ERP Implementation Satisfaction - A Data Quality Approach

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ABSTRACT

Enterprise resource planning (ERP) systems are an important development to help increase cross-functional efficiency and effectiveness. Data quality issues are critical for the successful implementation of any type and size of systems, especially for ERP systems, because ERP systems are inter-connected, and highly integrated. The primary measurement of system success often derived from user satisfaction. This study proposes a research framework of using a data quality approach to measure ERP implementation user satisfaction. We utilized survey methodology to test the research hypotheses and framework. The results of the survey supported the proposed research framework, and showed that data quality of the ERP system affects the users' perceived usefulness of the information, and perceived usefulness of the information affects the users' satisfaction of the ERP implementation.

Keywords: ERP, data quality, user satisfaction, ERP implementation, research framework

1. INTRODUCTION

Enterprise resource planning (ERP) systems are an important development in the corporate use of information technology to enhance an organization's cross-functional efficiency and effectiveness (Davenport, 1998). Major business drivers for ERP implementations are improving productivity, competitiveness, and firm profits (Somers and Nelson, 2004). ERP systems are complex software, and the implementations of such complex systems are challenging for many companies, but it is increasingly seen as necessary for firms to succeed. The significance and risks associated with ERP projects makes it essential that organizations focus on the critical factors that improve ERP implementation (Somers & Nelson, 2004). The prior literature on this topic focuses on ERP implementation projects in larger companies (Amoako-Gyampah & Salam, 2004). There are many benefits of implementing ERP systems, such as increased efficiency in operations and better customer satisfaction (Duff & Jain, 1998; Gupta, 2000).

There are factors that affect the ERP systems implementation regardless of the size of a company. For example, all companies must pay attention to the quality of data and to the integrity of the processes for collecting the data. This might include cleaning the data from the old systems, having adequate data migration controls before transferring the data from the old systems to the new ERP systems, and once the data has been imported, having data quality controls in the new ERP system (Xu, Nord, Brown, & Nord, 2002).

The study developed a survey instrument to measure the data quality, usefulness of information and ERP implementation satisfaction. We have conducted case studies on data quality issues in ERP implementation previously, which revealed many interesting findings that we would like to address further with a larger scale survey study. The proposed research questions are:

1. Whether data quality measurements of the ERP affect the users' perceived usefulness of information.

2. Whether the users' perceived usefulness of information affects the ERP system implementation satisfaction.

Next, we provide a review of the literature and a discussion of the research framework for this study.

2. LITERATURE REVIEW

2.1 Perceived Usefulness

Many studies in the information systems (IS) field have used perceived usefulness as the measure of systems acceptance (Davis, 1989; Igbaria & Nachman, 1990; B. Ives, M.H. Olson, & J.J. Baroudi, 1983; Saarinen, 1996; Venkatesh, Morris, Davis, & Davis, 2003). Particularly, the Technology Acceptance Model (TAM) is widely used and recognized in the IS field, which established the significant relationship between perceived usefulness and use of the technology (Davis, 1989). Delone and Mclean established the model of IS success, which included system quality, information quality, use, user satisfaction, individual impact and organizational impact (DeLone & McLean, 1992). Seddon used an adapted version of the model of IS success, finding that systems quality and information quality affected perceived usefulness, and perceived usefulness affects user satisfaction (Seddon, 1997).

2.2 User Satisfaction

User satisfaction has been used as a form of measurement for IS success (DeLone & McLean, 1992; Ives & Olson, 1984; J., 2000; Rushineck & Rushineck, 1986), because without users' satisfaction, it is hard to claim the success of the systems implementation (Bailey & Pearson, 1983; Bernard & Satir, 1993; Doll & Torkzadeh, 1988; Raymond, 1987; Rocheleau, 1993; Tan & Lo, 1990).

There is much prior research in the development of user satisfaction concepts and measurement instruments, such as user information satisfaction, end-user computing satisfaction, service quality, information system success model, etc.(Roy & Bouchard, 1999). One of first questionnaires that measured the IS satisfaction was developed by Bailey & Pearson. It included 39 dimensions, such as top management involvement, vendor support, accuracy, format of output, error recovery, and confidence in the system (Bailey & Pearson, 1983). Ives et al. developed a shorter version of the questionnaire that has 13 dimensions (B. Ives, M. H. Olson, & J. J. Baroudi, 1983). There is other research that used and discussed the pro and cons of those instruments and some used some other similar instruments (Baroudi & Orlikowski, 1988). Some of the items we used for our research were derived from and supported by that previous research. Please see table 1 for the summary of the IS literature for user satisfaction and perceived usefulness for how we used existing literatures to help develop the research instrument for this study.

2.3 Data Quality

Data quality issues are important for any type of systems, regardless of the size of the organizations and the complexity of the system implementation. Without high quality data, none of the systems would produce useful information for operations, financial reporting, and decision-making. The data quality concept of garbage-in garbage-out is true to any type of system, especially for ERP systems, because in ERP systems everything is highly integrated, therefore, the data issues in one area would affect the quality of the information to the rest of the ERP systems. In an ERP system, all the transactions are part of the integrated processes (Gupta, 2000). Since many of the business processes in an ERP system are automated and inter-linked, data and real-time information in ERP system are shared across different functional areas (Nah, Lau, & Kuang, 2001; Themistocleous, Irani, & O'Keefe, 2001). Therefore, it is clear that data quality would have overall impact to the ERP system's implementation success. That is one of the rationales for us to develop a research framework for ERP implementation from a data quality perspective.

Table 1: Summary of IS Literature for Users' Satisfaction and perceived usefulness

	Bailey and Pearson (1983)	Ives et al. (1983)	Baroudi and Orlikowski (1988)	Doll and Torkzadeh (1988)	Venkatesh et al. (2003)	Wixon et al. (2005)
Model of Satisfaction						
• Understanding of system	X	X	X			
• Confidence in the system	X	X				
• Feelings of participation	X	X	X			
• Feelings of control	X	X				
• Degree of training	X	X	X			
• Job effects	X	X				
Perceived usefulness						
• Usefulness	X	X		X	X	
• Use of information	X					

3. RESARCH FRAMWORK

Based on the literature review, in order to assist answering the research questions, we developed a research framework for this study. Figure 1 shows the research framework for the data quality approach for ERP system implementation satisfaction that we proposed for this study.

It consists of three major components, and they are the measurements of the data quality in ERP systems, the users' perceived usefulness of information, and measurements of the ERP systems implementation satisfaction. In the research framework, there are two major proposed relationship links. There is a link between the data quality measurements and perceived usefulness of information, which represent the first hypothesis of the study:

H1: Data quality of the ERP system affects the users' perceived usefulness of the information from the ERP system.

There is also a link in between perceived usefulness and ERP implementation satisfaction measurements, which represents the second hypothesis of the study:

H2: Perceived usefulness of the information affects the users' satisfaction of the ERP implementation.

There is a small simple diagram at the bottom of the research framework. It represents the basic information system concepts of data, information and knowledge, and how it applied to the ERP data quality approach model we proposed.

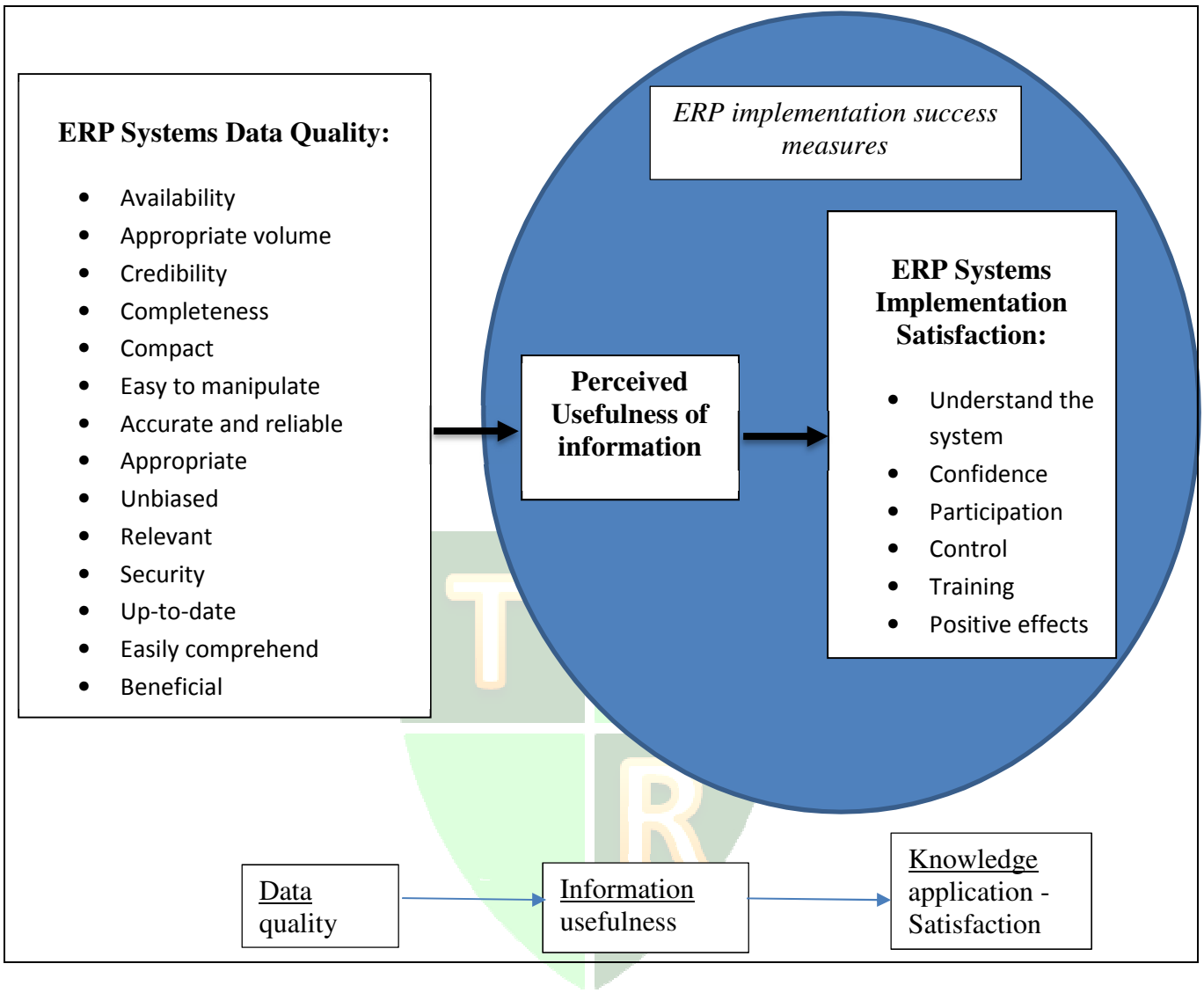

Figure 1: A data quality approach for ERP system implementation satisfaction

The research framework shows that data quality measures might have impact on the ERP users' perceived usefulness of information, and the usefulness of the information might influence the users' satisfactions to the ERP system. The system implementations success could be measured using two measures: the usefulness and ease of use of the systems. Many previous systems researchers (Davis, 1989; Chau, 1996) have validated those two success measures. For this research project, we are using a data quality approach. Such an approach focuses its interest on users' perceived usefulness of information from the ERP system, and its' impact on end users' satisfaction as ERP implementation success measures. The implementation success measures in the research framework were partially based on the Technology Acceptance Model (TAM) (Davis, 1989), which has been observed to be valid (Chau, 1996). According to TAM, systems use depends on behavioral intention to use, which in turn implies attitude towards use, which is divided into two elements: perceived usefulness and perceived ease of use. Previous

research has also attempted to use the extended TAM in the ERP implementation environment (Amoako-Gyampah, Salam, 2004).

Academic research and industry practice gave rise to many different data quality measurement dimensions developed over the years (Ballou & Pazer, 1982, 1985, 1987; Ballou, Wang, Pazer, & Tayi, 1993; Nelson, Wixom, & Todd, 2005; Wang & Strong, 1996; Wixom & Todd, 2005). Commonly used sets of dimensions of information quality are completeness, accuracy, format, and currency (Nelson et al., 2005; Wixom & Todd, 2005); and accuracy, timeliness, completeness, and consistency (Ballou & Pazer, 1982, 1985, 1987; Ballou et al., 1993).

We studied and combined many of the data quality dimensions from existing literature, and chose the ones more related to ERP system for this study, which are included in the research framework. We used those data quality dimensions to help develop the data quality measurements for the survey instrument used in this study.

4. METHODOLOGY

We employed survey methodology to collect the data for this study. Existing literature in related fields and the previous research we have done in the area provided many insights that helped to develop the survey questionnaire. Some items for the questionnaire were based the existing literature in data quality, IS, and ERP fields as we discussed in the previous sections of the paper. There were four main parts for the questionnaire; the first was to capture issues related to ERP implementation's data quality measurements. The second was to measure the user's perspective of usefulness of the information. The third was to measure the outcome of the ERP implementation, focusing on user satisfaction. The final section captured the demographic information of the respondents and their companies.

The target respondents for the survey were the senior IT and accounting professionals, as well the ERP systems users that include different levels of management, as well as daily systems users. The ideal respondents would have experience working with the system implementation or using the ERP system, and could provide valuable assessment of data quality, usefulness of information and ERP implementation success. As it is difficult to find respondents for ERP related research, we used a convenient sampling method to help distribute the questionnaire. We sent the survey to local, regional, national and international companies that we have knowledge of having implemented ERP systems; we sent many of them through personal and professional contacts the research team has. There were total of 115 completed surveys returned. The following section discusses the data analysis, which include some descriptive and inferential statistics that help to answer the research questions and test the research framework.

5. DATA ANALYSIS AND DISCUSSIONS

In the data analysis section, we first start with the some basic statistical analysis. The following are some of the background information about the respondents of the survey.

5.1 Gender

Males represent 65% of the survey respondents whereas 35% are female. Please see figure 2 below. This origin of this imbalance between genders of the survey respondents likely

results from the fact that many systems related fields have more male than female employees. Females that without much experience with either ERP implementation or using ERP system might self-selected to not to complete the survey after reading the research description that we included as part of the questionnaire.

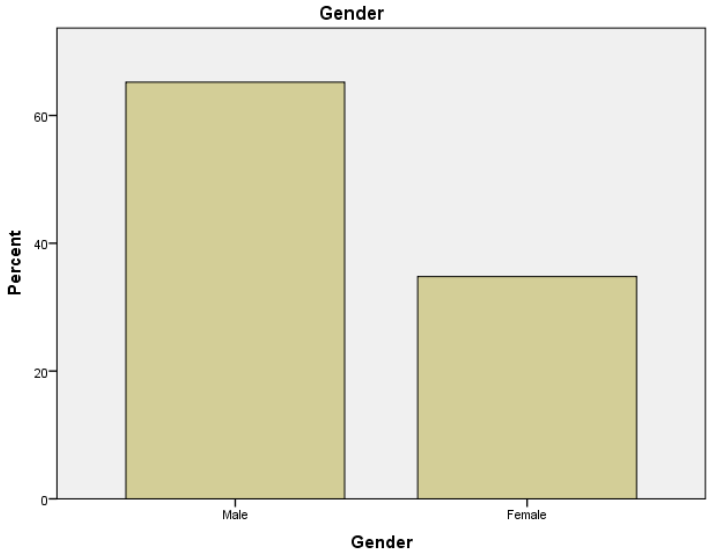

Figure 2: the Gender of the survey respondents

5.2 Age

Table 2 shows the survey respondents' age distribution. Around 15% of the respondents are between the ages of 21-30; around 8% between 31-40 years of age; and 27% of the respondents' age is between 41-50 years old. The largest group of the respondents' age group is over 50 year of age, which is 50% of respondents.

Table 2: the age of the survey respondents

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21-30	17	14.8	14.8	14.8
	31-40	9	7.8	7.8	22.6
	41-50	31	27.0	27.0	49.6
	Over 50	58	50.4	50.4	100.0
	Total	115	100.0	100.0	

5.3 Job Responsibility

With regard to job responsibility, the respondents have a large span of their job responsibility levels. 28% of the respondents are executive / top management, 35% are middle management, 13% are supervisors, and 24% are non-management employees. All the different levels of the job responsibility are well represented from the survey respondents.

Job_responsibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Exeutive/Top management	32	27.8	27.8	27.8
	Middle Management	40	34.8	34.8	62.6
	Supervisor	15	13.0	13.0	75.7
	Non-managment employee	28	24.3	24.3	100.0
	Total	115	100.0	100.0	

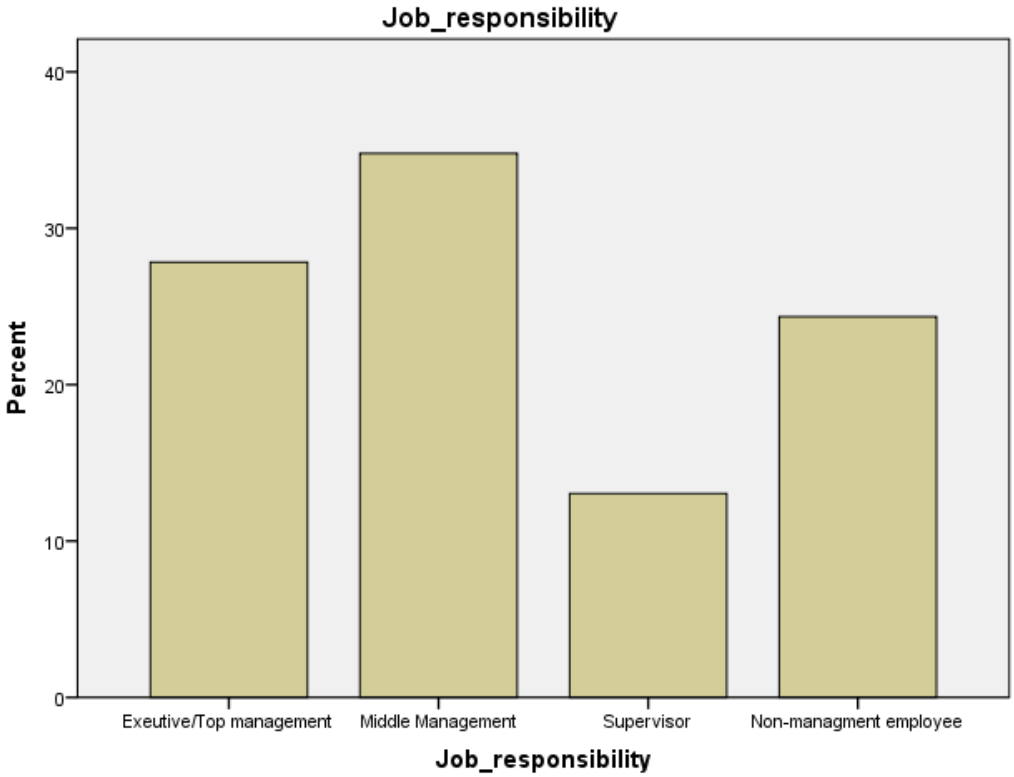

Figure 3: job responsibility of the survey respondents

Next, we conduct descriptive and inferential statistics analysis for the variables and test relationships that related to the research framework and hypotheses.

5.4 Data Quality Measurements

ERP system data quality are critical measurements for this study. It is also the first phase of the data-information-knowledge concepts. Therefore, they are vital for the model building of this study.

Table 3 shows the descriptive statistics for ERP system's data quality measurements. It is to make clear that those are subjective assessments by the survey respondents of the data quality for their organizations ERP systems. They were not derived from objective measurements of the ERP systems. The survey instrument used a 5-likert scale for data quality dimensions as

measurements. The scale are 1 as 'poor', 2 as 'fair', 3 as 'good', 4 as 'very good', and 5 as 'excellent'. There is an added option on the questionnaire labeled N/A, which is to be used for those respondents are not able to assess particular data quality dimensions. We coded this additional option of N/A separately in data file from the 5-likert scale, so that it will not impact the results of the survey.

Just for some additional background of how to interpret the data quality dimensions measured on a 5-likert scale: anything greater than 3 is considered to be a good and normal results. Anything below 3 would generally mean that area of the data quality is not measured well and needs some attention. If a data quality dimension is measured above 4, which would be an indication of a very good performance for that particular data quality dimension.

Table 3: Descriptive statistics for ERP systems data quality measurements

Descriptive Statistics

	Mean	Std. Deviation	Skewness	
				Std. Error
DQ1.available_retrievable	3.45	1.038	-.346	.228
DQ2.appropriate_volume	3.56	.950	-.624	.229
DQ3.true_credible	3.75	.986	-.051	.229
DQ4.complete	3.76	.877	-.347	.230
DQ5.compact	3.49	1.033	-.219	.231
DQ6.easy_manipulate	3.54	1.130	-.414	.228
DQ7.accurate	3.63	.953	-.222	.229
DQ8.appropriate_data	3.95	.917	-.690	.230
DQ9.unbiased	4.11	.891	-.630	.237
DQ10.relevant	3.83	.893	-.356	.229
DQ11.security	4.19	.954	-1.156	.249
DQ12.up_to_date	3.99	.891	-1.141	.244
DQ13.easy_comprehend	3.87	.919	-.756	.239
DQ14.beneficial	3.98	.914	-.909	.229

From the table 3, it can be seen that all the 14 data quality dimensions have a mean value of above 3, which means in general, the survey respondents believe the data quality in their organizations ERP system are good and normal. There are 2 data quality dimensions that have a mean of more than 4, namely, 4.11 for unbiased and 4.19 for security. Those two dimensions were described in the questionnaire as 'the extent to which data is unbiased, unprejudiced, and impartial', and 'the extent to which data is restricted appropriately to users to ensure security'. This means that the survey respondents believe that their organizations have done a very good job in ensuring those areas of data quality in ERP systems. By looking closely into those data quality dimensions that received a rating between 3 and 4, almost all of them are close to and above 3.5, with 5 of them above 3.8. Combining the above analysis for the data quality

dimensions measurements from the survey, it is clear that the survey respondents are generally satisfied with data quality from their ERP systems, and believe they are at above average acceptable level.

5.5 Data Quality's Impact on Usefulness of Information

In order to answer the first research question and test the hypothesis 1 of the study, we investigate whether there is a relationship between the data quality measures and perceived usefulness of information from the ERP system from the survey data. We run a univariate analysis of variance using 'usefulness of information' as the dependent variable, and all the 14 data quality dimensions as independent variables.

Table 4: the model between data quality measures and perceived usefulness of information
Tests of Between-Subjects Effects
Dependent Variable: Usefulness_information

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	86.337[a]	60	1.439	4.968	.000
Intercept	36.534	1	36.534	126.144	.000
DQ1.available_retrievable	2.308	4	.577	1.993	.110
DQ2.appropriate_volume	.496	5	.099	.343	.885
DQ3.true_credible	.372	3	.124	.428	.734
DQ4.complete	.194	2	.097	.334	.717
DQ5.compact	4.241	5	.848	2.929	.021
DQ6.easy_manipulate	4.829	4	1.207	4.169	.005
DQ7.accurate	14.494	5	2.899	10.009	.000
DQ8.appropriate_data	4.568	4	1.142	3.943	.007
DQ9.unbiased	2.929	4	.732	2.529	.052
DQ10.relevant	3.014	3	1.005	3.469	.023
DQ11.security	1.678	4	.419	1.448	.232
DQ12.up_to_date	4.608	3	1.536	5.303	.003
DQ13.easy_comprehend	5.252	4	1.313	4.533	.003
DQ14.beneficial	.773	4	.193	.668	.617
Error	14.771	51	.290		
Total	2040.000	112			
Corrected Total	101.107	111			

a. R Squared = .854 (Adjusted R Squared = .682)

Table 4 shows the results of this model. The overall corrected model of 14 data quality dimensions as independent variables as a whole are significantly related to the dependent variable of the 'usefulness of information' at p=.000. The model's R Squared = .854 (Adjusted R Squared = .682).

By looking into the each individual data quality dimension's relationship with the dependent variable of 'usefulness of information' from Table 4, some of them are significant whereas others of them are not significant. The seven data quality dimensions that are significant with the dependent variable of 'usefulness of information' are 'compact', 'easy manipulate', 'accurate', 'appropriate data', 'relevant', 'up-to-date', and 'easy comprehend'.

Research question 1 posits whether data quality measurements of the ERP affect the users' perceived usefulness of information, based on the data analysis of the study. The answer is yes, data quality measurements of the ERP affect the users' perceived usefulness of information. At the same time, this supports hypothesis 1 of this study.

5.6 Satisfactions

We measured user's satisfactions of the ERP implementation by using six variables; those are described as follow in the survey:

- I understand the ERP system
- I have confidence in the ERP system
- I feel I appropriately participated in the ERP system implementation
- I feel I have control over the ERP system
- I received the appropriate training for using the ERP system
- Using the ERP system has positive effects for my job

Table 5 shows the descriptive statistics for users' satisfactions for ERP implementation. It includes the mean, standard deviation, standard error, and 95% confidence interval for mean for each of the satisfaction measure as well as for each of the options for each measure.

The scaled used to measure the satisfaction variables is also 5-likert scale, but with different descriptions for each option, and they are 1 as strongly disagree, 2 as disagree, 3 as neutral, 4 as agree and 5 as strongly agree.

Table 5: Descriptive of ERP systems implementation satisfactions

Descriptives

						95% Confidence Interval for Mean	
			Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
SAT.understand	1	4	3.00	.816	.408	1.70	4.30
	2	2	2.50	.707	.500	-3.85	8.85
	3	13	4.00	.913	.253	3.45	4.55
	4	47	4.00	.834	.122	3.76	4.24
	5	48	4.02	.729	.105	3.81	4.23
	Total	114	3.95	.829	.078	3.79	4.10
SAT.confidence	1	4	1.25	.500	.250	.45	2.05
	2	2	1.50	.707	.500	-4.85	7.85
	3	13	3.85	.689	.191	3.43	4.26
	4	47	4.06	.567	.083	3.90	4.23
	5	48	4.04	.824	.119	3.80	4.28
	Total	114	3.89	.919	.086	3.72	4.06
SAT.participation	1	4	1.00	.000	.000	1.00	1.00
	2	2	2.00	1.414	1.000	-10.71	14.71
	3	13	3.38	1.044	.290	2.75	4.02
	4	47	3.87	.797	.116	3.64	4.11
	5	47	3.89	1.005	.147	3.60	4.19
	Total	113	3.69	1.078	.101	3.49	3.89
SAT.control	1	4	1.25	.500	.250	.45	2.05
	2	2	1.50	.707	.500	-4.85	7.85
	3	13	3.31	.855	.237	2.79	3.82
	4	47	3.53	1.139	.166	3.20	3.87
	5	48	3.71	1.304	.188	3.33	4.09
	Total	114	3.46	1.263	.118	3.23	3.70
SAT.training	1	4	1.50	.577	.289	.58	2.42
	2	2	1.50	.707	.500	-4.85	7.85
	3	13	3.08	.760	.211	2.62	3.54
	4	47	3.64	1.258	.184	3.27	4.01
	5	48	3.69	1.055	.152	3.38	3.99
	Total	114	3.48	1.199	.112	3.26	3.70
SAT.positive_effects	1	4	1.00	.000	.000	1.00	1.00
	2	2	2.00	.000	.000	2.00	2.00
	3	13	3.85	.801	.222	3.36	4.33
	4	47	4.00	.626	.091	3.82	4.18
	5	48	3.73	.917	.132	3.46	4.00
	Total	114	3.73	.962	.090	3.55	3.91

All six satisfaction variables have means between 3 to 4, and closer to 4. They are 3.95 for 'understanding', 3.89 for 'confidence', 3.69 for 'participation', 3.46 for 'control', 3.48 for 'training' and 3.73 for 'positive effects'. With the meaning explained earlier for each option used for the scale for those satisfaction questions, it can be interpreted as user' responses for those questions represented that their satisfaction of the ERP implementation is ranged from 'neutral' to 'satisfied', and more towards 'satisfied'.

5.7 Usefulness of Information's Impact on ERP System Implementation Satisfaction

In order to answer the second research question and test hypothesis 2 of the study, we would next investigate whether there is a relationship between the perceived usefulness of information and the ERP system implementation satisfaction from the survey data. We utilized one-way ANOVA to help with this investigation. In the ANOVA analysis, the user's perceived 'usefulness of information' is the factor independent variable and the six user satisfaction measures are dependent variables. The results of the ANOVA are shown in table 6.

Table 6: One-Way ANOVA for the usefulness of information's affect to ERP system implementation satisfaction

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SAT.understand	Between Groups	8.205	4	2.051	3.218	.015
	Within Groups	69.479	109	.637		
	Total	77.684	113			
SAT.confidence	Between Groups	41.850	4	10.463	21.250	.000
	Within Groups	53.667	109	.492		
	Total	95.518	113			
SAT.participation	Between Groups	39.380	4	9.845	11.713	.000
	Within Groups	90.779	108	.841		
	Total	130.159	112			
SAT.control	Between Groups	30.722	4	7.680	5.595	.000
	Within Groups	149.638	109	1.373		
	Total	180.360	113			
SAT.training	Between Groups	28.878	4	7.220	5.891	.000
	Within Groups	133.587	109	1.226		
	Total	162.465	113			
SAT.positive_effects	Between Groups	39.399	4	9.850	16.474	.000
	Within Groups	65.171	109	.598		
	Total	104.570	113			

The one-way ANOVA shows that the factor (independent variable) 'usefulness of information' statistical significantly affect each of the six user satisfaction measures individually. Five of them have signification level of .000, one with .015.

Therefore, we derive an answer to research question 2 and for hypothesis 2: Perceived usefulness of the information affects the users' satisfaction of the ERP implementation is supported.

The above data analysis and discussions also confirmed the proposed research framework for data quality approach for ERP implementation satisfaction that shown in figure 1.

6. CONCLUSIONS

ERP systems are used by many type and size of organizations. One way to measure system implementation success is to use user satisfaction of the system. Many studies have been conducted in the area of user satisfaction, and particularly for ERP system. Data quality issues are critical for all kind of the information system, especially for ERP system, because of the integration nature of the ERP systems, everything from data, information, process, reports, to analytical tools etc. are all inter-connected. The poor data quality would cause much damage to the ERP system and system failure, if not addressed promptly and appropriately. Therefore, there is a need to connect data quality issues with the ERP system implementation success, in particular, this study developed a research framework for data quality approach to ERP system implementation satisfaction. It tried to link the ERP data quality measurements with the perceived usefulness of information, and usefulness of information to user satisfaction of ERP implementation. We conducted a survey to test the research model and hypotheses. The results of the data analysis confirmed the proposed relationships in the research framework. The study showed that overall users rated the data quality of the ERP systems as above average and acceptable level. The results of the data analysis also indicated the survey respondents are generally satisfied with the ERP implementation in their organizations. Another important contribution of this study, in addition to proposed and tested the research framework for data quality approach for ERP implementation satisfaction, is to test the two research hypotheses, with findings that the survey data support both. They are data quality of the ERP system affects the users' perceived usefulness of the information from the ERP system, and perceived usefulness of the information affects the users' satisfaction of the ERP implementation.

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