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Abstract

Data warehouses are user-driven; therefore, a very important aspect of data warehousing research would be studying the interaction between end-users and data warehouses. As user satisfaction is commonly acknowledged as the most useful measurement of system success, we intend to identify in this article the underlying factors of end-user satisfaction with data warehouses, especially the roles of information centers in the use of data warehouses. The study demonstrates that most of the items in classic end-user satisfaction measure are still valid in the data warehouse environment and that end-user satisfaction with data warehouses heavily depends on the roles and performance of Information Centers in organizations.

Introduction

William Inmon defined a data warehouse as "a subject-oriented, integrated, nonvolatile, time-variant collection of data organized to support management needs" (Castelluccio, 1996). The purpose of a data warehouse, as stated in the definition, is to facilitate managerial decision-making. Data warehousing provides the end users with decision-making tools that create a competitive advantage. Moreover, it positions the organization to meet the demands of electronic commerce (Van Den Hoven, 1997). A data warehouse collects information from multiple systems and stores it in a fashion that allows end-users to have faster, easier, and more flexible access to key information (Edwards, 1994; Teresko, 1996).

Inmon et al. (1996) stated that a data warehouse is user driven. It provides users with much greater flexibility in using data than traditional information systems. As organizations move from centralized data warehousing and mining, which require the support of specialists in mainframe-centric environment, to client/server data warehousing and mining, which allow end-users to operate directly from their desktop computers, even greater flexibility and more possibilities are demonstrated (Fogarty, 1994; Krivda, 1996).

A large number of recent studies emphasize the effect of support groups on user satisfaction (e.g., Tafti, 1992). ICs providing adequate training and support, along with developing policies for control are factors consistently related to the success of EUC (Rittenberg & Seen, 1993). Since data warehousing is still a relatively new concept to the majority of end-users, training and support from ICs are necessary in order for end-users to operate the system more efficiently and effectively.

User satisfaction has been acknowledged as the most useful measurement of system success (Guimaraes and Gupta, 1988). Delone and McLean (1992) identified three reasons why user satisfaction has always been widely used as the single measure of IS success, 1) high degree of face validity, 2) development of reliable tools for measure, and 3) conceptual weakness and unavailability of other measures. Therefore, identifying the user satisfaction level of a system reveals a significant part of the success of the system. This research tries to identify the underlying factors of end-user satisfaction with data warehouses, especially the roles of information centers(ICs) in the use of data warehouses.

Research Methodology

There has been an overwhelming amount of research attention in finding a valid measure for user satisfaction since 1980. Among this research, Bailey and Pearson (1983) developed a semantic differential instrument with 39 items measuring overall computer user satisfaction, which was later revised by Ives et al (1983) to a 13-item instrument. Based on Ives et al. instrument, Doll and Torkzadeh (1988) developed a 12-item instrument, which consisted of five factors of end-user computing satisfaction: information content, accuracy, format, ease of use, and timeliness.

Large volumes of data and computational intensive analyses are putting enormous pressure on the choices of hardware and software for organizations' data warehousing applications (Jeffery, 1995). Therefore, our research includes these aspects of data warehouses.

A literature review dealing directly with data warehousing and end-user satisfaction issues was conducted to identify 35 potential research items. These items were incorporated into a preliminary questionnaire, which was sent to a number of academics and practitioners for review. The respondents were asked to rate the relevance of the items in terms of end-user satisfaction with data warehouses on a five-point Likert scale. The questionnaire was refined and finalized based on the results from the pretest and comments of the respondents (Appendix 1). The respondents were instructed to answer the questions on

Factor Matrix

	FACTOR 1	FACTOR 2	FACTOR 3
A1		.66123	
C1			.75934
A2		.78332	
C2			.86264
A3		.76015	
A4		.79676	
A5		.72283	
A6		.71467	
C3			.53747
A7		.65079	
S1	.82537		
S2	.78993		
S3	.66531		
S4	.61467		
S5	.87193		
S6	.73756		

Figure 1

a five point Likert scale, where 1 = almost never; 2 = some of the time; 3 = about half of the time; 4 = most of the time; and 5 = almost always. The questionnaire was distributed on 53 managers in a metropolitan area qualified as being full-time employee with some experience and knowledge of date warehousing technology. Among all the returned questionnaires, 42 were found to be complete and usable.

The criterion-related validity measures how closely the measure relates to some relevant criterion behavior external to the measuring instrument. A global item of end-user satisfaction with data warehouses was included in the questionnaire; thus, the extent to which each item correlates to the global item is indicative of its criterion-related validity. Correlation between the overall user satisfaction and individual item scores using Pearson's correlation coefficients were calculated. Items were retained if the significance level of correlation with the overall satisfaction was less than 0.05 ($p < 0.05$). The results showed that 5 out of 21 items failed to meet the requirement. The eliminated items were: up-to-date information, availability, response time, ease of use and accessibility

Factor Analysis

Exploratory factor analysis was conducted both to assess the construct validity of the measure and to determine the underlying factors of end-user satisfaction with data warehouses. In this study, the Bartlett's test of sphericity ($p=0.00$) indicates that correlation among items exists, and the Kaiser-Meyer-Olkin measure (0.73) showed middling sampling adequacy according to Dziuban and Shirkey (1974). The factor analysis was conducted on the 16 retained items using principal components analysis as the extraction technique and varimax as the method of rotation. Without specifying the number of factors, three factors with eigenvalues greater than one emerged. The factor matrix is presented in figure1. All of the primary factors loading are greater than 0.5, which demonstrates a good match between the factor and the items.

The three factors and items within the factors are presented in figure 2. The three factors are support satisfaction; accuracy, format, and timeliness; and content and ease of use. Most of the items from Doll and Torkzadeh's instrument were loaded on factor 2 (accuracy, format, and timeliness) and factor 3 (content and ease of use). This suggests that all of the items are still valid in measuring user satisfaction with data warehouses. Factor 1 (support satisfaction) consists of six items regarding the support to the end-users of data warehouses from IC, which were not in Doll and Torkzadeh's instrument

Three Factors Extracted from the Sixteen Items

Factor 1: Support Satisfaction.

S1: Do you think that IS department will provide satisfactory support to users using data warehouse?
S2: Do you think that your suggestions for future enhancement of data warehouses will be responded by IS department cooperatively?
S3: Do you think that data warehouse applications will provide proper level of on-line assistance and explanation?
S4: Do you think that data warehouse applications will provide users with adequate error-control facilities including error prevention, error detection, error correction and error recovery.
S5: Do you think that IS department will provide users with adequate level of training on using data warehouses?
S6: Do you think that data warehouse developers will interact with users extensively during the development of data warehouses?

Factor 2: Accuracy, Format, and Timeliness.

A1: Do you think that data warehouses will provide the precise information you need?
A2: Do you think that data warehouses will provide reports that seem to be just about exactly what you need?
A3: Do you think that data in data warehouses will be accurate?
A4: Do you think that you will be satisfied with the accuracy of data in the data warehouses?
A5: Do you think that the output of data warehouses will be presented in a useful format?
A6: Do you think that the information extracted from data warehouses will be clear?
A7: Do you think that you will get the information you need in time from data warehouses?

Factor 3: Content and Ease of Use.

C1: Do you think that the information content of data warehouses will meet your needs?
C2: Do you think that data warehouses will provide sufficient information for your decision making?
C3: Do you think that data warehouses will be user friendly?

Figure 2

Discussion of Findings

Our findings suggest that the end-users' satisfaction is dependent on the support provided by ICs. In discussing this, we have to study the stages that ICs go through within the organization. Researchers have come to agree that IC goes through four stages: initiation, expansion, formalization, and maturity. (Montazemi et al., 1996). Considering the fact that data warehousing is a fairly new concept to many organizations, it is safe to assume that the ICs in these organizations–when dealing with the data-warehousing project - are in the initialization stage. In other words, the end-user's performance and satisfaction is highly dependent on the training and support provided by the IC. It has to be clear, however, that the success of the data warehouse project depends on

both the IC and the end-user. On the IC side, its success depends on IC's ability to deliver adequate training and support to the end-users. On the user side, the end-user has to understand the meaning of the data included in the data warehouse. (King, 1996).

ICs should know that there is more to excellent service than near-perfect uptime (Santosus, 1995). Specifically, IC must understand the differences among the end-users. End-users are not the same on the bases of ability, functions, or needs. In their study, Ford et al. (1996) discovered that demographic factors, prior computer training, and experience had significant impacts on the participant's use of computers. Rivard (1987) found that *support provided to end-users* had the highest correlation with user satisfaction among the six factors that contribute to user satisfaction, and experiences have shown that higher user satisfaction could be achieved when ICs provided the kind of support preferred by end-users. Therefore, the support offered by the IC has to clearly assess those differences in order to provide adequate service (Mirani and King, 1994). Data warehousing applications usually take a long time to develop and perfect. IC's interaction with users during the development and improvement phases will increase end-users' satisfaction with the system. Communication with end users is considered one of the most important critical success factors for IC (Mage et al., 1988) This study has found that they should be valued as a crucial part of evaluating end-users' satisfaction with data warehouses.

Conclusion and Future Research

In this research, we have discussed the important role played by the ICs in enhancing end-users' satisfaction in dealing with data warehousing environment. Researchers should explore in depth the role of ICs by developing measures to evaluate. The different support provided by the IC to different end-users, as well as the end-users' view of the support they are getting from the IC. Researchers should answer the following questions: What element will enhance the service offered by IC? What is the appropriate training that must be provided to both the IC specialists and end-users with regard to the data warehousing environment? How do we establish a constant flow of feedback from end-users in order to improve the quality of the service provided?

References

References available upon request from (first) author (ldchen@cc.memphis.edu).