The Impact of Implementation Issues on Data Warehousing Development Success: Experience from the UAE

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***Abstract* - This study is aimed at identifying the impact of system support and implementation factors on successful development of data warehousing in the United Arab Emirates. The theoretical framework of the study 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 design and 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 and implementation factors have dominant impact on this success throughout the different phases of DW development.**

***Index Terms* - Data Warehousing Development, Implementation Issues, Success Factors, the UAE Experience.**

I. INTRODUCTION

The last three decades 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 [5]. There is a need for a study to investigate data warehousing success.

Although many related studies to data warehousing have been published, 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. Very few academic studies have endeavored to explore the factors that may affect data warehousing implementation (e.g., [75]). However, one may argue against their generalizability to the data warehousing problems in non-Western countries.

Many empirical studies have examined the different effects of individual organizational factors on the successful implementation of different IT tools ([80]; [132]; [43]; [83]; [39]; [113]; [4]; [7]; to name a few). Many ideas and theories have been accumulated and several models of implementation have been proposed for information systems [76]; [84]; and [115]). However, a comprehensive research model, according to [19], should provide a basis for answering research questions which build upon prior research and which have a good probability of significantly enhancing an understanding of the implementation process.

The studies conducted by [66] and [19] are two major endeavors to construct empirical integrative models to deal with success of information technology implementation. They proposed a model in which IT adoption is a function of task compatibility and technology characteristics. Yet, cultural factors were left behind. Overall, there is a scarcity of empirical studies that examine the data warehousing success in general and the effect of cultural factors on this success within an integrative model.

The current exploratory study intends to focus on the effect of the system support and implementation factors on the data warehousing success. It aims at providing empirical evidence that identifies the system support and implementation 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.

II. THE THEORETICAL FRAMEWORK

Though there is evidence that sequential stage models of technology diffusion may not depict actual implementation processes [36] [131], recent work suggests that such models may be more appropriate for technologies which are borrowed or adapted rather than custom made [89].

Cooper and Zmud [19] 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. At one time it is necessary to relax and let the organization search for effectiveness; at another it is necessary to focus on efficiency in order to control costs [15: Chapter 7].

A. A Model of The Data Warehouse 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. Two factors that contribute to system appropriation: shared understanding & meanings of the DW project, and clarity of routines & processes.

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.

Although effort is exerted to identify all factors that may influence Data warehousing success, this study is meant to concentrate on analyzing the impact of corporate culture & organizational climate on that success. 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 [41] and Sanders and Courtney [109] 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, as a DSS related 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 [46].

Prior research viewed management support systems' success from a variety of perspectives and used varying definitions and measures of success, including: (1) overall user satisfaction and decision-making satisfaction (e.g., Sanders and Courtney, 1985), (2) levels of system usage (e.g., Mykytyn, 1988), (3) perceived benefits of the information system (e.g., Money, Tromp and Wegner, 1988), (4) improved decision quality and performance (e.g., Sharda et al., 1988), and (5) business profitability (e.g., McIntyre, 1982).

Primary interviews of DW experts revealed that data warehousing success indicators should differ from one DW development phase to another. Therefore, it seems crucial to select different sets of DW success variables, such that each set of variables relates to a specific stage of successful completion. The concern here is with dynamic implementation of the DW.

Support Characteristics

Data warehousing projects are described in the literature as expensive, time-consuming undertakings [54] [108] [127][100]; therefore, having adequate resources should be critical to their success [12].

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

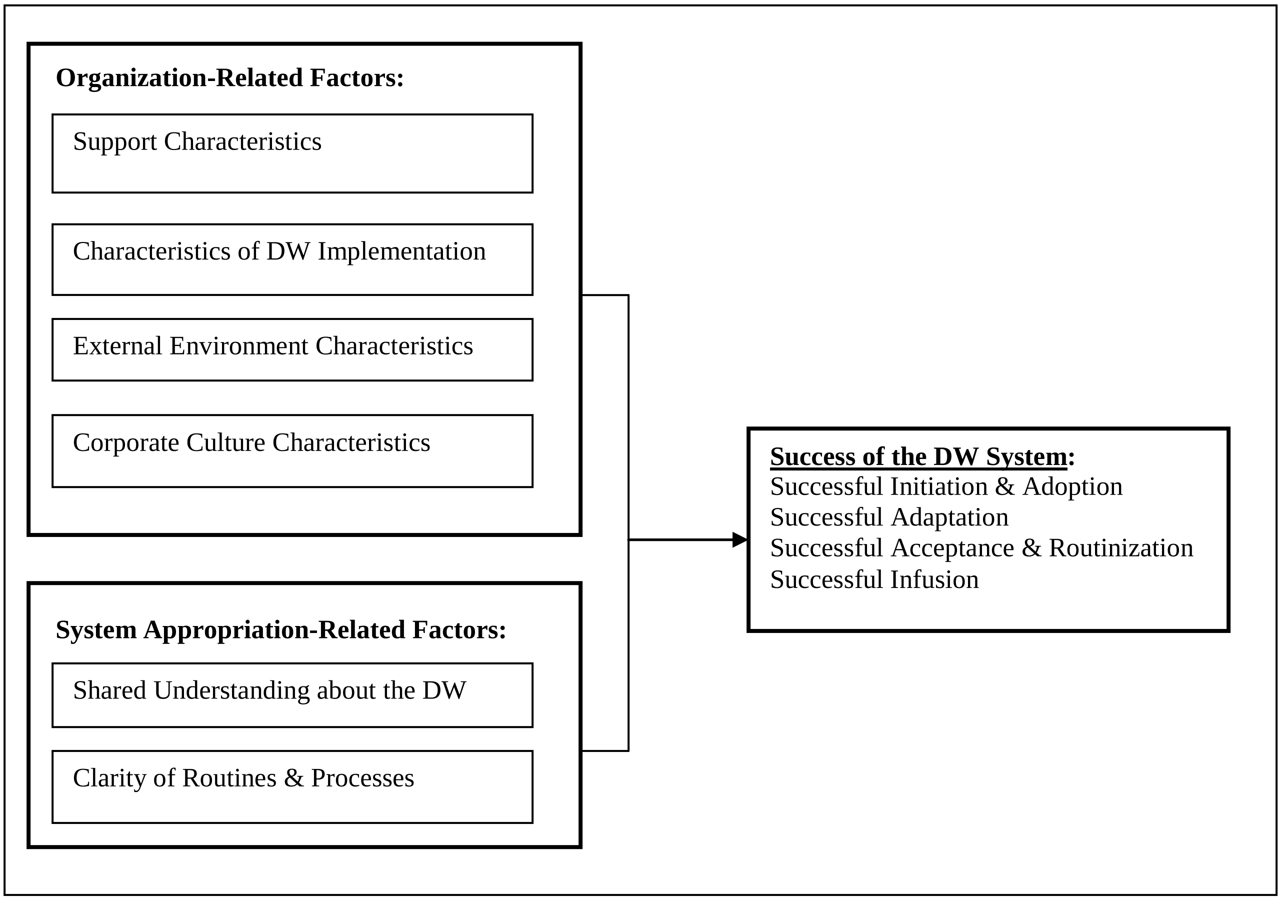

Figure 1
Integrated Model of the Factors that Influence DW Success

Past studies have found that the quality of an organization's data can have a profound effect on systems initiatives and that companies that improve data management realize significant benefits [34] [42].

Poe [92] 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 [27] states that it is essential to guarantee that needed skills are in place to support the adoption of a data warehouse.

The people who participate in systems implementations should be as important to implementation success as the way the project is managed and approached [123] [124]. 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 [12] [104]. Research has addressed many facets of teams, including the impact of the quality of teams on implementation and the effects of team member characteristics [18] [129].

The functional dependency of a DW on other operational databases in the firm, according to Lazos [70] is fundamental. Front-end analysis and decision support tools allow users to process the data, both in the data warehouse directly and in local extracted copies. Moreover, it has been argued that a marriage of Internet and DW technologies is natural [95].
Data warehousing implementations are large, complex undertakings, and funds should be available when needed; otherwise, tasks cannot be completed, deadlines are missed, and requirements cannot be met [102] and [75]. In fact, research has shown that as the time and funds increase, the likelihood of system success increases [116].

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.

The importance of organization's environmental context for innovation has been acknowledged conceptually, but rarely examined empirically. One of the pioneering studies that have explored the effect of this variable was Kimberly and Evansiko [66]. Intensive competition has become the norm in nowadays business environment. Kimberly and Evansiko [66] 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 [117]. One of the primary means for doing so is collecting more information [40]. The higher perceived environmental uncertainty, the greater the felt need for information [4] [43]. In fact, information is often defined in terms of its ability to reduce uncertainty [21].

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 [35] [117] [33] [53]. Both dimensions are likely to affect the design requirements relating to scope (complexity) and timeliness (volatility) of data warehousing systems through the 'strategic choice' of the executives in an organization [16].

Economic stability and complexity are cited as major influences on innovation behavior and technological innovation success [130] [93].

There is some convergence around the notion that more complex environments encourage adoption of innovation as an organizational strategy for coping with the uncertainty that accompanies unpredictability [8].

Implementation Characteristics

System implementation is defined, according to Cash et al. [15: p. 50], as the phase that involves extensive user-IT coordination as the transition is made from the predominately technical, IT-driven tasks of the construction step to its completed installation and operation in the user environment.

The implementation consideration has been shown as a key element in successful development of information systems [125: pp. 1-46] [120: Chapter 13]. 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" [29].

Gray [45]; Keenan [64]; Darling [23]; Griffin [47], to name a few, have postulated that managerial difficulties are important factors in successful management of the data warehouse.

Planning the DW project is very important, too. Data warehousing initiatives are large and complex undertakings, and planning for them should be carefully addressed [30] [108]. Project planning has been identified quite often as an important factor of information systems implementation success [55].

King [67] stresses the importance of MIS planning. The process of MIS planning includes: defining the mission and the objectives of information systems, and mapping them to those of the enterprise on the decision, to adopt such systems. It is one of transforming the organizational strategic purpose and direction into an appropriate, relevant, and consistent MIS objectives, constraints, and design strategies.

Researchers have recognized the crucial impact of top, executive, and operating management support on successful implementation of MSS in general. Large, complex systems projects (e. g., data warehousing) induce change within the organization and likely cause resistance through redistribution of organizational power or from the resulting uncertainty among employees [37] [62]. 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 [11: p. 72].

At the core of the data warehousing issue are two tightly intertwined questions: Who should own the data warehouse? And what is IS's role in data warehousing? Some would see that as long as data in the warehouse is used for business decision-making, therefore, the responsibility and ownership lie primarily with the business areas that generate the data and feed the warehouse. Advocates of Data Marts' viewpoint stresses that this ownership lie typically with the functional area person responsible for the particular issue. Others assert that successful exploitation of a data warehouse necessitates organizational changes, which means move away from the functional ownership concept and move towards a shared way of using information and resources. Still a third group believes that as long as this central core of information - the data warehouse - is critical to the success of management in the firm, somebody has to own it. Clearly, the CIO is the one who is going to have to own it.

As for the IS service role, it is focused on creating, maintaining, and administering the warehouse, not "owning it". An open flexible IS department is often a critical aspect in the success of a warehousing project [103].

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 [60] argues that in systems based on operational data, the classic systems-development-life- cycle applies, with the first step being requirements gathering. In 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 [75].

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 [120]. It is important to know if there are very different understandings and interpretations among users, management, and IT group of what the information the DW system provides is used for.

The Northwestern University studies of the fate of management information systems and operations research provide some clues. Published results of this research [88] [96] [97] [98] indicate that several factors are associated with successful implementation.

Operational and tactical information systems, such as Transactions Processing Systems, Information Reporting Systems, and Decision Support Systems, are different from strategic information systems, such as Executive Information Systems and Data Warehousing Systems. Making decisions, looking for trends, planning, taking action, finding problems, historical reference, budgeting, controlling and guiding activities, reporting to superiors, aiding in increasing productivity, cutting costs are the primary concerns of operational and tactical information systems [38] [77]. Strategic information systems, on the other hand, aim at improve competitiveness by changing the nature or conduct of business [125].

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 [132] [6].

Zmud [132] 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.

B. Hypothesized Effect of the Data Warehouse Implementation Factors on the System Success

Based on the above-mentioned integrative model of data warehousing success and focusing on the expected effects of the data warehouse implementation-related factors, the following functional relationships are hypothesized.

Hypothesized Effect of System Support Characteristics

Prior studies on IT implementation have found technology characteristics of existing system to be an important variable to explain innovation adoption and diffusion [19], and have found it to be positively associated with adoption and adaptation [119] [36]. 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 [69]. Poe [92] predicates that data management is an important ingredient to the success of a data warehouse system. 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 [59] points out to the importance of information and communications technology on DW success. The more 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 [27] 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 [12] [104]. Research has addressed many facets of teams and their effect on system success [18] [129]. Amoroso and Cheney [6] reports positive influence of support team responsiveness on IS successful adaptation & infusion. As needed skills to develop, manage, and maintain the new system are perceived as available, the more likely this system development will be successful. 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.

Hypothesized Effect of Implementation Characteristics

End-user involvement has long been considered an important determinant of system implementation success. Its importance can be traced from the organizational behavior literature [36]. However, empirical tests have not agreed on its expected relationship to system success [49]. While Swanson [115] showed a positive relationship, Locas [77] showed a nonsignificant relationship, Doll and Torkzadeh [40] and Olson and Ives [41] showed mixed results. Further empirical test by Guimaraes et al. [49] revealed a significant positive relationship. The more the end-users are involved in adopting and managing the system, the more likely they use it and will consider it as a success. Still, dependent on the correspondence between the users' prior expectations and the actual outcome of the system, is their perception of the system success. Hence, one would expect:

H0(2-1a): The higher the end-user involvement in and expectations about the new system, the more successful the new system adoption.
H0(2-1b): The higher the end-user involvement in and expectations about the new system, the more successful the new system adaptation.
H0(2-1c): The higher the end-user involvement in and expectations about the new system, the more successful the new system routinization.
H0(2-1d): The higher the end-user involvement in and expectations about the new system, the more successful the new system infusion.

On the other side, practical experience indicates that use of prototyping and incremental implementation is important for the DW success [29]. Inmon [59] expects a positive relationship between use of prototyping and DW success. Therefore, one would expect:

H0(2-2a): The more the use of prototyping in implementing the new system, the more successful the new system adoption.
H0(2-2b): The more the use of prototyping in implementing the new system, the more successful the new system adaptation.
H0(2-2c): The more the use of prototyping in implementing the new system, the more successful the new system routinization.
H0(2-2d): The more the use of prototyping in implementing the new system, the more successful the new system infusion.

Several researchers have emphasized the importance of top management support as a determinant of system success [38] [72] [73] [76] [109] [49]. In the innovation literature, positive associations have been proposed or found with adoption [53] [8]. In the MIS literature, Lucas (1978) found support to be positively associated with system success, while Lee [72] reported that lack of support was a critical barrier to more effective system utilization. OR/MS/MIS research has found positive association with adaptation and usage [65] [96] and with satisfaction [132]. Therefore, one would expect:

> *H0(2-3a): The stronger the management commitment to the new system, the more successful the new system adoption.*
> *H0(2-3b): The stronger the management commitment to the new system, the more successful the new system adaptation*
> *H0(2-3c): The stronger the management commitment to the new system, the more successful the new system routinization.*
> *H0(2-3d): The stronger the management commitment to the new system, the more successful the new system infusion.*

III. RESEARCH METHOD

A. Sampling Procedure

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. First, the number of companies included in the study sample from each of the UAE industries varied as a function of how important the respective industry was to the national economy. Second, the number of questionnaires to be filled out by each of the selected companies is determined (10, 20, or 30 depending on the company size approximated by its sales). Third, a random sample of individuals (30% senior management, 40% functional management end-users, and 30% IS personnel) within each of the chosen companies is selected.

B. Measurement of Variables

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" [59: p. 1]. The following is how each of the study variables was measured in this study.

Success of The Data Warehouse

Four variables are used to measure success of the data warehouse systems through its different phases of development: success at the initiation & adoption phase, success at the adaptation phase, success at the acceptance & routinization phase, and success at the infusion phase. 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 [19], timely DW decision to invest to exploit the new opportunity and make use of new technology, DW used in organization's work [19], DW answers new decision questions [75], and DW is in long term business plan,
2. Data warehouse success at the adaptation phase: DW is ready to use [19], DW is responsive [61], and can identify different and sophisticated uses [107],
3. Data warehouse success at the acceptance & routinization phase: how successful is the project team in resolving initiation issues [119], expandable DW use [104], scaleable DW [6], DW planned workability [6], DW use encouraged [19], people induced to commit to DW use [19], how successful is the steering committee in resolving integration issues [42], work practices are flexible modified [6], DW viewed as asset [109], and DW changing executives' work [85],
4. Data warehouse success at the infusion phase: the organizational systems adjusted for DW [19], and DW used to full potential [19].

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 [6]: 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 [59]: 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 [59]: High level of compatibility among hardware, network, and software, tuning each data mart for the particular function it provides for each business area,

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 [32] [53]: Volitality of the firm economic environment, volitality of the firm competitive environment, complexity of the firm competitive environment, volitality of the firm regulatory environment,

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 to operationalize these two variables are given in the following.

1. End-user involvement & expectations [9]: 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 [59] [29]: Importance of quick and frequent building of prototypes to the DW implementation, importance of prototyping tools to the DW implementation,
3. Management commitment [49]: 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,

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 [115] [10]: 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 [86]: 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,

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 to operationalize this variable are given in the following.

1. DW is aimed at executive use [125]: 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.

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 [57]: Clarity about the organizational procedures of capturing data, clarity about the organizational procedures of processing data,

C. 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.

IV. DATA ANALYSIS

A. 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.

Respondent Experience

Two criteria were used to insure reasonable respondent knowledge of the system: (1) The respondent must have had a minimum of six months' experience in using IT tools, and (2) The respondent must have had at least two years total experience as a top manager/executive, functional manage/staff, or IS personnel to qualify as a member of his or her respective constituency group.

As expected, the individuals surveyed had a high degree of experience with respect to using IT tools. Their IT experience ranged from six months to twelve years, with a mean of 2.25 years and a standard deviation of 0.56 years.

B. 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 [112] [71] [111] [52].

a. Reliability of Independent Variables

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. All the other variables passed this internal consistency test. Thus, there will be 11 valid independent variables to use in all further analysis.

b. Reliability of the Dependent Variables

Cronbach's Alpha for each of the study dependent variables is computed. All of the selected variables pass the 0.7 threshold requirement [17]. Thus, all dependent variables are considered reliable to use in further analysis.

C. Validity of Dependent And Independent Variables

Validity is the degree to which an instrument measures the construct under investigation (Maxim, 1999: pp. 208-211 and 233-236).

Validity can be established by submitting the data for factor analysis [111] [17]. The results of factor analysis can confirm whether or not the theorized dimensions emerge.

A confirmatory factor analysis 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.

Validity of Independent Constructs

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. Therefore, there were eleven independent variables to use in analysis.

Validity of Dependent Constructs

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.

D. 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 model employed is designed with two sides: dependent and independent. The dependent side included four dependent variables (success of the DW at the different DW adoption & diffusion phases). However, the independent side included two main effect factors (4 levels of DW adoption/diffusion phase, and 7 levels of jobs). It also included the interaction effect between DW development and job positions (to account for the perceptions of users who are responsible for different jobs and use DW systems at different phases of development) and eleven covariates. In order for MANOVA to reflect the way that the data was collected and because of the fact that respondents were grouped within firms, analysis was constructed so that to distinguish between effects related to DW adoption & diffusion phases and job positions, on one hand, and firms within phases, on the other. Finally, eleven covariate terms representing the reliable and valid independent variables widely used in related literature are included. The design reads as follows:

$$\left\{\begin{array}{l}\text{DW Success at initiation \& adoption}\\ \text{DW Success at adaptation}\\ \text{DW Success at acceptance \& routinization}\\ \text{DW Success at infusion}\end{array}\right\} = \begin{array}{l}\text{Intercept + PHASE + JOB + PHASE*JOB}\\ \quad\text{+ FIRM(PHASE) + X5DATA}\\ \quad\text{+ X5GOODIT + X5SUPPRT}\\ \quad\text{+ X7ENVIRO + X8PRTCP}\\ \quad\text{+ X9USEREX + X9PROTYP}\\ \quad\text{+ X10COMIT + X13RESPN}\\ \quad\text{+ X16EXECS + X17PROCS}\end{array}$$

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

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.

All dependent and independent variables in the model were computed on the basis of the simple unweighted average of the items included of the reliable and valid variables per the analysis given in the previous section.

E. Estimating the Model

Multivariate Results

Table 1 reports estimation results of the above model at the multivariate level of analysis using collected data from 580 respondents.

Table 1
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 2 reports 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.

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.

Table 2
Tests of Between-Subjects Effects

Source	Dependent Variable	F	Sig.	Source	Dependent Variable	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)

Parameter Estimates

In order to investigate this behavior in more detail, one should look into the 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 3 presents the results for estimating X constructs' parameters.

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.

Table 3
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.

F. Results for the Hypotheses

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, 1-2a, and 2-1a.

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 hypotheses 1-1b, 2-1b, 2-2b, and 2-3b. 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.

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 hypotheses 1-2c, and 2-3c. 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 hypotheses 1-2d, 2-1d, and 2-2d. 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.

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.

V. DISCUSSION

A. System Support Characteristics

As the world's largest oil-producing region, the GCC (including the UAE) is a rich area that is fully embracing information technology. Because the GCC is still in the early stage of development, security and control are an important issue. In the UAE, information systems management is driven first by information infrastructure then by operational issues [127]. As such, data resources, skills, funds, and physical support are expected to be of main concern to management of information systems in the UAE.

1.1 Data Management (X5DATA)

Poe (1996) predicated that data management would be an important ingredient to the success of a data warehouse system. 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 problems have constituted important part among the physical support problems that some DW systems experience at the late phases of their development.

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 [69] 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). The items used in this construct ask the subjects to state their degree of agreement of whether availability of data management tools are important to manipulate the data and whether availability of meta data is important to provide a detailed attribute map of all data. Note that the construct coefficient is insignificant at both advanced phases of DW development. 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 this 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.

1.2 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 [9] and [36].

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 [65], Tornatzky and Klein [119], and Premkumar et al. [94] 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 [69].

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.

1.3 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 [36], and Sanders and Courtney [109] 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 [19], and to be positively associated with adoption and adaptation [119].

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.

B. Implementation Characteristics

The IS implementation literature has pointed at implementation characteristics as a key element in successful development of information systems [125: pp. 1-46). Careful system implementation has been repeatedly cited as essential to this success [120: Chapter 13] [29].

2.1 End-User Involvement & Expectations (X9USEREX)

Fourth, the IS theory has recognized the importance of end-user involvement since the late seventies [132]. Evidence of the importance of end-user involvement in DSS development appeared in the survey of Alter [2]. More importantly, many researchers suggested that end-user involvement affected successful information systems [57]. Support for the concept goes back to the organizational behavior literature [63].

The current study found end-user involvement & expectations (X9USEREX) as a significant influence on the DW success, at the multivariate level of analysis. These results agree with Guimaraes et al. [49], Baronas [57], and Sanders and Courtney [109].

However, tests of between subjects effects show that end-user involvement & expectations (X9USEREX) has significant impact on the DW success at the initiation (YINIT), adaptation (YADAPT), and infusion (YINFUSE) phases. End-user involvement & expectations has insignificant effect on the system success at the acceptance & routinization phase (YACCEPT). Cognitive differences between MIS users and MIS designers have been suggested as a major deterrent to effective user involvement in the development of information systems [34] [57].

Analysis of estimated parameters shows that end-user involvement & expectation (X9USEREX) has a positive influence on the DW success at each of the initiation & adoption (YINIT), the adaptation (YADAPT), and infusion (YINFUSE) phases. Yet, end-user involvement & expectations does not have significant relationships with DW success at the acceptance & routinization (YACCEPT) phase. This result supports the result concerning user participation (X8PARTCP). Although user participation should not be confused with user involvement, both issues are related. Results show that respondents do feel that the aspects of user expectations, sponsorship, and involvement are taken into account during the very early phase of system development. The DW technology is new and as such end-users are not fully aware of this technology to the limit they are hesitant to get involved, or sponsor it. A normal reflection of this attitude is seen in their perception that their expectations are not accounted for in implementing the system. End-users feel that the system is oriented towards executive use, and that IT group members are in control, technically speaking. It is a temporary issue that lasts only during the early stages of the DW development. As the system develops, they are getting actively involved.

2.2 Use of Prototyping (X9PROTYP)

Inmon [59], and DeLong and Rockart [29] cite quick and frequent building of prototypes, and regular use of prototyping tools as a major method for achieving careful implementation of DW projects.

Multivariate tests reveal that use of prototyping (X9PROTYP) is significant in its association with the DW overall success.

Yet, tests of between subjects effects show that use of prototyping (X9PROTYP) has significant impact on the DW success at the initiation & adoption (YINIT), the adaptation (YADAPT), and the infusion (YINFUSE) phases.

These results agree with the findings of DeLong and Rockart [29], and Little [75] and the expectations of Kown and Zmud [69].

Analysis of estimated parameters tells that use of prototyping (X9PROTYP) has positive effect on the DW success at both the adaptation (YADAPT) and infusion (YINFUSE) phases. Nonetheless, it is negatively associated with DW success at the initiation & adoption (YINIT) phase. One would expect a positive impact of using prototyping on DW success at all phases of development, in general. However, the initiation & adoption phase, in the current study, has its own characteristics that relate to finding a match between DW solutions and its applications, and employing the DW in organizational work. On one side, both of these aspects will not lend themselves easily to prototyping. On the other side, as it shows from the results, the current study subjects do not expect a match between DW solutions and its applications at this early phase of DW development. They do not see prototyping as a feasible approach to enable employing the DW in organizational work either.

Ironically, use of prototyping (X9PROTYP) does not have significant impact on DW success at the acceptance & routinization (YACCEPT) phase. Apparently, there is a disagreement among the current study subjects on their perceptions toward the effect of using prototyping on successful DW acceptance & routinization. A possible reason of this disagreement may be found in the content of the use of prototyping construct. The construct contains two elements: quick building of prototypes and regular use of prototyping tools. Each of these element can have different effect on success at the acceptance &

routinization phase. Although the construct is coherent, obviously its contents may not have the same impact on success at the acceptance & routinization phase. For example, while regular use of prototypes tools is not expected to help the development team in resolving initiation problems (see previous paragraph), quick developing of prototypes may provide this help. In addition, a firm may develop its own prototypes without using prototyping tools.

2.3 Management Commitment (X10COMIT)

Both formal and informal organizational structures influence the introduction of technological innovations [128] [25] [118]. Much research has investigated the effect of formal structural factors on innovation, especially regarding initiation & adoption behaviors [69]. The current study concentrates only on the formal structural aspects of the DW innovation at different development phases.

It has been argued that the organizational setting characteristics significantly influence information systems adoption behavior. Certain features of organizations themselves either facilitate or encourage adoption of innovation.

Management support is repeatedly cited in the related literature as a vital consideration on successful implementation of information systems. At the multivariate level of analysis, management commitment appears significant in influencing the DW success. This finding agrees with many studies [75] [92] [49] [29] [14], to name a few.

Univariate statistical results showed that management commitment (X10COMIT) has significant influence on the DW success at the adaptation (YADAPT), the acceptance & routinization (YACCEPT), and the infusion (YINFUSE) phases. It did not have such significant effect on the DW success at the initiation & adoption (YINIT).

Analysis of estimated parameters shows that although management commitment (X10COMIT) is positively associated with both the DW success at both the adaptation (YADAPT),and the acceptance & routinization (YACCEPT). However, management commitment (X10COMIT) is negatively associated with the DW success at the infusion (YINFUSE) phases. This finding may be explained in terms of the system growth pains and management search for control. If IS management is incapable of handling the system integration problems, usually management tends to issue many new rules to achieve more control over the use of the new system then the system suffers. It becomes difficult for the system to be employed in organizational work, and for the organizational systems to adjust to account for the DW, and for the DW to be used within the organization to its fullest potential. It seems somewhat reasonable to assume that the UAE large firms that acquired DW systems and reached the infusion phase of diffusion are subject to some of these integration problems. The impression here is likely that management commitment is expected to get weaker as the system development completes. Full operational, executive, senior, and top management support normally shift their attention and support to other projects as the first project concludes.

Management commitment does not have significant association with DW success at the "initiation & adoption" (YINIT) phase. This relates to novelty of the DW technology. One does not expect that all management members in a developing country such as the UAE, especially top management, to be aware of the DW technology, their firms' need to employ such a technology, and how much support it takes to develop. As such, it is not unusual for them to allocate needed funds on demand and wait until situations develop where their managerial support is needed. Normally, there would be very few problems that require their intervention at the initiation & adoption phase.

C. Validation Interviews

A sample of representative respondents of the constituency groups were interviewed for the purpose of validating the study results. Seventy five individuals (13%) of the original study sample subjects (580 subjects) were contacted, however only 41 individuals (7%) have positively co-operated with the researcher. The interviews were administered by telephone calls. The sample members were asked if they are surprised by or agree with the study main conclusions.

Throughout each of these interviews each subject was asked to allow the researcher thirty minutes of his/her time to hear each of the study main results (and their interpretation) and give his/her answer in agree/disagree format. If disagree was the answer, the respondent was asked to give his/her alternative comment.

The overall percentage of validation sample individuals' agreement with the study significant factors that influence the DW overall success ranges between 76% and 100%. The highest overall percentage of agreement corresponded to suitability of IT, management commitment, user partnership, end-user involvement & expectations, and use of prototyping. This is where all constituencies have full agreement with the study results. Yet, the lowest overall percentage of agreement corresponded to clarity of procedures, data management, and responsibility for the system.

Top management has fully agreed with the study results that suitability of IT, industry environmental pressures, user partnership, end-user involvement & expectations, use of prototyping, management commitment, responsibility for the system, and DW aiming at executive use are the most important factors that influence DW overall success. However, end-users have fully agreed with the study findings and top management validation results that suitability of IT, user partnership, end-user involvement & expectations, and management commitment are the most important factors that influence DW overall success. On the other side, IS personnel have fully agreed with the study results that data management, suitability of IT, system reliability & support team responsiveness, management commitment, and DW aiming at executive use are the most important factors that affect DW overall success.

VI. 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.

A. Implications for Research

A DW is a formal strategic, deliberately planned technological innovation composed of man, machine, database, and procedures that is introduced into an organization in response to a perceived need on the part of one or more organizational members. Not only do these members represent various segments of the organization, but also the needs of precipitating an MIS implementation effort also span a broad range of individual and organizational motives.

As a result, related literature points to the difficulty in successfully implementing a DW as lying in the complexities of the organization's internal and external environments. This literature follows the adaptive view of planning. According to this view, the organization is expected continually to assess its internal as well as external environment variables. It proposes that the organization and its parts change in order to be aligned with the environment conditions [55]. This model suggests dominance of environment-organization-performance relationships in a simultaneous time frame fashion. In the current study, the interpretive view of planning is seen more appropriate to deal with the issue of DW implementation.

The Interpretive view of planning defines a plan as orienting frames of reference that allows the organization and its environment to be understood by organizational user groups and motivates them to act in ways that are expected to produce favorable results [128]. It emphasizes to deal with the environment through symbolic actions and communications. Still in its attempts to deal with structural complexity, notably conflicting and changing demands for organizational output, it emphasizes attitudinal and cognitive complexity among diverse constituency groups in the organization. This model suggests dominance of user groups' satisfaction-traditional performance-strategy relationships and environment-users' satisfaction relationships.

Accepting this view as well as the multi-staged view of IS implementation, the necessity of expanding the currently limited perspective of IS implementation to include user, organizational, support, innovation, implementation process, cultural, external environmental, and system appropriation related variables seems apparent.

While many of the previous studies have examined the effect of a single organizational variable on an IS's success, few studies have endeavored to explain the relationships between organizational variables and IS success employing integrative models. The current study employed an integrative model to its analysis.

Despite some explicit appreciation of organization-related variables' effect on IS success, very few of the integrative studies have examined the effect of innovation related variables on IS success. The current study model included a specific construct on innovation characteristics to test their impact on DW success within the study integrative model.

None of the reviewed integrative studies have included any culture-related variables. The current study model encompassed a distinct construct on corporate culture & organizational climate to test their influence on DW success within the study model. Statistical results of this testing showed that culture-related constructs were dominant in influencing DW overall success and explaining differences in this success between different (acceptance & routinization and on-going use) development phases.

Accepting the fact that IS success is a multifaceted, multidimensional, and multivariate phenomenon, the current study had to draw on different related literatures. Although, the current study relates more to the literature of IS implementation on which it mainly builds its model, it also builds on the organizational behavior, corporate culture and innovation literatures.

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

While most of the constructs and factors identified in this particular study are similar to some of the factors identified in the implementation literature, it must be noted that some constructs are totally new and have not been previously identified. Additionally, there are major differences in some of the items making up those constructs from those found in earlier implementation studies.

The implication here is that, the current study model is an endeavor to contribute to a contingency theory that to help the implementation efforts with respect to data warehousing. Other researchers may use the current study as a model to achieve contributions with respect to other information systems toward the development of a contingency theory. Appreciating the dynamic nature of IT and the current rate of introduction of new technologies, the development of a normative model that is generally adaptable to any system development may never be possible.

B. Implications for Practice

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.

On one side, system support and implementation aspects should be on the top of the implementation-process-related list.

It behooves top management, end-users, and IS developers in the UAE to carefully consider the factors which contribute to the DW success during the planning stage as well as throughout the entire DW diffusion process on a contingency basis.

Since individuals assuming different job positions in the UAE firms seem to have important effect on the DW success at different phases of development, there is necessary to invite these parties to increase their involvement in adopting and managing the system. Their expectations should carefully be investigated and their partnership should be encouraged.

VII. CONCLUSION

A. Study Contributions

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 [14] [69] [75].

Typically, managers who are concerned with planning the development of a particular DW system would not focus their attention on one or two variables. They would usually device a plan to manage this development. This plan is multifaceted and multivariate. It is only when a pattern can be discerned in a large number of variables that it is possible to describe or define a particular firm's DW development plan. For this reason, the attention here is focused on groups of variables, which together describe major components of the total plans of the UAE companies' DW development. Organization variables will be discussed first followed by system appropriation variables.

Generally speaking, most of the variables included in this section of the current study were subject to investigate in other studies. Most of these studies have examined the effect of a single organizational variable on an IS's success (e.g., [110] [91] [122] [31] [94], to name a few). Few studies have endeavored to explain the relationships between organizational variables and IS success employing integrative models (e.g., [49] [28] [38] [105] [69] [19] [66]).

Multivariate statistical analysis shows that users' perceptions about the DW development phase benefits & problems have significant explanatory power of the system success. More importantly, it shows that the following are the most influential organizational and system appropriation factors that impact the DW overall success: (1) support characteristics (data management, suitability of IT, and system reliability & support team responsiveness), (2) industry environmental pressures, (3) implementation characteristics (end-user involvement & expectations, use of prototyping, and management commitment), (4) corporate culture & organizational climate (user partnership, and responsibility for the system), (5) shared understanding & meanings about the system, and (6) clarity of organizational routines & processes.

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. Also, while all of the above-mentioned factors are hypothesized to have positive impact on the DW success at all its development phases, statistical estimation of relationship coefficients indicates that some of these factors may have negative effect on this success at certain development phases.

Focusing on the system support and implementation variables, DW success at the initiation phase is positively affected by data management, suitability of the information system, and user involvement and expectations. At the adaptation phase, DW success is positively influenced by data management, user involvement and expectations, use of prototyping, and management commitment. 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, and management commitment. However, responsiveness of IT and support team (X5SUPPRT) needs careful attention at this phase because of its negative effect on success. Still, while success of the DW at the infusion phase is positively influenced by suitability of information system, user involvement and expectations, and use of prototyping, it is negatively influenced by management commitment.

B. Study Scope and Limitations

It is worthy to mention that the 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.

C. Suggestions of Future Research

The current study's focus was on the UAE firms' behavior towards data warehousing. An important finding of the study was that corporate culture-related variables were significant explanatory determinants of data warehousing success. The UAE is a member of the GCC countries which represent one distinct culture block. If this is true, then it would be interesting to test the same study model on data from Saudi Arabia, Kuwait, or Qatar (all are members of the same cultural block). Comparison between results from these <u>different countries that relate to the same national block</u> would constitute a real of the study model and the effect of these culture-related variables.

More importantly, it is interesting to investigate the same phenomenon, data warehousing success, using data from <u>different countries that belong to other national cultural blocks, geographic regions, economic structures, political/legal environments, or technological status</u> and compare their results with current results.

The current study has concentrated on the UAE firms behavior towards data warehousing. All firms that were interested in this new technology during the study period, were included in the study population frame. This had the advantage of providing for a large population to select the sample from to satisfy different statistical analysis considerations. Also, it provides for enriching the analysis with reasonable degree of diversity in terms of industry, background, adoption & diffusion phase, .. etc. However, this was on the expense of business homogeneity of these firms. It may be feasible in the future to have larger number of firms that will be interested in data warehousing. If this is the case, it would be interesting to apply the current model on <u>different samples of business (specialization) homogeneous</u>

firms. This would control for business heterogeneity and test for the effect of business homogeneity. The assumption here is that internal and external environments' circumstances are very different from a business to another and they constitute major impacts on data warehousing success.

As an exploratory research, the current study is an endeavor toward investigating the factors that may influence DW success. The results gained from such a study shed light on the associative relationships between the dependent and independent sides of its model. As this technology matures, these relationships should prove stable and real. In this case, a more elaborative type of research would be feasible and important. Application of a causal analytical model would be recommended there. Latent variable structural equations model (employing LISREL, or partial least squares (PLS) techniques), and path analysis are two types of these models.

Validating the study conclusions revealed two areas of disagreement between the validating sample and the study. They concern the negative effect of use of prototyping and clarity of procedures on the DW success at the initiation & adoption phase. It might be a good idea to reinvestigate these two relationships.

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