The influence of System Support Characteristics on the Success of Data Warehousing Adoption & Diffusion

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Abstract-- **This study aimed at identifying the impact of system support factors on successful development of data warehousing in the United Arab Emirates. The study framework is formulated based on analysis of related literature coupled with the information gained from interviewing data warehousing experts.**

Five hundred and eighty data warehouse users in 34 companies were surveyed to obtain their perceptions of the extent that each of 132 items had actually contributed to their firms' DW success at different phases of development.

Rigorous multivariate statistical analysis procedure has been followed to construct an overall model of DW success. The model has proven that all its independent variables have significant influence on the DW overall success and that system support factors have dominant impact on this success throughout the different phases of DW development.

INTRODUCTION

The last twenty five years have witnessed cautious spreading of data warehouses (DW) across different industries in the Western world. Although data warehousing providers have repeatedly reported many success stories of the use of data warehousing, a number of failure cases have been published, too. In essence, the economic result of using data warehousing on business performance has been mixed (Agosta, 2006). There is a need for a study to investigate data warehousing success.

Although many related studies to data warehousing have been published (McCaskey, 1976; Zmud, 1979; Gordon and Narayanan, 1983; Meador, Guyote and Keen, 1984; Fulk, Steinfield, Schmitz, and Power, 1987; Sharda, Barr, and McDonnell, 1988; Alavi and Joachimsthaler, 1992; Adelman and Moss, 2001; Ariyachandra and Watson, 2005; to name a few), they have been concerned with technical issues. They have provided a comprehensive understanding of the technical factors affecting data warehousing success, they did not however account for many other important dimensions. Business/culture/implication related issues are of interest and fall among these left for future studies. Overall, there is a scarcity of empirical studies that examine the data warehousing success within an integrative model.

The current exploratory study intends to focus on the effect of the system support factors on the data warehousing success. It aims at providing empirical evidence that identifies the system support factors that influence successful adoption & diffusion of data warehousing, thereby extending the body of knowledge concerning management support systems implementation in general and data warehouses in specific.

THE THEORETICAL FRAMEWORK

Though there is evidence that sequential stage models of technology diffusion may not depict actual implementation processes (Ettlie, 1973; Witte, 1972), recent work suggests that such models may be more appropriate for technologies which are borrowed or adapted rather than custom made (Pelz, 1983).

Cooper and Zmud (1990) proposed a model that described the adoption and diffusion of IT innovation in terms of six stages: initiation, adoption, adaptation, acceptance, routinization, and infusion.

The current study uses a similar model to describe the DW completion process. The process consists of four phases: initiation & adoption, adaptation, acceptance & routinization, infusion. This approach usefully emphasizes the continual tension between efficiency and effectiveness in the use of IT (Cash et al.,1992: Chapter 7.)

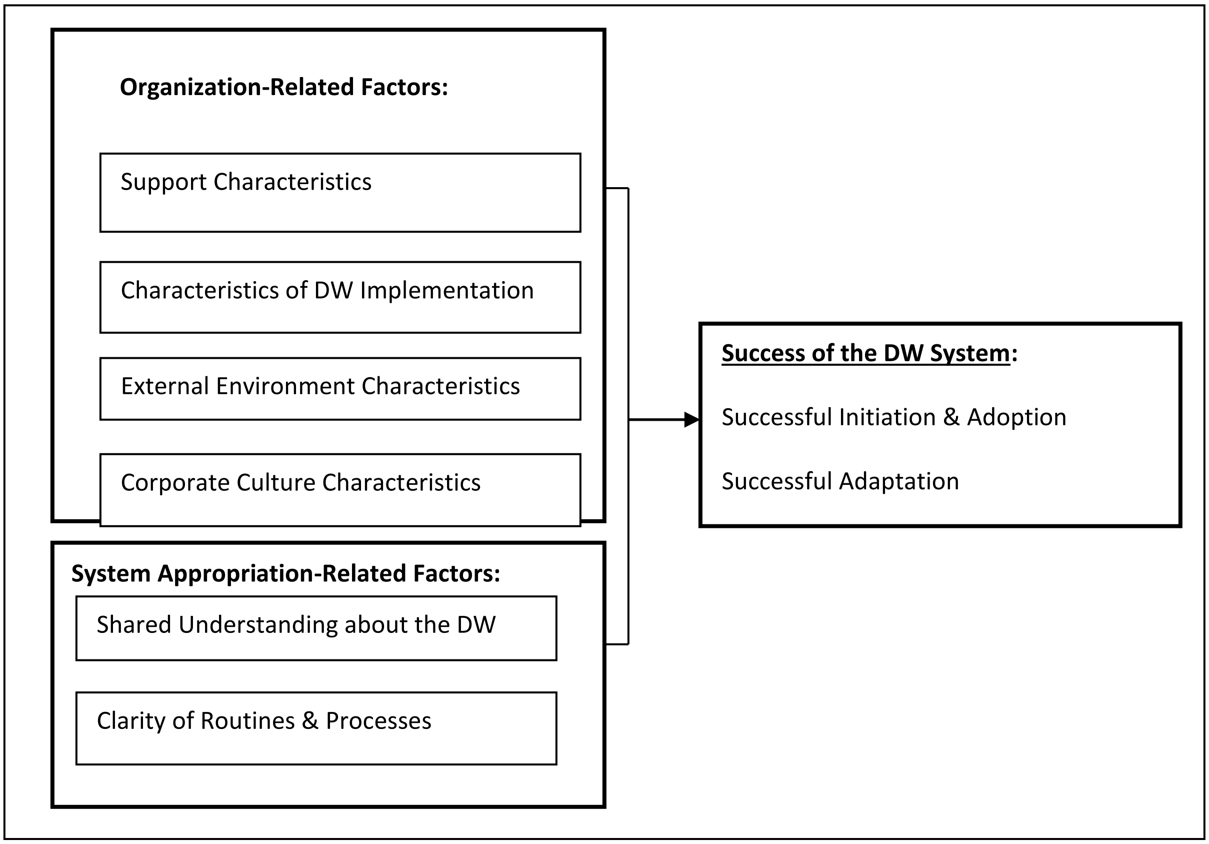

Figure 1. Integrated Model of the Factors that Influence DW Success

Reviewed related literature and semi-structured interviews of data warehousing experts have suggested four groups of explanatory variables: support characteristics, external environment characteristics, implementation characteristics, and organization characteristics. However, the current study expects a sound impact of corporate culture as a major organization dimension. It also introduces the system appropriation-related effects to the model.

Figure 1 depicts the model of DW success examined in this study. The model is comprised of seven sets of variables: (1) success of the DW, (2) support characteristics, (3) characteristics of DW implementation, (4) external environment characteristics, (5) corporate culture & organizational climate characteristics, (6) meanings & understanding of what the DW project is about, and (7) clarity of routines & processes of capturing, processing and reporting data from the DW.

Constructing an integrative model of DW success enables the researcher to account for the effects of non-corporate culture & organizational factors when estimating the model.

Success of the Data Warehousing System

Initially, Golfarelli and Rizzi (2009) and Sanders and Courtney (1985) posit that successful adoption of a DSS contributes positively to its successful management after adoption. Data warehouses are used in conjunction with decision support systems at large. Therefore, successful adoption of a data warehouse is expected to contribute positively to the data warehouse successful management.

Success of a data warehouse project, is defined in terms of its ability to encompass the real information needs of the business. Generally speaking, the most difficult data warehousing problems do not have to do with technology. Rather, they have to do with delivering value to users, maintaining the data warehouse and shifting from a transaction processing to a decision-support mindset (Greenfield, 1996).

Primary interviews of DW experts revealed that data warehousing success indicators should differ from one DW development phase to another.

Support Characteristics

Data warehousing projects are described in the literature as expensive, time-consuming undertakings (Hildebrand, 1995; Sakaguchi and Frolick, 1997; Watson and Haley, 1997; Reeves, 2009); therefore, having adequate resources should be critical to their success.

Adequate resources are defined in terms of data, skills, money, and IT related infrastructure facilities to support the data warehouse.

Poe (1996) predicates that quality of the source data (degree of detail, cost, age, how data is integrated and transformed, and integrity) is an important ingredient to the success of a data warehouse system. Besides, Davydrov (1996) states that it is essential to guarantee that needed skills are in place to support the adoption of a data warehouse.

The functional dependency of a DW on other operational databases in the firm, according to Lazos (1991) is fundamental.
Data warehousing implementations are large, complex undertakings, and funds should be available when needed (Retting and Simon, 1993; and Little, 1998).

External Environment Characteristics
The environment surrounding the DW is defined as the external environmental factors that influence its use of information. The existence of powerful forces affecting the enterprise such as turbulence in the economic, competitive or regulatory environments is a good example of such factors.

One of the pioneering studies that have explored the effect of this variable was Kimberly and Evansiko (1981). Intensive competition has become the norm in nowadays business environment. Kimberly and Evansiko (1981) hypothesized that competition in an organization's domain is related to adoption behavior.

Uncertainty about the environment is a fundamental problem with which executives must cope (Thompson, 1967). One of the primary means for doing so is collecting more information (Galbraith, 1974).

Environmental turbulence has been discussed most frequently as consisting of two dimensions: complexity – the number of factors that must be addressed – and volatility – the rate of change of those factors (Emery and Trist, 1965; Thompson, 1967; Duncan, 1972; Hall, 1980).

Implementation Characteristics
Careful system implementation is defined as "the degree to which user training, data integration, benefits/costs relationship, selecting a pilot application, quick and frequent building of prototypes, incremental implementation, proactive and publicized reporting, and end-user involvement affect the data warehouse success" (DeLong and Rockart, 1986).

Planning the DW project is very important, too. Data warehousing initiatives are large and complex undertakings, and planning for them should be carefully addressed (Devlin, 1997; Sakaguchi and Frolick, 1997).

Researchers have recognized the crucial impact of top, executive, and operating management support on successful implementation of MSS in general (Franz and Robey, 1984; Keen, 1981.) Management support can help overcome such resistance.

Corporate Culture Characteristics
Data warehousing raises a number of cultural issues such as the problems that arise when people are not used to sharing their data. IT staff can also be a problem. They need to be able to produce demonstration systems quickly and to think themselves into the shoes of line management without detailed requirement specifications (Bird, 1996: p. 72).

A data warehouse is not an operational system that people have to use to do their jobs. It has value, however, only if used. Inmon (1999) argues that the data warehouse world, the life cycle is reversed. A simple data warehouse is built and then over time, as people understand what the data can and cannot do for them and the warehouse evolves, the requirements become understood. In other words, the life cycle of the data warehouse is data-driven rather than requirements-driven.

Finally, researchers have recently recognized the fundamental impact of cultural factors on large information systems success (Hegazy, Wheeler, and Ghorab, 2001).

Shared Understanding & Meanings of the DW Project
This variable deals with learning and shared understanding of what the DW project is about, what it means for them, for the organization, for the different stakeholders (Turban et al, 1996).

The Northwestern University studies of the fate of management information systems and operations research provide some clues. Published results of this research (Neal and Radnor, 1973; Radnor and Bean, 1973; Radnor and Neal, 1973; Radnor et al., 1968) indicate that several factors are associated with successful implementation.

Clarity of Routines and Processes

This variable is defined as how clear are the procedures and organizational process that relate to the DW, for organizing new data entry, for extracting reports, or if there are ambiguities in the way data is captured, processed and reported (Zmud, 1979; Amoroso and Cheney, 1991).

Zmud (1979) postulated that this variable is concerned with how clear are the procedures and organizational process that relate to the DW, for organizing new data entry, for extracting reports, or if there are ambiguities in the way data is captured, processed and reported.

SETTING THE HYPOTHESES

Prior studies on IT implementation have that the more the data management tools characteristics of existing IS are perceived as appropriate to new DW, the more likely it is that the new system's adoption and adaptation will be a success (Kwon and Zmud, 1987). Hence, one can expect:

H0(1-1a): The greater the data management considerations of the existing system, the better the new system adoption.

H0(1-1b): The greater the data management considerations of the existing system, the better the new system adaptation.
H0(1-1c): The greater the data management considerations of the existing system, the better the new system routinization.
H0(1-1d): The greater the data management considerations of the existing system, the better the new system infusion.

Further, Inmon (1996) points out that the better the existing system's IT features are perceived as suitable to new DW, the more likely it is that the new system's initiation, adoption and adaptation will be successful. Therefore, one would expect:

H0(1-2a): The greater the IT suitability of the existing system, the better the new system adoption.
H0(1-2b): The greater the IT suitability of the existing system, the better the new system adaptation.
H0(1-2c): The greater the IT suitability of the existing system, the better the new system routinization.
H0(1-2d): The greater the IT suitability of the existing system, the better the new system infusion.

Yet, Davydrov (1996) supports the necessity of guaranteeing that needed skills are in place to support the adoption of a data warehouse. The learning curve in data warehousing is very steep, and the project suffers if the skills of project members are inadequate to complete the project tasks (Bischoff and Alexander, 1997; Rist, 1997). Research has reported positive influence of support team responsiveness on IS successful adaptation & infusion (Amoroso and Cheney (1991.) Thus, one would expect:

H0(1-3a): The more reliable the system and responsive the support team are ,the better the new system adoption.
H0(1-3b): The more reliable the system and responsive the support team are, the better the new system adaptation.
H0(1-3c): The more reliable the system and responsive the support team are, the better the new system routinization.
H0(1-3d): The more reliable the system and responsive the support team are, the better the new system infusion.

RESEARCH METHOD

A random sample of data warehouse users is selected from each firm in the study population of firms that satisfied the research criterion. The sampling design is nearly proportionate stratified random sampling.

All medium-to-large firms that are known to be undergoing or having completed a data-warehousing project are included in the study pool from which the sample is drawn.

A data warehouse is defined in the current study as "a subject-oriented, integrated, time-variant, nonvolatile collection of data that is used in the support of management's decision-making process" (Inmon, 1996: p. 1.) The following is how each of the study variables was measured in this study.

Measurement of Success of The Data Warehouse

Four variables are used to measure success of the data warehouse systems through its different phases of development. Here is a list of detailed items that are used to operationalize each of the DW success variables.

1. Data warehouse success at the initiation & adoption phase: match of DW with organization (Cooper & Zmud, 1990), timely DW decision to invest to exploit the new opportunity and make use of new technology, DW used in organization's work (Cooper and Zmud, 1990), DW answers new decision questions (Little, 1998), and DW is in long term business plan,
2. Data warehouse success at the adaptation phase: DW is ready to use (Cooper and Zmud, 1990), DW is responsive (Keen, 1988), and can identify different and sophisticated uses (Rogers, 1983),
3. Data warehouse success at the acceptance & routinization phase: how successful is the project team in resolving initiation issues (Tornatzky and Klein, 1982), expandable DW use (Rist, 1997), scaleable DW (Amoroso and Cheney, 1991), DW planned workability (Amoroso and Cheney, 1991), DW use encouraged (Cooper and Zmud, 1990), people induced to commit to DW use (Cooper and Zmud, 1990), how successful is the steering committee in resolving integration issues (Goodhue, Wybo, and Kirsch, 1992), work practices are flexible modified (Heflin, 1992), DW viewed as asset (Sanders and Courtney, 1985), and DW changing executives' work (Money et al, 1988),
4. Data warehouse success at the infusion phase: the organizational systems adjusted for DW (Cooper and Zmud, 1990), and DW used to full potential (Cooper and Zmud, 1990).

Measurement of Support Characteristics

Three variables are employed to measure the support characteristics: data management, IT suitability, and system reliability & support team responsiveness. The following is a list of detailed items that are widely selected by related literature to represent each of these three support characteristics:

1. Data management (Amoroso & Cheney, 1991): Availability of data management tools to manipulate the data as necessary, availability of metadata to provide a detailed attribute map of all DW data,

2. IT suitability (Inmon, 1996): Suitability of the DW platform, sophistication of IT networking in place, tuning each data mart for the particular function it provides for each business area ,
3. System reliability & support team responsiveness (Inmon, 1996): High level of compatibility among hardware, network, and software, tuning each data mart for the particular function it provides for each business area,

Measurement of External Environment

A single variable is utilized to measure the external environment: industry environmental pressures . Detailed items that are employed to operationalize this variable are given in the following.

1. Industry environmental pressures (Duncan, 1972; Hall, 1980): Volitality of the firm economic environment, volitality of the firm competitive environment, complexity of the firm competitive environment, volitality of the firm regulatory environment,

Measurement of Characteristics of the Data Warehousing Implementation

Two variables are frequently cited in related empirical studies to measure the characteristics of data warehousing implementation: end-user involvement & expectations, and use of prototyping. The detailed items that are employed are given in the following.

1. End-user involvement & expectations (Barki & Hartwick, 1994): Importance of user expectations about the DW potential capabilities to the DW implementation, importance of the system user sponsorship to the DW implementation, importance of end-user involvement to the DW implementation,
2. Use of prototyping (Inmon, 1996; DeLong & Rockart, 1986): Importance of quick and frequent building of prototypes to the DW implementation, importance of prototyping tools to the DW implementation,
3. Management commitment (Guimaraes et al, 1992): A top manager who is a visionary or a leader supports the DW system, a top manager who believes that DW creates business opportunities supports the DW system, top management is strongly in favor of the concept of DW, a committed and informed executive sponsor supports the DW system, a committed and informed operating sponsor supports the DW system, top management support to increase IT infrastructure capabilities,

Measurement of Corporate Culture & Organizational Climate

Three variables are chosen to measure the characteristics of corporate culture & organizational climate: user parntnership, and user responsibility for the system. The detailed items that are utilized in operationalizing these three variables are given in the following.

1. User partnership (Swanson, 1988; Bergerson et al., 1991): The DW users, management, and IT group are partners in adopting the DW, the DW users, management, and IT group are co-operating in managing the DW,
2. User responsibility for system (Mumford., 1969): Responsibility for the system lies with the business area that generates the data, responsibility for the system lies with the functional area, responsibility for the system is shared among all users,

Measurement of Shared Understanding & Meanings of the DW Project

A single variable is utilized to measure the shared understanding & meanings of the DW project: DW is aimed at executive use. The detailed items that are used are given in the following.

1. DW is aimed at executive use (Ward & Griffiths, 1996): The DW aims at improving the way managers conduct business, the DW aims at allowing managers to share information with customers and vendors, the DW aims at integrating information for effective use by executives.

Measurement of Clarity of Routines & Processes

A single variable is used to measure the clarity of routines & processes: clarity of procedures. The detailed items that are utilized to operationalize this variable are given in the following.

1. Clarity of procedures (Iiavari, 1987): Clarity about the organizational procedures of capturing data, clarity about the organizational procedures of processing data,

Employed Analytical Procedure

A detailed questionnaire is developed, reviewed, pilot tested, and revised. Reliability and confirmatory factor analyses are employed to check reliability and validity aspects of the dependent and independent side variables.

Multivariate variance analysis and multivariate regression analysis are utilized to examine the relationships between the dependent and independent variables in the study model and test the study hypotheses.

DATA ANALYSIS

Sample Characteristics

The sample contained almost equal percentages of governmental and public companies, on one hand, and private companies, on the other. All these companies were medium to large size and with annual sales between 200 and 800 million Dirhams.

The study sample nicely represents all possible levels of DW technology adoption among these firms. A reasonable degree of adoption levels, i.e. moderate variation, would be favorable for any further statistical investigation.

Reliability OF Dependent and Independent Variables

Cronbach's Alpha is perhaps the most recommended method of measuring reliability, and the recommended measure of internal consistency for each of the dimensions determined from the factor analysis (Sethi and King, 1991; Lederer and Sethi, 1992; Sekaran, 1992; Hair, Anderson, Tatham, and Black, 1995).

Reliability analysis is performed on all the eleven independent variables. Only system reliability & support team responsiveness had lower Cronbach's Alpha than the predetermined cut off point of 0.70. It had an Alpha of 0.67, which is slightly below the acceptable 0.70 threshold, but still can be tolerated if the constructs make sense (Nunnally, 1978). Thus, there will be 11 valid independent variables to use in all further analysis.

Cronbach's Alpha for each of the study dependent variables is computed. All of the selected variables pass the 0.7 threshold requirement. Thus, all dependent variables are considered reliable to use in further analysis.

Validity of Dependent and Independent Variables

A confirmatory factor analysis (Sekaran, 1972; Churchill, 1979) is employed to show that the variables have discriminant validity. This discriminant validity is confirmed if the pattern of items loading onto extracted factors should produce the items in the variables – and this happens if the loading of each item is high on the designated factor and low on other factors.

All the items of all the variables are entered into factor analysis where the number of factors extracted is equal to the number of variables. Ideally, items in one variable load strongly only onto one factor. If an item or a variable produce bad results then one should remove the offending item (so long as the remaining variable is reliable) or remove the variable entirely and seek a solution with fewer factors.

Investigating the offending data items in the initial confirmatory factor analysis based on the Maximum Likelihood method of extraction (ML) with oblimin rotation according to the above criteria, eleven factors resulted. The eleven extracted components/factors are associated with eleven constructs that were identified previously, but with slight changes by removing certain items from these constructs. The KMO statistic was .804. The eleven extracted factors explained 84.6% of the total variation in the data items.

As is done with the independent variables, confirmatory factor analysis is performed to show that these outcome variables have discriminant validity, too.

Analysis shows that the variables are satisfactory since they correspond to the four extracted factors (KMO is .848) and the off-factor weightings are all below 0.4 . Therefore, there were four success variables to use in analysis.

The Model Design

The classical procedure of developing a multivariate analysis model of variance analysis was followed. First the main effects were determined, then the interaction effects, followed by the within terms, and finally the covariantes effect.

The design reads as follows:

(DW Success at initiation & adoption
DW Success at adaptation
DW Success at acceptance & routinization
DW Success at infusion) = Intercept + PHASE + JOB + PHASE*JOB
+ FIRM(PHASE) + X5DATA
+ X5GOODIT + X5SUPPRT
+ X7ENVIRO + X8PRTCP
+ X9USEREX + X9PROTYP
+ X10COMIT + X13RESPN
+ X16EXECS + X17PROCS

Where,

PHASE denotes DW phase of development,
JOB denotes respondent job,
PHASE*JOB denotes the interaction effect of DW phase and respondent job
FIRM(PHASE) denotes the firm effect within the different DW phases of development
X5DATA denotes data management
X5GOODIT denotes IT suitability
X5SUPPRT denotes system reliability & support team responsiveness
X7ENVIRO denotes industry environmental pressures
X8PRTCP denotes user partnership
X9USEREX denotes end-user involvement & expectations
X9PROTYP denotes use of prototyping
X10COMIT denotes management commitment
X13RESPN denotes user responsibility for the system
X16EXECS denotes DW is ained at executive use
X17PROCS denotes clarity of procedures

ESTIMATING THE MODEL

Multivariate Results

Table I reports estimation results of the above model at the multivariate level of analysis using collected data from 580 respondents.

The results indicate that all the variables in the model are significant. Hence, the designed model is statistically dependable and can be used in analyzing the relationships between the criterion and predictor variable sets and further analysis is feasible.

Table I
Multivariate Tests

Effect	Pillai's Trace		Hypothesis df	Error df	Sig.
	Value	F			
Intercept	0.050	6.621	4.000	508.000	0.000
FIRMNUM(PHASE)	0.625	3.156	120.000	2044.000	0.000
PHASE	0.528	27.234	12.000	1530.000	0.000
JOB	0.236	5.346	24.000	2044.000	0.000
PHASE * JOB	0.188	1.396	72.000	2044.000	0.017
X5DATA	0.073	9.983	4.000	508.000	0.000
X5GOODIT	0.264	45.630	4.000	508.000	0.000
X5SUPPRT	0.027	3.582	4.000	508.000	0.007
X7ENVIRO	0.045	6.047	4.000	508.000	0.000
X8PRTCP	0.261	44.770	4.000	508.000	0.000
X9USEREX	0.066	8.933	4.000	508.000	0.000
X9PROTYP	0.078	10.775	4.000	508.000	0.000
X10COMIT	0.535	145.919	4.000	508.000	0.000
X13RESPN	0.122	17.725	4.000	508.000	0.000
X16EXECS	0.220	35.814	4.000	508.000	0.000
X17PROCS	0.072	9.825	4.000	508.000	0.000

Between-Subjects Effects

Table II shows the result of testing the between-subjects effects. Not all relationships between X and Y variables (or categorical factors) are significant.

First, the influence of the interaction between respondent's job position and DW phase of development on the system success is only significant at the adaptation phase. This suggests that not only the respondents' job positions play an important role on their perception of the DW success at the adaptation phase of the DW project, but this role depends also on the development phase of the DW they use.

Table II
Tests of Between-Subjects Effects

Source	Dependent	F	Sig.	Source	Dependent	F	Sig.
Corrected Model	YINIT[a]	25.901	0.000	X8PRTCP	YINIT	52.357	0.000
	YADAPT[b]	26.723	0.000		YADAPT	10.218	0.001
	YACCEPT[c]	42.708	0.000		YACCEPT	33.804	0.000
	YINFUSE[d]	5.663	0.000		YINFUSE	17.085	0.000
Intercept	YINIT	2.288	0.131	X9USEREX	YINIT	4.670	0.031
	YADAPT	20.936	0.000		YADAPT	5.013	0.026
	YACCEPT	6.852	0.009		YACCEPT	1.952	0.163
	YINFUSE	1.593	0.207		YINFUSE	18.881	0.000
FIRMNUM(PHASE)	YINIT	3.993	0.000	X9PROTYP	YINIT	11.776	0.001
	YADAPT	2.424	0.000		YADAPT	27.818	0.000
	YACCEPT	1.378	0.090		YACCEPT	0.044	0.834
	YINFUSE	3.085	0.000		YINFUSE	9.493	0.002
PHASE	YINIT	0.844	0.470	X10COMIT	YINIT	0.001	0.974
	YADAPT	158.815	0.000		YADAPT	23.984	0.000
	YACCEPT	1.845	0.138		YACCEPT	327.996	0.000
	YINFUSE	1.697	0.167		YINFUSE	3.442	0.064
JOB	YINIT	4.635	0.000	X13RESPN	YINIT	10.717	0.001
	YADAPT	4.933	0.000		YADAPT	27.121	0.000
	YACCEPT	2.721	0.013		YACCEPT	0.158	0.691
	YINFUSE	5.218	0.000		YINFUSE	30.285	0.000
PHASE * JOB	YINIT	1.210	0.247	X16EXECS	YINIT	45.722	0.000
	YADAPT	2.060	0.006		YADAPT	15.138	0.000
	YACCEPT	1.000	0.458		YACCEPT	10.313	0.001
	YINFUSE	0.636	0.872		YINFUSE	12.573	0.000
X5DATA	YINIT	18.211	0.000	X17PROCS	YINIT	7.769	0.006
	YADAPT	11.170	0.001		YADAPT	14.010	0.000
	YACCEPT	0.280	0.597		YACCEPT	0.007	0.935
	YINFUSE	0.206	0.650		YINFUSE	24.720	0.000
X5GOODIT	YINIT	31.583	0.000				
	YADAPT	27.743	0.000				
	YACCEPT	54.339	0.000				
	YINFUSE	14.823	0.000				
X5SUPPRT	YINIT	3.527	0.061				
	YADAPT	0.009	0.923				
	YACCEPT	11.069	0.001				
	YINFUSE	8.380	0.004				
X7ENVIRO	YINIT	1.821	0.178				
	YADAPT	2.691	0.102				
	YACCEPT	7.913	0.005				
	YINFUSE	6.426	0.012				

a R Squared = .775 (Adjusted R Squared = .745)
b R Squared = .781 (Adjusted R Squared = .751)
c R Squared = .850 (Adjusted R Squared = .830)
d R Squared = .430 (Adjusted R Squared = .354)

Second, firms within DW phases of development (FIRMNUM (PHASE)) have significant impact on the DW success at the initiation (YINIT), adaptation (YADAPT), and infusion (YINFUSE). At these particular phases, the effect of the DW phase of development on the system success differs considerably from a firm to another.

Third, the DW phase of development has significant influence only on success at the adaptation phase (YADAPT).

Fourth, job position is significant in its relationship with DW success at all system phases' development.

Fifth, data management (X5DATA) has significant effect on DW success at the initiation and adaptation phases. Good IT (X5GOODIT), user partnership (X8PARTCP), and oriented DW toward executive use (X16EXECS) significantly influence the system success at all its phases of development. System reliability & support team responsiveness (X5SUPPORT) and external industrial environmental pressures (X5ENVIRO) significantly affect the system success at the "acceptance & routinization" and infusion phases. End-user involvement and expectations (X9USEREX), prototyping (X9PROTYP), responsibility for the system (X13RESPN), and clarity of procedures (X17PROCS) have significant influence on the system success at the "initiation & adoption", adaptation, and infusion phases. Management commitment (X10COMIT) has significant impact on system success at both the adaptation and "acceptance & routinization" phases.3.

Parameter Estimates

Literature review, expert interviews, and statistical analysis reported in previous section led to the choice of two sets of variables (dependent and independent.) Regression parameters generated by the GLM procedure will be discussed in light of statements of prior expectations concerning the parameters of the model. Table III presents the results for estimating X constructs' parameters.

Table III
Parameter Estimates – Convariate Terms

Dependent Variables	YINIT	YADAPT	YACCEPT	YINFUSE
Intercept	0.504	-1.235 *	0.338	0.893
X5DATA	0.183 *	0.169 *	0.020	-0.036
X5GOODIT	0.173 *	-0.191 *	0.198 *	0.221 *
X5SUPPRT	0.061	0.004	-0.095 *	-0.177 *
X7ENVIRO	0.052	0.075	0.095 *	0.183 *
X8PARTCR	0.172 *	-0.090 *	0.121 *	-0.184 *
X9USEREX	0.061 *	0.074 *	0.034	0.228 *
X9PROTYP	-0.085 *	0.154 *	0.005	0.143 *
X10COMIT	-0.001	0.238 *	0.653 *	-0.143 *
X13RESPN	0.090 *	0.169 *	-0.010	0.283 *
X16EXECS	0.205 *	0.139 *	0.085 *	-0.201 *
X17PROCS	-0.070 *	0.111 *	0.002	0.234 *

* Significant at 0.05 level.

Most of the independent covariates estimated parameters are positive, suggesting a positive relationship; only few are negative. Also, most of these parameters are significant at ($p < 0.05$) level indicating strong relationship between these constructs and DW success at various phases of development.

TESTING THE HYPOTHESES

I. Significant Factors that affect the DW Success at Each Phase of Development

DW success at the initiation phase is positively affected by six characteristics – data management (X5DATA), suitability of IT (X5GOODIT), user partnership (X8PARTCP), end-user involvement & expectations (X9USEREX), responsibility for system (X13RESPN), and DW aimed at executive use (X16EXECS). This supports hypotheses 1-1a and 1-2a.

At the adaptation phase, DW success is positively influenced by seven characteristics – data management (X5DATA), end-user involvement & expectations (X9USEREX), use of prototyping (X9PROTYP), management commitment (X10COMIT), responsibility for system (X13RESPN), DW aimed at executive use (X16EXECS), and clarity of procedures (X17PROCS). This supports hypothesis 1-1b. There are two characteristics that need careful handling at this phase: suitability of IT (X5GOODIT), and user partnership (X8PARTCP) because of their negative impact on this phase success.

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However, success at the acceptance & routinization phase is positively affected by the following five characteristics – suitability of IT (X5GOODIT), industrial environmental pressures (X7ENVIRO), user partnership (X8PARTCP), management commitment (X10COMIT), and DW aimed at executive use (X16EXECS). This result supports hypothesis 1-2c. Only responsiveness of IT and support team (X5SUPPRT) needs careful attention at this phase because of its negative effect on success.

Still, success of the DW at the infusion phase is positively influenced by the following six characteristics - suitability of IT (X5GOODIT), industrial environmental pressures (X7ENVIRO), end-user involvement & expectations (X9USEREX), use of prototyping (X9PROTYP), responsibility for system (X13RESPN), and clarity of procedures (X17PROCS). This result supports hypothesis 1-2d. Three characteristics have negative influence on success at the infusion phase: responsiveness of IT and support team (X5SUPPRT), user partnership (X8PARTCP), DW aimed at executive use (X16EXECS) and require careful treatment.

II. Significant System Implementation Factors that affect the DW Success across Different Phases of Development

The results show that end-user involvement & expectations (X9USEREX) has positive influence on the DW success at the initiation & adoption (YINIT), adaptation (YADAPT), and infusion (YINFUSE) phases. This result supports the previous result concerning user participation.

Use of prototyping (X9PROTYP) is positively associated with the DW success at the adaptation (YADAPT) and infusion (YINFUSE) phases. Surprisingly, use of prototyping is negatively associated with the DW success at the initiation & adoption (YINIT) phase.

Management commitment (X10COMIT) has positive effect on the DW success at the adaptation (YADAPT) and acceptance & routinization (YACCEPT) phases.

DISCUSSION

Data Management (X5DATA)

Statistical results show that data management (X5DATA) has a significant impact on the DW success at the multivariate level of analysis.

Nonetheless, tests of between subjects effects show that data management (X5DATA) is significant in explaining DW success at both the initiation & adoption (YINIT), and adaptation (YADAPT) phases. Despite that, it did not show the same significant effect on the DW success at the acceptance and routinization (YACCEPT), or the infusion (YINFUSE) phases.

Data management is an important support characteristic for healthy DW development. From a normative point of view, DW success should increase at all phases of system development as data management improves. Analysis of estimated parameters reveals that data management has positive impact on the DW success at both the initiation & adoption (YINIT) and adaptation (YADAPT) phases.

As such, the current study confirms Kown and Zmud (1987) result that the better data management tools characteristics of existing IS are perceived as appropriate to new DW, the more likely it is that the new system's adoption and adaptation will be a success.

However, analysis of the model estimated parameters reveals that data management shows no significant impact on DW success at both the acceptance & routinization (YACCEPT) and infusion (YINFUSE). A possible interpretation of this result may be related to the availability at these two advanced phases of other tools to manipulate data in the system such as meta data itself and OLAP, for example. In addition, meta data is not used in the system, at these advanced phases, just to provide a detailed attribute map of all data. Meta data is used to extract, summarize, transform, and describe data in the DW. Only the last function "describe" has something to do with providing detailed attribute map of all data in the DW. Normally, this is a continuing process, yet most of it will be done during the early stages of DW development. The researcher believes that these two reasons are behind the conflicting responses on these two items that result in the insignificant relationship between data management and success at these two phases.

Suitability of IT (X5GOODIT)

Suitability of DW IT (X5GOODIT) appears as a significant influence on DW overall success, at the multivariate level.

Also, tests of between subjects effects show clearly that this particular variable affects DW success at each of its development phases. Here, firms had to make critical decisions in regard to which platform to use and which networking setting to apply.

This result agrees with the positive associations between innovation compatibility and development, and implementation that have been found in Barnett (1953), and Ettlie and Vellenga (1979).

Related literature indicates that this variable should continue consistently to be important and critical during all the system's life cycle . At the general level, Kimberly (1981), Tornatzky and Klein (1982), and Premkumar et al. (1994) have linked between innovation characteristics and information systems success. The IT implementation model posited that task and technology characteristics (compatibility) affect various stages of the implementation process (Kwon and Zmud, 1987; O'Callaghan et al., 1992).

Suitability of IT (X5GOODIT) has to do with selecting the DW platform, planning IT networking, and tuning data marts for the functions they provide different business areas of the firm. No doubt that these aspects reflect good physical support to the DW and hence should have positive impact on its success. Although suitability of IT has positive impact on the DW success at the initiation & adoption (YINIT), acceptance & routinization (YACCEPT), and infusion (YINFUSE) phases, it has a negative coefficient with DW success at the adaptation phase (YADAPT). This negative coefficient suggests that enhancements of suitability of IT lead to decreasing DW success at the adaptation phase. This unexpected result is due to the dissatisfaction among the subjects with respect to how good is the system to provide the required responsiveness, and to enable their organizations to identify and develop sophisticated uses. Note that some constituencies will not be able to assess these highly technical issues especially at this particular phase of development when the system is in deep need for them.

System Reliability & Support Team Responsiveness (X5SUPPRT)

Multivariate tests reveal that DW system reliability & builders technical skills responsiveness (X5SUPPRT) has a significant influence on DW overall success.

Tests of between subjects effects indicate a positive effect of this variables on DW success at the acceptance & routinization (YACCEPT) and the infusion (YINFUSE) phases.

This result agrees with Ettlie and Vellenga (1979), Mansfield (1961, and 1968), and Singh (1966) in regard to the positive association between innovation relative advantage and implementation success. Technology characteristics of existing system (including system reliability and support team responsiveness) are found important in explaining system adoption and diffusion (Cooper and Zmud, 1990), and to be positively associated with adoption and adaptation (Tornatzky and Klein, 1982).

Analysis of estimated parameters reveals that the DW success at both the acceptance & routinization (YACCEPT) and infusion (YINFUSE) phases decreases as the construct pertaining to responsiveness of IT and support team (X5SUPPRT) improves. Normally, one would expect the relationship to be positive between these dependent and independent sides. It seems that improving the system reliability and enhancing technical skills among the DW builders at these two phases come at the expense of some of the items that make up successful "acceptance & routinization" (YACCEPT) and successful infusion (YINFUSE). Introducing major changes to the system in order to improve its reliability at these advanced phases when the users already got used to the system may not be appropriate. These changes can induce resistance to change, hinder the system flexibility with organizations systems, and slow down organization adjustability to the DW. On the other hand, resistance to change escalates as activities to enhance technical skills among DW builders shifts to depend on external sources of these skills.

Responsiveness of IT and support team (X5SUPPRT) does not have significant relationship with DW success at the "initiation & adoption"(YINIT) and adaptation (YADAPT) phases. It seems that respondents disagree on this issue among themselves. Especially when it comes to comparing the new system with the traditional IS the subjects used to use, one would not expect one way responses. The reason is that the new system is still in its early stages whereas these subjects have used the traditional systems for long. However, they expect important impact of IT and support team responsiveness on the system success at more advanced phases of system development.

STUDY IMPLICATIONS

Analysis in the current study demonstrated that the substantial differences in DW success among the UAE firms might be due to organizational factors, system appropriation factors, and the DW stage of development. This implies that these firms need to be extremely cautious when adopting a DW system. Different organizational or system appropriation variables might be more dominant in determining the system success during a development phase than they might be in another.

This study is valuable to DW researchers because it identifies key areas that organizations need to address in their implementation process.

The fact that there is significant effect of DW development phase on UAE firms' data warehousing success as evaluated by their top management, end-users, and IS developers highlights the demanding organizational activity of dealing with relevant implementation-process-related and organizational-behavior-related aspects of DW implementation.

CONCLUSION

The current study has built an overall multivariate model that treats the DW success at the different phases of development (YINIT, YADAPT, YACCEPT, and YINFUSE) as a Y vector associated with the same set of factors (PHASE, JOB, PHASE*JOB, and FIRMNUM(PHASE)) and X variables (data management, suitability of IT, system reliability and IT team responsiveness, industry environmental pressures, user partnership, end-user involvement & expectations, use of prototyping, management commitment, responsibility for the system, system aiming at executive use, and clarity of procedures). The model has proven that all its factors and independent covariates have significant influence on the DW overall success.

The researchers have explicitly stated their expectation to arrive at different sets of independent variables that each may be more important than the others in explaining the DW success at each of the different phases of DW development. The acceptance of the fact that some variables are important in a particular system implementation may be totally different from variables determined to be important in other systems or applications is beginning to be acknowledged by some researchers (Cameron, 1980; Kwon and Zmud, 1987; Little, 1998).

Although some organizational and system appropriation issues were important to DW success across all its development phases, univariate statistical analysis (in terms of tests of between-subjects effects) reveals also that some issues are more important to this success at certain phases than at the others.

Focusing on the system support variables, DW success at the initiation phase is positively affected by data management and suitability of the information system. At the adaptation phase, DW success is positively influenced by data management. The impact of suitability of IT is negative and hence requires careful attention. Success at the acceptance & routinization phase is positively affected by sutiability of IT. However, responsiveness of IT and support team (X5SUPPRT) needs careful attention at this phase because of its negative effect on success. Still, success of the DW at the infusion phase is positively influenced by suitability of information system.

Finally, worthy to mention that current study, like all others, is subject to some limitations. Generalizability of the analysis results may be perceived by certain reviewers as limited by variables included in the study model, study sample, items included in survey analysis, and nature of exploratory research.

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