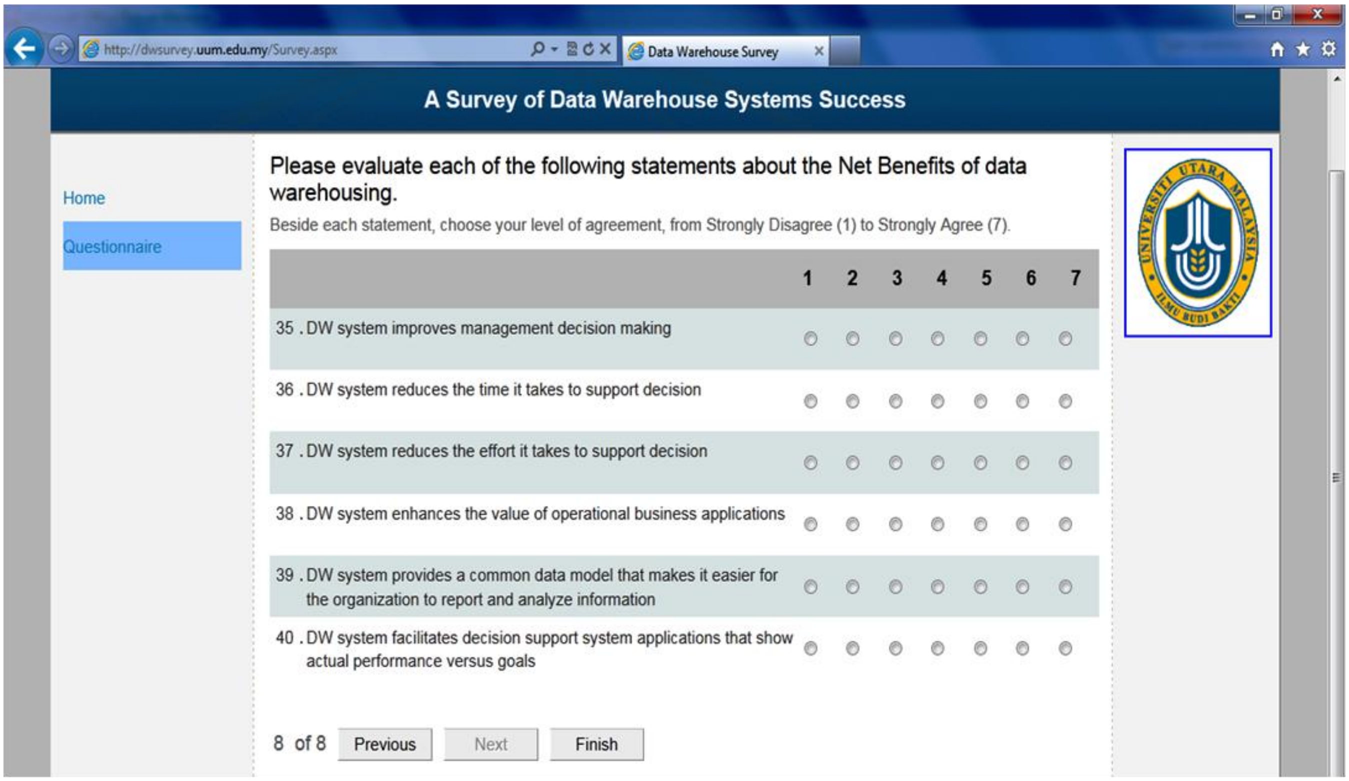
Questionnaire

Please evaluate each of the following statements about the Business Quality of data warehousing.

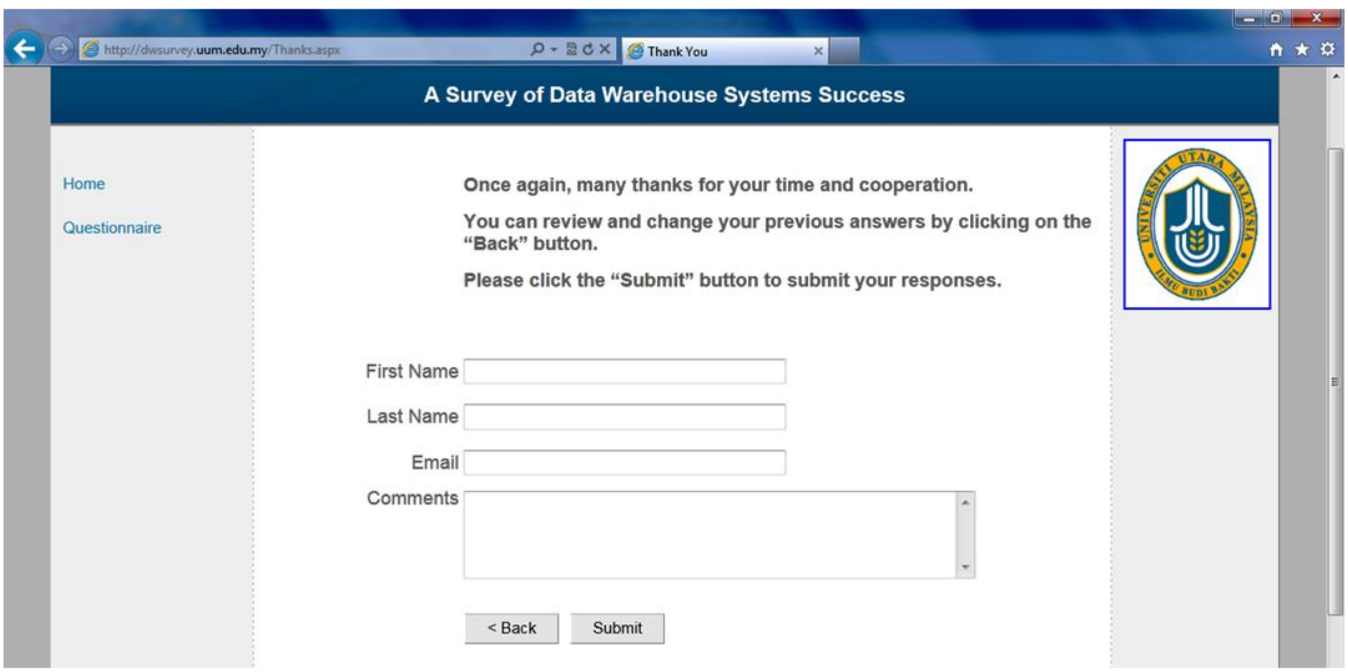
Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).

	1	2	3	4	5	6	7
47 . DW system strongly supports the business strategy	○	○	○	○	○	○	○
48 . DW team is aware of the business plan	○	○	○	○	○	○	○
49 . DW system is responsive to a change in business needs	○	○	○	○	○	○	○
50 . My organization clearly defines the business requirements of DW system	○	○	○	○	○	○	○
51 . My organization seeks to exploit the emerging DW capabilities to impact business scope	○	○	○	○	○	○	○
52 . My organization understands how to use DW in order to achieve greater competitive advantage	○	○	○	○	○	○	○

7 of 8 Previous Next



http://dwsurvey.uum.edu.my/Survey.aspx
Data Warehouse Survey
A Survey of Data Warehouse Systems Success
Home
Questionnaire
Please evaluate each of the following statements about the Net Benefits of data warehousing.
Beside each statement, choose your level of agreement, from Strongly Disagree (1) to Strongly Agree (7).
1 2 3 4 5 6 7
35 . DW system improves management decision making
36 . DW system reduces the time it takes to support decision
37 . DW system reduces the effort it takes to support decision
38 . DW system enhances the value of operational business applications
39 . DW system provides a common data model that makes it easier for the organization to report and analyze information
40 . DW system facilitates decision support system applications that show actual performance versus goals
8 of 8
Previous
Next
Finish



http://dwsurvey.uum.edu.my/Thanks.aspx
Thank You
A Survey of Data Warehouse Systems Success
Home
Questionnaire
Once again, many thanks for your time and cooperation.
You can review and change your previous answers by clicking on the "Back" button.
Please click the "Submit" button to submit your responses.
First Name
Last Name
Email
Comments
< Back
Submit

Appendix 4

Rental Agreement for TDWI Email List

1105 MEDIA INC

E-MAIL LIST RENTAL AGREEMENT

1. The E-mail list rental agreement is entered into as of the date specified below by and between 1105 Media, Inc. (List Owner) through Merit Direct (List Manager) and the List Renter named below.
2. The following terms and conditions apply to every e-mail list rental order placed on List Owner's lists by the List Renter. The Agreement covers a twelve-month period from the date signed.
3. List Renter agrees that this Agreement grants one-time, non-transferable use of the list for a broadcast of specifically and expressly pre-approved e-mail content.
4. List Renter agrees that the e-mail message will be deployed by the List Owner or its agent. List Owner will not release the e-mail list to the List Renter or Broker/Agency.
5. List Renter acknowledges that at all times the list remains the sole property of List Owner.
6. List Renter shall be solely responsible for providing e-mail content to be sent to this list, and therefore, shall be solely responsible for the content contained therein. List Renter is solely responsible for the content of its message, and hereby represents that its proposed message does not contain any of the following: (a) any unlawful, threatening, abusive, libelous, defamatory, obscene, pornographic, profane, or otherwise objectionable information, including without limitation any transmission constituting or encouraging conduct that would constitute a criminal offense, give rise to civil liability, or otherwise violate any local, state, federal, provincial or international law; (b) any misleading or deceptive information, or any misrepresentation with respect to products or services offered by List Renter; (c) any chain letters, illegal pyramid, or such schemes; (d) any information, audio, graphics, software, or other works in violation of any person's copyright, trademark or any other intellectual property rights; (e) any deceptive information which would imply endorsement, affiliation, or sponsorship with any entity or person other that List Renter without written consent of such entity/person; (f) any virus, worm, time bomb, or similar contaminating/destructive element; and (g) any data gathering or depositing device, including but not limited to cookies. List Owner reserves the right to refuse to transmit any message not in accordance with the representations contained in this paragraph.
7. Although List Owner uses reasonable efforts to ensure accuracy of the list, List Owner does not represent or warrant that the information contained in the list is complete or free from error. List Owner is broadcasting to the list "as is", with any and all defects, errors and deficiencies. List Renter agrees to indemnify and hold harmless List Owner from any and all claims, damages, losses or expenses, however incurred, occasioned by the use of the list(s). List Renter understands and agrees that List Owner makes no representations or warranties with respect to the list. List Owner understands that response rates are not guaranteed.
8. List Renter agrees to supply the List Owner with specific information, so as to comply with the 'Can Spam Act".
   a. The physical address of the List Renter must be included in the content of the e-mail provided. Street addresses are required, P.O. Boxes are not acceptable.
   b. A clear and conspicuous subject line. The subject line may not be misleading in any way.
   c. A specific Email address or URL (website address) where List Renter's remove requests can be processed. The List renter is fully responsible for insuring that this opt-out mechanism is functional at the time of and following the transmission. The List renter is also responsible for applying collected opt-outs to all of their future broadcasts within 10 days of receipt.
   d. A suppression file containing e-mail addresses of all persons who have previously opted-ed out of receiving e-mail messages from List Renter. List Renter understands that they are responsible for honoring opt-outs within 10 days of receipt and will supply all addresses necessary to comply. It is understood that additional fees may be charged for applying such suppression files.

9. List Renter understands that List Owner will add an e-mail header and footer to each e-mail message that is deployed.

10. List Renter agrees to make full payment to List Manager for List Rental within thirty days from mail date. List Owner will hold responsible for payment whatever party, whether broker, agency or direct account that has signed the contract.

11. In the event the List Renter uses the list contrary to the provisions of this Agreement, the List Renter shall be held unconditionally responsible. Therefore, any and all costs/expenses incurred by List Owner in enforcing this Agreement, including attorney's fees, will be the List Renter's responsibility.

12. List Renter will be liable to List Owner for any loss, expense or damages (including attorney fee and legal costs) incurred by List Owner as a result of any breach by the List Renter.

13. Orders must be cancelled in writing prior to stated transmission date. Orders cancelled prior to the stated mail date but after the testing process will incur a $500 cancellation fee plus any incurred test fees. Cancellations after the names have been pulled will incur full payment charges.

14. List Renter agrees to reciprocal rental if the List Renter has a list on the market. By signing this list rental agreement, the List Renter agrees to this reciprocity.

LIST RENTER'S AUTHORIZATION FOR COMPLETION OF ORDER:
List Renter acknowledges reading this Agreement, understanding it, and agreeing to be bound by its terms and conditions. List Renter further agrees that it is the complete and exclusive statement of the Agreement between List Renter and List Owner which supersedes any proposal or prior agreement, oral or written, and any communications between List Renter and List Owner relating to the subject matter of this Agreement.

List Renter Company Name University Utara Malaysia (UUM)

Authorized Representative Name (please print) AlaaEddin

Address, City, State, Zip B-11-01, Juta Mines Condo, JLN Tanmin Permai1

Phone 006-0174463240 Fax ____ E-mail AlaaEddin@ucti.edu.my

Signature ____ Date 12/7/2010

This form must be completed and returned prior to list shipment. Please fax form to:

Dana LaMance
Merit Direct
Fax: 914-368-1147

Suppression File Waiver

Mailer/Advertiser AlaaEddin (herein referred to as 'Mailer')

List Manager Elizabeth Jackson

List TDWI - The Data Warehousing Institute Email List Email List

Order Number 3000

Date 12/7/2010

Email Delivery Service: 1105 Media

It is understood that, as an authorized representative of the Mailer, I am aware of the requirements of the "Can Spam Act of 2003," which states that all Mailers must keep, maintain and provide a suppression file for every third party email campaign.

I can attest to the fact that, as of the date stated above, the Mailer does not currently maintain an email suppression file, or any other email suppression records in any format. Therefore, we cannot provide these records to 1105 Media at this time to apply to this third party mailing.

Please proceed with the third party mailing accordingly.

Mailer's Authorized Representative:

Signed

Print Name AlaaEddin

Title PhD Student

Date 12/7/2010

Appendix 5

Frequency Table for Respondents Profile

Business Location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	USA	82	33.6	33.6	33.6
	Canada	66	27.0	27.0	60.7
	Europe	35	14.3	14.3	75.0
	Australia	30	12.3	12.3	87.3
	Asia	14	5.7	5.7	93.0
	Africa	5	2.0	2.0	95.1
	Central or South America	5	2.0	2.0	97.1
	Middle East	7	2.9	2.9	100.0
	Total	244	100.0	100.0	

The Current Status of Data Warehouse Project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Live	125	51.2	51.2	51.2
	In development	74	30.3	30.3	81.6
	Planned	42	17.2	17.2	98.8
	Don't know	3	1.2	1.2	100.0
	Total	244	100.0	100.0	

Current Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	DW Business Analyst	31	12.7	12.7	12.7
	DW Manager	26	10.7	10.7	23.4
	DW User	28	11.5	11.5	34.8
	DW DBA	28	11.5	11.5	46.3
	DW Specialist (architect/engineer/developer)	41	16.8	16.8	63.1
	IT Manager	36	14.8	14.8	77.9
	IT Specialist/Staff	41	16.8	16.8	94.7
	Other	13	5.3	5.3	100.0
	Total	244	100.0	100.0	

Period in Current Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	52	21.3	21.3	21.3
	1 to 3 years	68	27.9	27.9	49.2
	3 to 6 years	65	26.6	26.6	75.8
	More than 6 years	59	24.2	24.2	100.0
	Total	244	100.0	100.0	

Period in Current Organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2 years	56	23.0	23.0	23.0
	2 to 5 years	62	25.4	25.4	48.4
	5 to 10 years	62	25.4	25.4	73.8
	More than 10 years	64	26.2	26.2	100.0
	Total	244	100.0	100.0	

Scope of Data Warehouse Implementation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enterprise-wide	123	50.4	50.4	50.4
	Departmental in one or more multiple locations	60	24.6	24.6	75.0
	Pilot only in a single department or location	56	23.0	23.0	98.0
	Don't know	5	2.0	2.0	100.0
	Total	244	100.0	100.0	

Organization's Industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agriculture	2	.8	.8	.8
	Chemical/petroleum	8	3.3	3.3	4.1
	Consulting/professional services	17	7.0	7.0	11.1
	Financial services	34	13.9	13.9	25.0
	Government: Federal	21	8.6	8.6	33.6
	Healthcare	22	9.0	9.0	42.6
	Insurance	11	4.5	4.5	47.1
	Manufacturing (non-computers)	13	5.3	5.3	52.5
	Media	7	2.9	2.9	55.3
	Real Estate	5	2.0	2.0	57.4
	Software/Internet	13	5.3	5.3	62.7
	Transportation/Logistics	4	1.6	1.6	64.3
	Advertising/Marketing/PR	2	.8	.8	65.2
	Computer Manufacturing	12	4.9	4.9	70.1
	Construction/architecture/engineering	5	2.0	2.0	72.1
	Education	16	6.6	6.6	78.7
	Government: State/local	4	1.6	1.6	80.3
	Hospitality/travel	7	2.9	2.9	83.2
	Pharmaceuticals	5	2.0	2.0	85.2
	Non-profit/Trade association	7	2.9	2.9	88.1
	Retail/Wholesale/Distribution	8	3.3	3.3	91.4
	Telecommunications	10	4.1	4.1	95.5
	Utilities	8	3.3	3.3	98.8
	Other	3	1.2	1.2	100.0

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agriculture	2	.8	.8	.8
	Chemical/petroleum	8	3.3	3.3	4.1
	Consulting/professional services	17	7.0	7.0	11.1
	Financial services	34	13.9	13.9	25.0
	Government: Federal	21	8.6	8.6	33.6
	Healthcare	22	9.0	9.0	42.6
	Insurance	11	4.5	4.5	47.1
	Manufacturing (non-computers)	13	5.3	5.3	52.5
	Media	7	2.9	2.9	55.3
	Real Estate	5	2.0	2.0	57.4
	Software/Internet	13	5.3	5.3	62.7
	Transportation/Logistics	4	1.6	1.6	64.3
	Advertising/Marketing/PR	2	.8	.8	65.2
	Computer Manufacturing	12	4.9	4.9	70.1
	Construction/architecture/engineering	5	2.0	2.0	72.1
	Education	16	6.6	6.6	78.7
	Government: State/local	4	1.6	1.6	80.3
	Hospitality/travel	7	2.9	2.9	83.2
	Pharmaceuticals	5	2.0	2.0	85.2
	Non-profit/Trade association	7	2.9	2.9	88.1
	Retail/Wholesale/Distribution	8	3.3	3.3	91.4
	Telecommunications	10	4.1	4.1	95.5
	Utilities	8	3.3	3.3	98.8
	Other	3	1.2	1.2	100.0
	Total	244	100.0	100.0	

Appendix 6

Factor Analysis Steps

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of SamplingAdequacy.		.940
Bartlett's Test of Sphericity	Approx. Chi-Square df	6457.865 703
	Sig.	.000

Communalities

	Initial	Extraction
Information Quality 1	1.000	.728
Information Quality 2	1.000	.744
Information Quality 3	1.000	.701
Information Quality 4	1.000	.739
Information Quality 5	1.000	.734
Information Quality 6	1.000	.733
System Quality 1	1.000	.692
System Quality 2	1.000	.647
System Quality 3	1.000	.669
System Quality 4	1.000	.685
System Quality 5	1.000	.709
System Quality 6	1.000	.716
System Quality 7	1.000	.725
Service Quality 1	1.000	.699
Service Quality 2	1.000	.804
Service Quality 3	1.000	.781
Service Quality 4	1.000	.720
Service Quality 5	1.000	.699
Service Quality 6	1.000	.650
Relationship Quality 1	1.000	.639
Relationship Quality 2	1.000	.674
Relationship Quality 3	1.000	.645
Relationship Quality 4	1.000	.629
Relationship Quality 5	1.000	.627
Relationship Quality 6	1.000	.664

User Quality 3	1.000	.789
User Quality 4	1.000	.776
Business Quality 1	1.000	.689
Business Quality 3	1.000	.661
Business Quality 4	1.000	.678
Business Quality 5	1.000	.713
Business Quality 6	1.000	.650
Net Benefits 1	1.000	.699
Net Benefits 2	1.000	.617
Net Benefits 3	1.000	.734
Net Benefits 4	1.000	.705
Net Benefits 5	1.000	.655
Net Benefits 6	1.000	.568

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	15.208	40.021	40.021
2	3.050	8.027	48.048
3	2.871	7.555	55.602
4	1.722	4.532	60.134
5	1.455	3.828	63.962
6	1.077	2.835	66.797
7	1.003	2.639	69.436
8	.793	2.088	71.524
9	.716	1.884	73.409
10	.662	1.741	75.150
11	.640	1.683	76.833
12	.595	1.565	78.398
13	.573	1.507	79.905
14	.552	1.454	81.358
15	.531	1.398	82.756
16	.506	1.331	84.087
17	.457	1.202	85.290
18	.419	1.103	86.392
19	.378	.994	87.387
20	.358	.942	88.329
21	.355	.933	89.262
22	.351	.923	90.185
23	.342	.900	91.085

24	.315	.828	91.913
25	.313	.823	92.736
26	.297	.782	93.518
27	.285	.751	94.269
28	.259	.681	94.950
29	.248	.652	95.602
30	.226	.595	96.197
31	.223	.588	96.785
32	.210	.554	97.339
33	.197	.519	97.858
34	.186	.490	98.348
35	.175	.459	98.807
36	.164	.431	99.238
37	.153	.402	99.640
38	.137	.360	100.000

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.208	40.021	40.021	4.678	12.311	12.311
2	3.050	8.027	48.048	4.465	11.749	24.060
3	2.871	7.555	55.602	4.278	11.257	35.317
4	1.722	4.532	60.134	4.069	10.708	46.025
5	1.455	3.828	63.962	3.657	9.623	55.647
6	1.077	2.835	66.797	3.615	9.513	65.160
7	1.003	2.639	69.436	1.625	4.277	69.436
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Information Quality 1	.611						
Information Quality 2	.637						
Information Quality 3	.607						
Information Quality 4	.592						
Information Quality 5	.498		-.483				
Information Quality 6	.624						
System Quality 1	.685						

System Quality 2	.636						
System Quality 3	.699						
System Quality 4	.635						
System Quality 5	.676						
System Quality 6	.718						
System Quality 7	.686						
Service Quality 1	.708						
Service Quality 2	.739						
Service Quality 3	.745						
Service Quality 4	.727						
Service Quality 5	.676						
Service Quality 6	.680						
Relationship Quality 1	.649						
Relationship Quality 2	.574						
Relationship Quality 3	.653						
Relationship Quality 4	.669						
Relationship Quality 5	.620						
Relationship Quality 6	.714						
User Quality 3	.513						
User Quality 4	.474						
Business Quality 1	.575		.570				
Business Quality 3	.449		.553				
Business Quality 4	.582		.534				
Business Quality 5	.446		.553				
Business Quality 6	.464		.535				
Net Benefits 1	.675						
Net Benefits 2	.663						
Net Benefits 3	.670						
Net Benefits 4	.656						
Net Benefits 5	.605						
Net Benefits 6	.617						

Extraction Method: Principal Component Analysis.

7 components extracted.

Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
Information Quality 1		.755					
Information Quality 2		.746					
Information Quality 3		.756					
Information Quality 4		.799					
Information Quality 5		.802					
Information Quality 6		.771					
System Quality 1	.704						
System Quality 2	.696						
System Quality 3	.645						
System Quality 4	.746						
System Quality 5	.754						
System Quality 6	.689						
System Quality 7	.736						
Service Quality 1			.707				
Service Quality 2			.776				
Service Quality 3			.743				
Service Quality 4			.683				
Service Quality 5			.705				
Service Quality 6			.630				
Relationship Quality 1						.625	
Relationship Quality 2						.754	
Relationship Quality 3						.644	
Relationship Quality 4						.622	
Relationship Quality 5						.602	
Relationship Quality 6						.615	
User Quality 3							.727
User Quality 4							.771
Business Quality 1					.676		
Business Quality 3					.753		
Business Quality 4					.710		

Business Quality 5					.820		
Business Quality 6					.754		
Net Benefits 1				.631			
Net Benefits 2				.631			
Net Benefits 3				.750			
Net Benefits 4				.734			
Net Benefits 5				.719			
Net Benefits 6				.626			

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 7 iterations.

Component Transformation Matrix

Component	1	2	3	4	5	6	7
1	.455	.391	.439	.415	.315	.389	.157
2	.425	.499	-.378	-.370	.253	-.448	.163
3	-.004	-.570	-.150	.006	.755	.014	.287
4	-.637	.457	-.387	.414	.216	.057	.121
5	-.404	.234	.417	-.681	.180	.264	.205
6	.123	.056	-.374	-.214	.215	.548	-.670
7	.171	-.075	-.422	-.101	-.377	.524	.600

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Appendix 7

Pearson's Correlations of Constructs

Correlations[a]

		InfoQ	SysQ	ServQ	RelQ	UserQ	BusQ	NetB
InfoQ	Pearson Correlation	1						
	Sig. (2-tailed)							
SysQ	Pearson Correlation	.598**	1					
	Sig. (2-tailed)	.000						
ServQ	Pearson Correlation	.492**	.602**	1				
	Sig. (2-tailed)	.000	.000					
RelQ	Pearson Correlation	.439**	.522**	.732**	1			
	Sig. (2-tailed)	.000	.000	.000				
UserQ	Pearson Correlation	.316**	.441**	.351**	.366**	1		
	Sig. (2-tailed)	.000	.000	.000	.000			
BusQ	Pearson Correlation	.303**	.523**	.377**	.432**	.608**	1	
	Sig. (2-tailed)	.000	.000	.000	.000	.000		
NetB	Pearson Correlation	.455**	.532**	.650**	.698**	.342**	.444**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

a. Listwise N=244

Appendix 8

Multiple Regressions

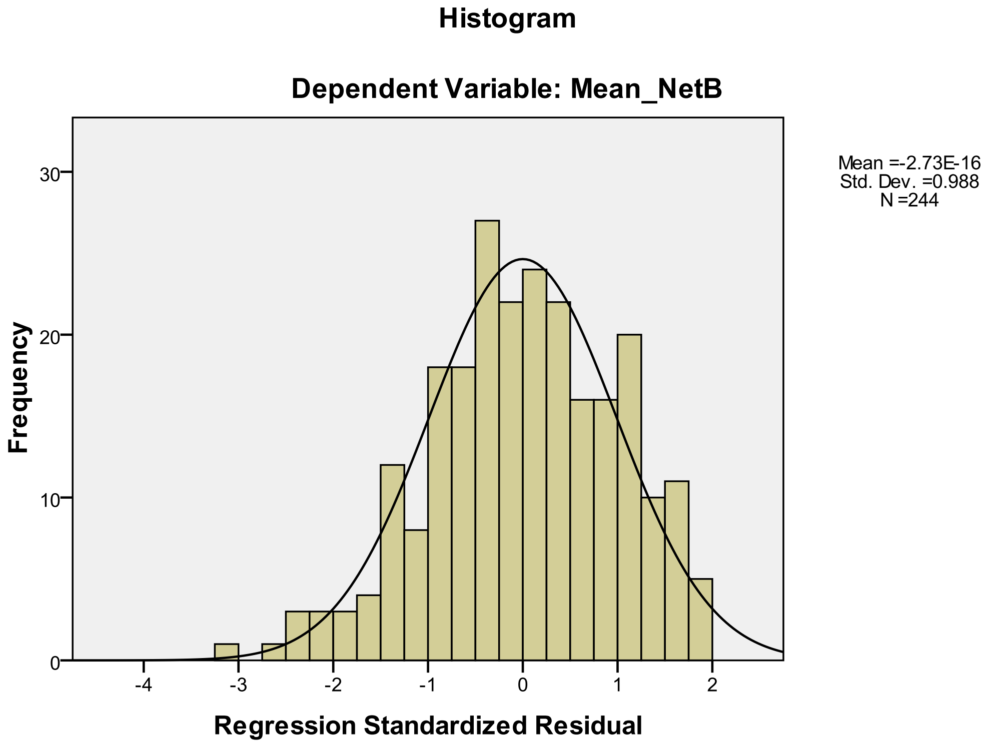
Quality Factors → Net Benefits

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.749[a]	.561	.549	.66487

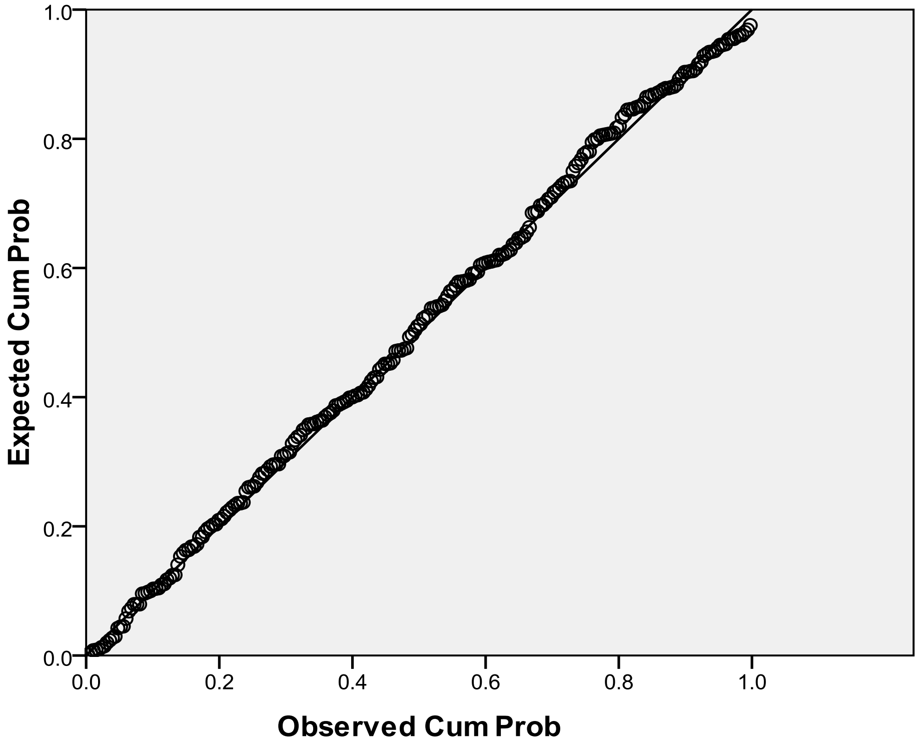
a. Predictors: (Constant), Mean_BusQ, Mean_InfoQ, Mean_RelQ, Mean_UsrQ, Mean_SysQ, Mean_SrvQ

b. Dependent Variable: Mean_NetB



Normal P-P Plot of Regression Standardized Residual

Dependent Variable: Mean_NetB



System Quality → Information Quality

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.598[a]	.357	.355	.73580

a. Predictors: (Constant), Mean_InfoQ

b. Dependent Variable: Mean_SysQ

Coefficients[a]

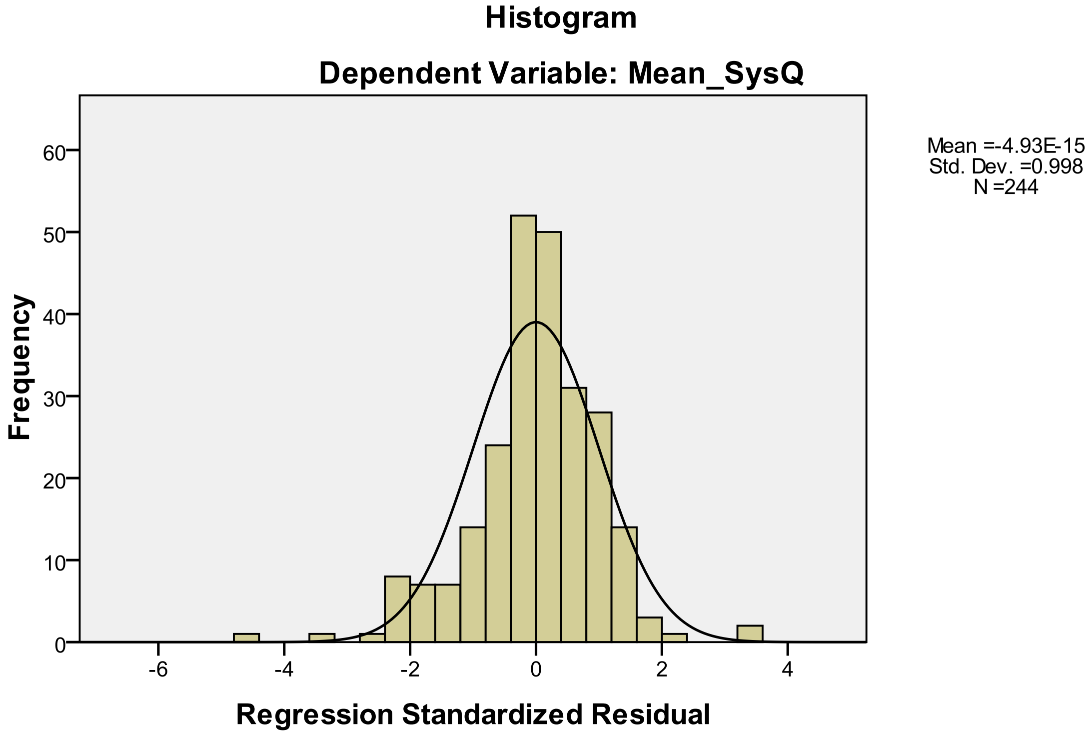
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.522	.242		10.402	.000
	Mean_InfoQ	.532	.046	.598	11.599	.000

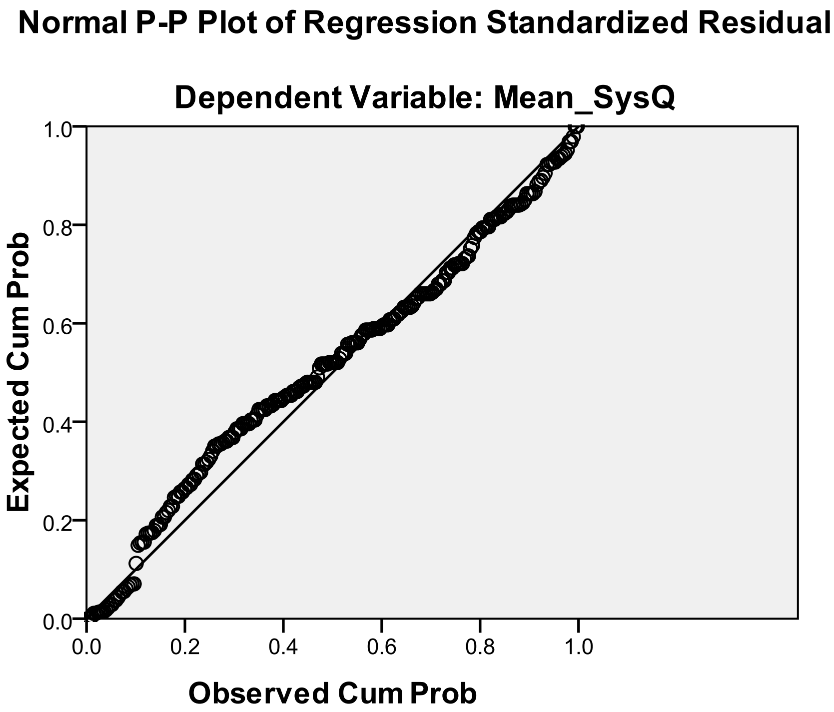
Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.598[a]	.357	.355	.73580

a. Predictors: (Constant), Mean_InfoQ

a. Dependent Variable: Mean_SysQ





Service Quality → Relationship Quality

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.732[a]	.536	.534	.67588

a. Predictors: (Constant), Mean_RelQ

b. Dependent Variable: Mean_SrvQ

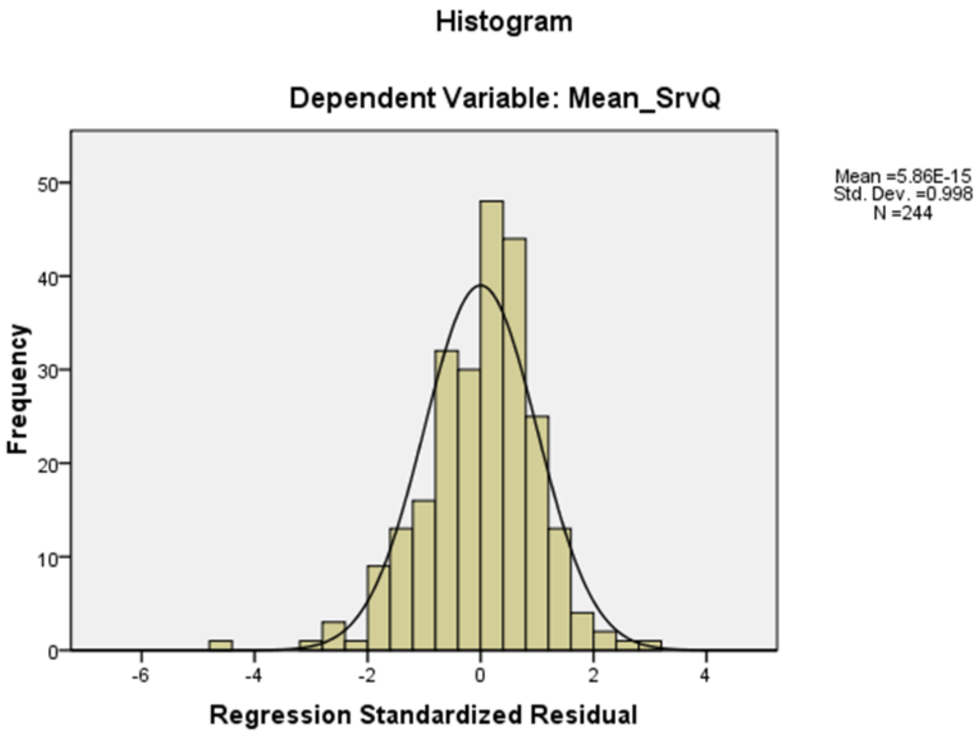
Coefficients[a]

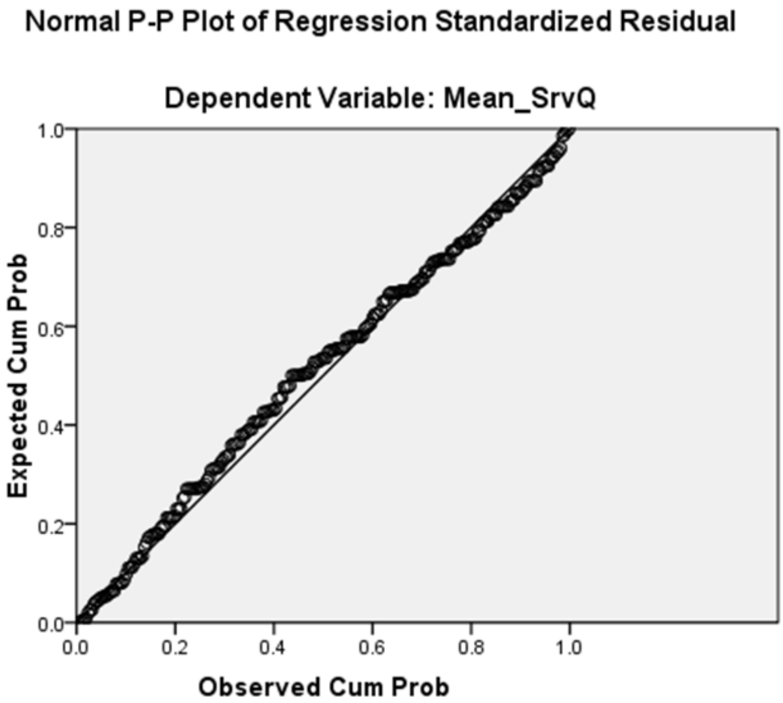
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.148	.245		4.678	.000
	Mean_RelQ	.760	.045	.732	16.718	.000

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.148	.245		4.678	.000
	Mean_RelQ	.760	.045	.732	16.718	.000

a. Dependent Variable: Mean_SrvQ





User Quality → Business Quality

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.608[a]	.370	.368	.85246

a. Predictors: (Constant), Mean_BusQ

b. Dependent Variable: Mean_UsrQ

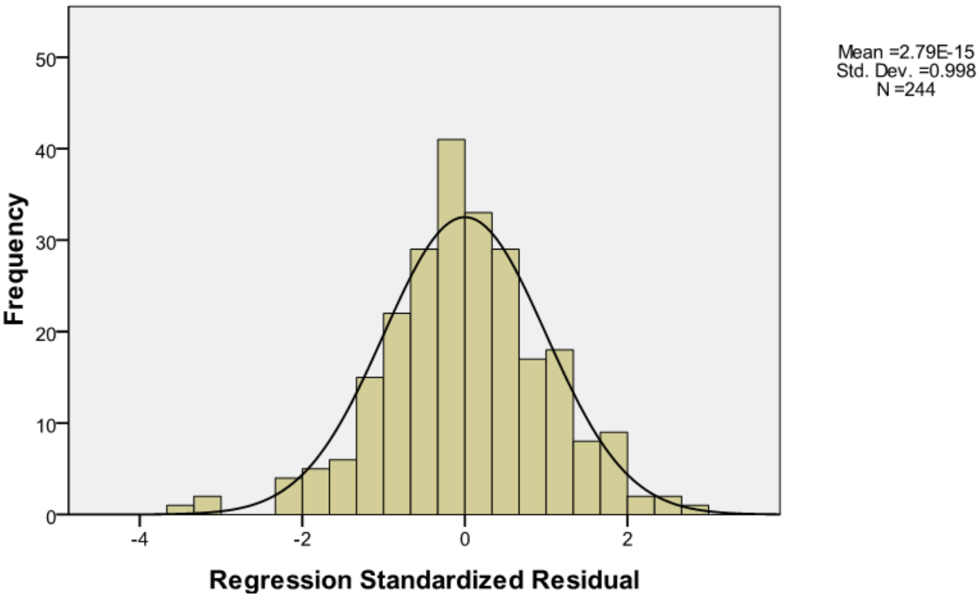
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.634	.309		5.291	.000
	Mean_BusQ	.699	.059	.608	11.927	.000

a. Dependent Variable: Mean_UsrQ

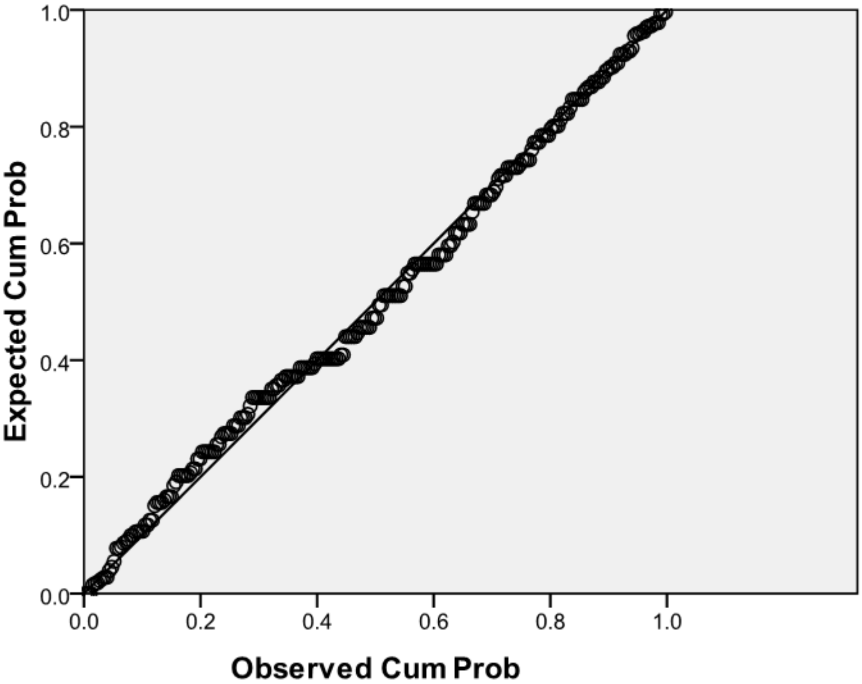
Histogram

Dependent Variable: Mean_UsrQ



Normal P-P Plot of Regression Standardized Residual

Dependent Variable: Mean_UsrQ



Appendix 9

Mediator Test

Examination whether Information Quality factor mediate the relationship between System Quality and Net Benefits

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.386	.315		7.565	.000
	Mean_SysQ	.575	.059	**.532**	9.777	.000

a. Dependent Variable: Mean_NetB

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.153	.291		10.827	.000
	Mean_InfoQ	.438	.055	.455	7.955	.000
2	(Constant)	2.049	.327		6.269	.000
	Mean_InfoQ	.205	.064	.213	3.204	.002
	Mean_SysQ	.437	.072	**.405**	6.072	.000

a. Dependent Variable: Mean_NetB

Examination whether Relationship Quality factor mediate the relationship between Service Quality and Net Benefits

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.051	.258		7.951	.000
	Mean_SrvQ	.650	.049	**.650**	13.310	.000

a. Dependent Variable: Mean_NetB

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.571	.258		6.090	.000
	Mean_RelQ	.725	.048	.698	15.173	.000
2	(Constant)	1.227	.259		4.743	.000
	Mean_RelQ	.497	.067	.479	7.383	.000
	Mean_SrvQ	.300	.065	**.299**	4.614	.000

a. Dependent Variable: Mean_NetB

Examination whether Business Quality factor mediate the relationship between User Quality and Net Benefits

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.762	.299		12.562	.000
	Mean_UsrQ	.316	.056	**.342**	5.667	.000

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.762	.299		12.562	.000
	Mean_UsrQ	.316	.056	**.342**	5.667	.000

a. Dependent Variable: Mean_NetB

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.980	.322		9.253	.000
	Mean_BusQ	.471	.061	.444	7.710	.000
2	(Constant)	2.808	.339		8.278	.000
	Mean_BusQ	.397	.077	.374	5.175	.000
	Mean_UsrQ	.106	.067	**.114**	1.582	.115

a. Dependent Variable: Mean_NetB