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Healthcare DSS: Perceived Effectiveness and Company Performance

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ABSTRACT

This study investigates decision support systems (DSS) in a simulated healthcare setting and assesses the factors that enhance DSS perceived effectiveness and their impact on company performance. Our analysis shows that perceived system effectiveness correlates to improved company performance. However, investing significant human resources in developing a system does not necessarily guarantee enhanced performance. The findings, consistent with previous empirical studies, strengthen the validity of the simulation exercise as a useful tool for measuring DSS perceived effectiveness.

KEYWORDS

Decision Support Systems, Simulation, Effectiveness, Healthcare.

INTRODUCTION

Healthcare companies worldwide use decision support systems (DSS) to provide computer-based support for decision makers charged with solving semi-structured and unstructured problems. Those systems support healthcare organizations in playing a critical role in one of the most essential endeavors in a humane society – the delivery of health care services (Lombardi, 2006).

Studies show that DSS will be effective if both the user and the system work toward the cooperative purpose of improving decision-making. That is, if the objectives or the expectations of the system are met, the system is effective. This is because the information needs of the users (the decision makers) are appropriately supported by the DSS (Khazanchi, 1991). Consequently, the question of measuring the effectiveness of a DSS appears to be in the hands of the users (Quinn, 2009).

This study investigates DSS in healthcare with a focus on factors that affect their effectiveness. We use a game simulation method for this research, where the game becomes the platform for the participants to experience DSS. We also examine the dissimilarity between the developed systems. This research follows an approach akin to that of Ben-Zvi (2010) who considered a DSS simulation and its educational efficacy. We augment that investigation by shifting the focus to the systems, the users, and the impact on company performance in healthcare. Classes of students formed groups and participated in a simulation exercise. The groups, simulating companies in the healthcare industry, developed DSS that were later characterized and analyzed. In addition, several variables related to DSS perceived effectiveness were evaluated and compared to group performance.

The paper is organized as follows: First, we review simulations. Then, we describe the employed simulation and set the study's hypotheses. Next, we examine the implementation of DSS in the proposed simulation and analyze related variables. Finally, we discuss the applicability of this study and draw conclusions.

SIMULATIONS

A general-purpose simulation is, by definition, a highly complex man-made environment. Its objective is to offer participants the opportunity to learn by doing in as authentic situation as possible and to engage them in a simulated

experience of the real world (e.g., Draijer and Schenk, 2004; Garris et al., 2002; Martin, 2000). This usually enhances the characteristics of the simulation, and behavior observed may be generalized to reality (e.g., Lainema and Makkonen, 2003). Over the years, researchers have reported the extent of usage of simulations in academe and business (e.g., Bharati and Chaudhury, 2004; Ben-Zvi, 2010; Chang and Cho, 2009; Chen and Lin, 2009; Durget and Smith, 2009; Léger, 2006; Nulden and Scheepers, 2001; Smith, 2010; Reinig, 2003; Yeo and Tan, 1994).

However, empirical studies employing simulations and measuring DSS effectiveness present mixed results. Some researches provide no support for the premise that the use of DSS improves group decision making effectiveness (Affisco and Chanin 1989, Goslar et al. 1986, Kasper 1985).

The simulation we employed represents a tool that successfully enables participants to develop analytical decision making skills, including problem identification skills; data handling skills and thinking skills. Furthermore, with the improvement of technology, simulation exercises have become more sophisticated and user friendly. We elaborate on the simulation in the next section.

HYPOTHESES AND METHODOLOGY

The Simulation Employed

This study employs the International Operations Simulation - INTOPIA B2B (http://www.intopiainc.com). We use the simulation to establish a managerial decision-making context: The simulation involves the participants in the executive process, motivates their need for decision-making aids and forces them to adopt a managerial viewpoint associated with management information systems (MIS) and DSS.

The simulation is played for a full semester. Each simulated company may cover any combination of the functions of manufacturing, marketing products or selling to overseas distributors, serving as a distributor or a subcontractor, exporting, importing, financing and licensing. The incoming participants play 6 to 10 game-periods. The task of the companies is to make decisions which will guide operations (simulated by the easy to realize computerized system) in the forthcoming period and which will affect operations in subsequent periods.

Decisions are made once a week. The length of the each time period simulated is usually referred to as one year. Dozens of decisions, covering the entire range of a typical business, are required of a company in each period. The decision-making process is based on an analysis of the company's history, interaction with other companies and the constraints stated in the player's manual (e.g., procedures for production, types of available marketing channels).

The performance of a company in each period is affected by its past decisions and performance, the current decisions, simulated customer behavior, and the competition – the other companies in the industry.

The simulation has become highly realistic as a result of the efforts invested in it to simulate the total environment. Participants in the simulation immerse themselves in this artificially created world. They form teams (without external intervention or manipulation), allocate responsibilities for specific functions, and work to achieve common goals which they themselves define.

The study was conducted in a university accredited by the Association to Advance Collegiate Schools of Business (AACSB). The participants were senior graduate students. The students were divided into 5-participant-groups (companies). We explored a class with 20 teams.

Study Hypothesis

This study aims to measure the effectiveness of the developed DSS. For that, we measure the participants' perceived benefits from using a DSS, variables related to DSS use, user satisfaction, and success. As we use the simulation as a tool for measuring MIS and DSS, we follow hypotheses examined by Ben-Zvi (2007). Our key hypothesis examines the relationship between DSS success factors and company performance.

Many researchers in MIS have studied the success and failure of DSS from several perspectives (Subramanium, T. and Patel, 2010; Todd and Benbasat, 1999; Zopounidis et al., 1992). Common measured criteria of DSS success include system's reliability and flexibility (Srinivasan, 1985), the ability of a system to support decision-making and problem-solving activities (Crowston et al., 2006; Garrity et al., 2005; Webby and O'Connor, 1994), use and user satisfaction (Baroudi et al., 1986; DeLone and McLean, 2003; Lawrence et al., 2002), and decision confidence

(Goslar et al., 1986). In this study we examine the following DSS success variables: usefulness, user satisfaction, system contribution to functional area and company success, own use and colleague use.

Our hypothesis relates DSS effectiveness variables to company performance: *The measures of DSS success are highly correlated with company performance.*

Procedures

At the end of the semester, after the last set of decisions had been made, each group was required to present its DSS in class and to submit a report consisting of: (1) a definition of the scope of the system; (2) a decision analysis; (3) a system design; and (4) a discussion of the contribution of the system in achieving the group's objectives during the simulation. At that same meeting, each of the students was asked to complete a short individual questionnaire on the DSS assignment (see the appendix for the text of the questionnaire). In total, we analyzed 98 questionnaires.

RESEARCH FINDINGS

Developed Systems

Most companies nominated a Chief Information Officer (CIO). All companies reported developing an information system but none of the companies reported major modifications during the semester. Most of the companies developed a Microsoft Excel spreadsheet-based DSS. The major characteristics of the systems developed are exhibited in Table 1.

For this study, the most relevant aspect of Table 1 is the extent to which the companies differed on their systems. Companies adopted different application areas with models including various statistical analyses, spreadsheets—and even linear regressions. While it cannot be claimed that the distribution of attributes of systems exactly measures that in the real world, the degree of diversity of systems developed, based on existing tools, does appear to be quite real.

Co.	System Area	Nature of System	Data Analysis	Graphics
1	R&D, Production, Finance, Marketing	Electronic Sheet	No	Yes
2	R&D, Production, Finance	Electronic Sheet	No	Yes
3	Production, Finance	Electronic Sheet	No	No
4	R&D, Production, Finance, Marketing, Market Analysis	Electronic Sheet	Yes	No
5	Production, Finance	Electronic Sheet	No	No
6	R&D, Production, Finance, Marketing, Market Analysis	Electronic Sheet	Yes	No
7	Production, Finance	Electronic Sheet	No	No
8	R&D, Production, Finance, Marketing, Market Analysis	Electronic Sheet	Yes	No
9	Production, Finance	Electronic Sheet	No	No
10	R&D, Production, Finance, Marketing, Market Analysis	Electronic Sheet	Yes	No
11	Production, Finance	Electronic Sheet	No	No
12	Production, Finance, Marketing	Electronic Sheet, Regressions	No	No
13	R&D, Production, Finance, Marketing	Electronic Sheet	No	No
14	R&D, Production, Finance, Market Analysis	Electronic Sheet, Regressions	Yes	No
15	R&D, Production, Finance	Electronic Sheet	No	Yes
16	Marketing, Market Analysis	Electronic Sheet, Regressions	Yes	No
17	Finance, Marketing, Market Analysis	Electronic Sheet	Yes	Yes

18	Production, Marketing	Electronic Sheet	Yes	Yes
19	R&D, Production, Finance, Market Analysis	Electronic Sheet, Regressions	Yes	No
20	Production, Marketing	Electronic Sheet	No	No

Table 1. Characteristics of Systems Developed.

Analysis

In order to enhance the validity our results, we compared them to previous findings reported by Ben-Zvi (2007). The analysis of the data relates both to individuals and to companies. First, the customary variable in DSS studies, degree of success, is analyzed. Next, company performance is analyzed with regard to the developed DSS. The internal consistency among the items, Cronbach's alpha was 0.8345.

Means and variance of responses to the first 10 questions are exhibited in Table 2.

Variable	Individuals (n=98)	
	Mean	S.D.
Familiarity	5.15	1.27
Usefulness	5.91	1.22
Own use	5.45	1.41
Contribution to functional area	5.76	1.55
User satisfaction	5.81	1.17
Use by colleagues	4.57	1.42
Contribution to company success	5.75	1.27
Participation	4.11	1.54
Disturbance	2.96	1.68
Met expectations	5.71	1.26

Table 2. Means and Standard Deviations (S.D.) of Responses for Individual and Companies.

Company Performance Analysis

This section investigates company performance versus all measured variables. Company performance was measured by the companies' accumulated retained earnings (accumulated profits). Table 3 exhibits the correlations between company performance and all DSS measured variables of this study. Correlation was made for the company level.

The results indicate that five variables are strongly related to the company's performance: system's usefulness, user satisfaction, contribution of the DSS to the diverse functional areas and to the entire company success and whether the DSS met its expectations. It seems that the greater the satisfaction from the developed system in meeting its intended aim as set by the users, the better the company's performance in the simulation. Nevertheless, the two variables related to the participation of users in defining the DSS present negative correlation with the company's performance. It seems that added involvement in developing the DSS impairs performance.

To summarize, it can be claimed that a successful DSS in the eyes of the users is related to better company performance in the simulation. However, investing a lot of human resources in developing a complicated system that makes use of several features does not necessarily guarantee enhanced company performance.

Variable	Correlation
Familiarity	-0.03
Usefulness	0.69
Own use	0.27
Contribution to functional area	0.71
User satisfaction	0.79
Use by colleagues	0.27
Contribution to company success	0.68
Participation	-0.24
Disturbance	-0.02
Met expectations	0.74

Table 3. Correlation between Company Performance and All Measured Variables (n=20 companies).

DISCUSSION AND CONCLUSIONS

This study examined companies in a simulated healthcare industry. Although the general environment that each team functioned within was similar, the companies became differentiated. That is, each company assumed a considerably different strategy, different operating decisions, and a different approach to DSS. And leaving DSS development decisions to the companies resulted in a variety of applications and a wide array of models, programs and modes of operation. It appears that these companies reflect most real life business approaches to healthcare DSS.

In addition, this study tested a hypothesis. We obtained mixed results: while some factors, such as perceived usefulness, perceived contribution of the system and user satisfaction, promote DSS perceived effectiveness and company performance, other factors, such as familiarity with the system, system use and participation in defining the system do not support this notion. These results replicate a number of previous findings.

More generally, our experience suggests that the efficacy of simulations as platforms for implementing DSS is twofold. First, participants practice the art of healthcare decision-making; participants are excited, motivated and strive to make better decisions; they become actively involved in the simulated decision-making process and in the development of MIS and DSS of their choice. Second, because the simulation is very practical, the participants themselves frame the relationship between the decision-making processes, the designed information systems and the outcomes of their use. This exemplifies how healthcare decision-making is more effective using DSS and also provides an integrative view of some of the tasks and practical uses of DSS in healthcare. The ultimate result is more effective MIS and DSS in the 'real' healthcare industry.

Furthermore, the results we obtained have implications for both researchers and practitioners. For researchers, this study demonstrates the importance of including subjective measures when examining DSS effectiveness. In this study we included variables related to DSS effectiveness. Nevertheless, studies should not be limited to those variables only. Other studies suggest other variables that can be measures. Nevertheless, researchers need to be cautious about using different measures of system effectiveness and performance. While some measures are positively associated with system effectiveness or company performance, other factors do not present a direct impact. In addition, researchers should clearly specify what the exact nature of the measured variables is. System use and system perceived effectiveness may exhibit entirely different phenomena.

The implications for healthcare practitioners are also important. They have to realize that a lack of strong behavioral indications of system familiarity, participation in defining a system or system use (either own use or use by colleagues) may not necessarily result in a negative outcome. If they do not recognize a strong connection between the two, the result may not necessarily be negative, i.e., losses for the company. By creating a better understanding of the perceived measures, healthcare professionals could better interpret and understand the data pertaining to those measures more accurately.

This study has limitations that should be noted. Most companies in this simulation developed spreadsheet-based DSS. Some may regard spreadsheets as over simplistic DSS. We believe, however, that presently, spreadsheets are popular and sufficient tools to create extremely powerful and practical DSS. Moreover, spreadsheets offer some substantial advantages: individuals, not necessarily IS oriented, are familiar with spreadsheet tools, so they can quickly employ them for the development of a DSS. Spreadsheets also allow a dynamic data updating and facilitate data visualization. Also, modern spreadsheet programs contain powerful data analysis tools (e.g., Analysis ToolPak in Excel); most teams incorporated data analysis tools into their DSS.

However, while feedback from participants is favourable and the simulation is sufficiently complex to provide challenges and a realistic simulation of decision making, no simulation can encompass all aspects of information systems in healthcare. Because the simulation decisions are more simplistic than those of the real world, the DSS required to support the decisions are less complicated than those in reality. Therefore, there is a need to determine how simulations can be augmented to study the more complex, dynamic aspects of the DSS domain: use and performance can be easily measured and evaluated, but the cost/benefit or return of investment of a specific information system is as vague in the game as it is in real life.

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APPENDIX

Questionnaire – Decision Support Systems Report

The following questions relate to the Decision Support System, which was developed in your company. Please indicate your answers:

		Not at all	To a very small degree	To a small degree	To a degree	To a large degree	To a very large degree	Maximally
1.	I am familiar with the system developed in the company	1	2	3	4	5	6	7
2.	The system is useful for decision making	1	2	3	4	5	6	7
3.	I personally used the system for making decisions in my role in the company	1	2	3	4	5	6	7
4.	The system contributed to the company's performance in my functional area	1	2	3	4	5	6	7
5.	I am satisfied with the system	1	2	3	4	5	6	7
6.	My colleagues in the company used the system for decision making	1	2	3	4	5	6	7
7.	The system contributed to the company's success	1	2	3	4	5	6	7
8.	I participated in defining the system	1	2	3	4	5	6	7
9.	Developing the system interfered with my functional role in the company	1	2	3	4	5	6	7
10.	The system's benefits met my expectations	1	2	3	4	5	6	7