Business Games as DSS Laboratories

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Abstract

In this study a business game is used as a vehicle for decision support systems (DSS) research. Eighteen companies, consisting of ninety graduating M.B.A. students, participating in a business game were required to develop DSS and to report on the systems developed. Each of the eighteen companies developed a system of their own choosing, without external guidance. Individual questionnaires were later used to evaluate a number of relevant variables: use of systems, contribution of systems, association with systems and user satisfaction.

Findings, compared with reported results of previous empirical study, exhibit differentiations in success of DSS between companies. This indicates the potential of using business games as a realistic environment for laboratory research on management information systems (MIS) and DSS.

1. Introduction

Many Methodologies are available for MIS research (Jenkins 1985; Palvia et al. 2004). Laboratory experiments are considered one of the main forms of research in the field. Moreover, Palvia et al. (2003) found that laboratory experiments are the dominant approach in research into DSS, group decision support systems (GDSS), and software/programming languages. In laboratory experiments research is conducted in a simulated laboratory environment, where the researcher manipulates the independent variables, controls the intervening variables, and measures the effect of the independent variables on the dependent variables. Human subjects are commonly used in a laboratory setting. As Laboratory experiments permit isolation and control of a small number of variables, they may provide insight into precise relationships between the variables studied.

Ein-Dor and Segev (1984) asserted that the multitude of variables affecting MIS, the resulting complexity, and the cost involved in creating simulated environments encourage researchers to employ field surveys or case studies rather than laboratory or field experiments. Although all MIS research methods are important and all contribute to the acquisition of knowledge, laboratory experiments are particularly attractive because of the preciseness of measurements which they permit and the ability to define and validate findings from the field. However, most such experiments in the past have been based on simulated environments prepared especially for the experiment on special purpose simulations, e.g., the Minnesota experiments in Dickson et al. (1977). The objective of this paper is to suggest general-purpose business games as a realistic environment for laboratory research on MIS and DSS and to report on an experiment with one such game.

2. Business Game Simulations

A general-purpose business game is, by definition, a highly complex man-made environment. The state of business simulation games is described from time to time from a variety of perspectives. Recently, a special issue of *Simulation & Gaming* (Volume 32, no. 4, 2001) was dedicated to the state of the art and science of simulation and gaming. Wolfe and Crookall (1998) assessed the state of simulation and gaming as a scientific discipline.

The objective of a business game is to let students learn by doing in as authentic a management situation as possible and provide them with the opportunity to plan and implement a strategy in a competitive environment (e.g., Ein-Dor and Segev 1984; Segev 1987). In most cases; this makes the business game impractical for controlled experimentation. However, it enhances the characteristics of the game as a simulation of real life and behavior observed may be generalized to reality (e.g., Babb et al. 1966; Lainema and Makkonen 2003).

Researchers have reported the extent of usage of simulation games in academe and business (e.g., Brozik and Zapalska 2000; Dasgupta 2003; Dickinson et al. 2004; Dickson et al. 1977; Eldredge and Watson, 1996; Faria 1998; Faria 1987; Larréché 1987; Lucas and Nielson 1980; Muhs and Justis 1981). However, these simulations created especially for research purposes are usually oversimplified and less realistic. Most involve only a single decision maker interacting with the computer program facing rather uncomplicated structured problems in a relatively restricted time period.

The Business Management Laboratory/Systems Laboratory for Information Management (BML/SLIM), introduced in the late 1970s, attempts dealing with these drawbacks. BML involves a variety of decisions ranging from structured to unstructured operational control, management control, and strategic planning problems (Courtney et al. 1983). The BML is a business game, which may be run with one or two products in one or

two market areas with up to eight simulated companies, and in which approximately 50 decisions are made for every period of play. The BML has been utilized as a research environment for studies of decision making (e.g., Affisco & Chanin 1988, 1987, 1986 and Courtney et al. 1983).

However, very mixed results of empirical studies of DSS effectiveness regarding the BML may be found in the literature. Some researches provide no support for the premise that the use of Decision Support Systems improves group decision making effectiveness (Affisco and Chanin 1989, Goslar et al. 1986, Kasper 1985). Researchers attribute these results to the following main reasons:

(i) Limited number of computers available, resulting in an inadequate amount of available computer time indicated by the study groups themselves.

(ii) Much time was dedicated for practicing the use of the system and dealing with the mechanics of the software rather than the decision making.

(iii) Training consisted solely of how to technically operate the existed DSS. Nevertheless, no training in its use as part of a logical decision making process was offered. As a result, the groups were expected to trust implicitly in results generated by the DSS, which utilized models of which they had no knowledge. The subjects received no instruction in the models that were utilized.

(iv) Many subjects felt that the BML was complex and not easy to comprehend and that "many of the decisions were ill-structured" (Courtney and Paradice 1993).

As the use of the BML did not significantly affect group decision making performance due to the above reasons, a better computerized software and environment conditions are

desirable. The International Operations Simulation Mark/2000 (hereafter INTOPIA) represents a tool that successfully deals with the BML weaknesses.

3. Hypotheses and Methodology

3.1 The game employed

This study employed the international version of a widely used business game developed in the United States and commonly known as INTOPIA. The prime purpose of this business game is to increase students' understanding of strategic management of international operations in general and those of the multinational corporation in particular. Furthermore, the game is designed to yield substantial payoff in general management training. It forces participants into a stream of truly entrepreneurial top management decisions of business philosophy and a search for logic and synergy in the business objectives-strategy-implementation sequence (Thorelli et al. 1995).

The game is played for a full semester and is operated by up to 25 competing companies. "Operated" is a broad concept and covers any one or any combination, of the functions of manufacturing, marketing of one's own products, serving as a distributor or a subcontractor, financing and licensing. The incoming participants enter a "going concern" with 4 periods of simulated history and play 6 to 10 additional 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. The decisions are made once a week and the length of the 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 as presented to players at the beginning of the game, interaction with other companies and external agents of the game (e.g., bankers, board

of directors), and the constraints stated in the player's manual (e.g., procedures for production, types of marketing channels available).

The decisions are input to the simulation. 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 game has become highly realistic as a result of the efforts invested in it to simulate the total environment. Students participating in the game immerse themselves in this artificially created world. They form small teams, allocate responsibilities for specific functions, and work to achieve common goals which they themselves define. While each of them becomes a specialist in his or her function, a joint effort is required to pursue the common objectives of the company.

3.2 Subjects

The study was conducted at the Faculty of Management, Leon Recanati Graduate School of Business Administration, Tel-Aviv University. The participants were senior M.B.A. candidates. The M.B.A. program consists of 28 semester units, of which 12 are core courses and 16 advanced electives. The advanced electives include specialization courses and the business game, which is usually taken towards the end of the curriculum. The sample studied was the entire group of 90 students who participated in the game during the spring semester of 2005. The students were divided into 18 companies, each with 5 participants.

The formation of the companies and allocation of roles within companies proceeded without external intervention or manipulation, and were reported to the game administrator before the game itself began.

3.3 Hypotheses

The hypotheses in this study relate variables in DSS studies (degree of success and degree of active involvement) to DSS effectiveness. They relate to both individual and company level. The following hypotheses will be addressed:

(1) The measures of success present high and significant correlation between them.

(2) The measures of active involvement present high and significant correlation between them.

(3) The relationships between the measures of success and active involvement are highly significant.

(4) Company differentiation: Variance between the companies is significantly different from the variance within the companies.

3.4 Procedures

This study follows the procedure set by Ein-Dor and Segev (1984) in their study of an Israeli version of a business game known as the New York University Graduate School of Business Administration Management Game. Their study was conducted with only 6 companies during the fall of 1982. This research intends to update their findings by extending their studied game to a much larger group. Although this study considers a different game, both games hold the same basic characteristics (e.g., a variety of executive functions, simulated environment, etc.).

At the beginning of the game, a requirement to develop and report on DSS was communicated to the participants. Each group (company) was required to submit a report on its developed DSS to the game administrator by a certain date. The report was to include the following items: (1) a definition of the scope of the system; (2) a decision analysis; (3) system design; and (4) a discussion of the contribution of the system to the game.

It is important to note that unlike in previous BML researches, this task was introduced as an organic part of the game in order to enhance the simulation, as the procurement, processing and communication of data and related support systems for decision making are of utmost importance in competitive business. The participants themselves, without any intervention from the game administration, had to decide who could develop the system and its scope.

3.5 Questionnaires

At the end of the semester, after the last set of decisions had been made and the companies had submitted their final reports, each of the students was asked to complete a short questionnaire on the DSS assignment. It was pointed out that the questionnaire would have no effect on companies or individual grades; students were encouraged to respond fully and accurately (see appendix A for the text of the questionnaire).

4. Notions and Findings

4.1 Developed Systems

The 18 companies developed different DSS, mainly based on Microsoft's Excel spread-sheet function. The major characteristics of the systems developed are exhibited in Table 1.

(Insert Table 1 here)

For this study, the most important aspect of Table 1 is the extent to which the companies differed on the dimensions relevant to research on MIS. Different companies approached different application areas with models including various statistical analyses, spread sheets, and even linear regressions. Only one company employed a package ("Easy

Plan"). Of the 18 systems developed, ten were interactive and eight were batch. Only four companies developed graphic outputs, while the remaining fourteen did not. Finally, the sophistication and complexity of the models employed varied enormously from simple spread-sheet analyses (companies 5 and 7) to a complex linear model (company 4). 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 very real.

4.2 Data Analysis

In order to test the possibility of using the business game as a DSS laboratory, the findings of this study were compared to previous findings reported by Ein-Dor and Segev (1984). As MIS and DSS variables can be measured either objectively or subjectively, in this study the compared data is participants' subjective assessments.

The analysis of the data related both to individuals and to companies. Company's data in this study aggregate the individual data of the company's members, and is conducted in order to determine whether the participants in the game coalesce into distinguishable companies. The criterion for differentiated companies was the degree to which the behavior of individuals within companies was more consistent than that for randomly chosen individuals. This will be elaborated in Section 4.5.

First, the customary variable in DSS studies, degree of success, is analyzed. Next, association with DSS is explored. Finally, company differentiation is discussed. Companies are represented in this study by average responses of members to the questions. The internal consistency among the items, Cronbach's alpha (Cronbach 1951), is 0.8165 at the individual level and 0.8274 at the company level. Cronbach's alpha for the measures of success was 0.8452 at the individual level and 0.8561 at the company level. Finally, Cronbach's alpha for

the measures of active involvement was 0.8794 at the individual level and 0.8903 at the company level. Means and variance of responses to the first 10 questions are exhibited in Table 2.

(Insert Table 2 here)

4.3 Success of DSS

Many researchers in MIS have studied the effects of a variety of variables on the success and failure of MIS (e.g., Ein-Dor and Segev 1981). In the DSS field, some studies have focused on the design, implementation and use of DSS (e.g., Ariav and Ginzberg 1985; Keen 1980). Common criteria for DSS success include profitability, application to major problems of the organization, quality of decisions or level of performance, user satisfaction, and widespread use.

We examined three of these variables in this study as follows:

1. Level of performance – contribution of the system to companies' performance in respondents' functional areas (question 4) and to the company's overall success (question 7).
2. User satisfaction – satisfaction (question 5) and usefulness of the system as evaluated by participants (question 2).
3. Use – own use by respondents (question 3) and use by colleagues (question 6).

In this study we adopt the approach taken by Ein-Dor and Segev (1984), which regards all success criteria as being codetermined and does not assume cause-and-effect relationships between them. The data obtained from this business game is compared to their findings based on this approach.

Table 3 exhibits all correlations between the success criteria in this study, as defined above, and reveals strong and highly significant relationships between all of them, except for

the correlation between own use and colleague use. The strong correlations found would seem to indicate that the criteria are indeed all related and presumably all measure some aspect of success. The lack of mathematical correlation between the own use and the colleague use variables does not imply that those two variables are not correlated. A depth examination revealed that participants were divided into two major categories, by companies: companies where all members had a relatively high use of the systems developed (a highly positive correlation between own use and use by colleagues) and companies where only one or two members used the system (a highly negative correlation between own use and use by colleagues). This caused the average correlation between the two variables to become infinitesimal.

(Insert Table 3 here)

There are very strong correlations between the measures of success at the level of companies. Note that the grouping procedure by companies largely increased the correlation between own use and use by colleagues. The finding that the correlations are not always highly significant can be attributed to the relatively small number of companies in this study. Even so, an examination of the relevant data (Table 4) indicates that in most cases the relationships are significant. Thus, the data in the study strengthen the hypothesis concerning the nature of success and failure of DSS and replicates previous empirical findings.

(Insert Table 4 here)

4.4 Association with DSS

Association of management with DSS (i.e., active involvement of management) has long been considered as contributing to, or perhaps even essential to, the success of DSS. In this study, association with DSS was evaluated on the basis of students' familiarity with their company's systems (question 1) and participation in defining the system (question 8).

In studying general association with MIS, Swanson (1974) found that appreciation and involvement with MIS are co-produced so that managers who are involved will be appreciated and those who are uninvolved will be unappreciated. He regarded understanding as an intervening variable through which involvement is transformed into appreciation. In this study, there is a high correlation of 0.829 (significance<0.001) between familiarity and participation; familiarity is the equivalent of Swanson's understanding, and involvement, or participation, is strongly associated with it. This, familiarity and participation are jointly used as measures of association. At the company level, the correlation between familiarity and participation is 0.864 (significance<0.001). These correlations are even higher than the correlations found in the previous business games study by Ein-Dor and Segev (1984), who reported of correlations of 0.68 and 0.45, respectively.

Previous studies also found that DSS are more successful where top management is more involved (e.g., Willoughby and Pye 1977). The relationships between the measures of association and the success of DSS at both the individual and company level are exhibited in Table 5.

The table indicates that at both individual and company level there is a fairly significant relationship between the measure of own use and association with DSS. However, other measures of success present more tenuous relationship with association with DSS. Moreover, familiarity is significantly more related to the measures of success than participation. Thus, the results of this study only partially conform to previous reported findings.

(Insert Table 5 here)

4.5 Company Differentiation

Ein-Dor and Segev (1978) indicated that the organizational and external environments of information systems are recognized as one of the factors impacting the success and failure

of information systems. Environments factors also present some of the major obstacles to DSS research since they are uncontrollable for all practical purposes. Furthermore, the companies' environments are so complex that full description is infeasible. As a result, these factors invariably cloud the meaning of data collected in trans-organizational comparisons of DSS.

One of greatest advantages of the business game as a research vehicle is the common and controlled external environment it provides for all companies. In spite of the identity of initial situations significant differences in DSS emerged by the end of the game. The data on differences of content between systems are contained in Table 1. Table 5 exhibits the analysis of variance, by companies, for each variable in the questionnaire. The data indicate that, for 5 of the 10 variables, the variance between companies is significantly different (at the .05 level) from the variance within companies.

There is a degree of consensus within companies as to their success. For two measures of success, the level of performance and the user satisfaction, results exhibit highly significant F values, indicating that the variance of responses within companies are appreciably smaller than those between companies. The third measure of success, the system's use, does not exhibit low variance of responses within companies. This can be attributed to the fact that some companies introduced a relatively high use of the systems developed by all members, while other companies performed with only one or two members using the system.

A closer examination at the companies' characteristics reveals that the key factor to success of the companies' DSS was their functional areas. Companies which adopted multifunctional DSS systems (e.g., Research and Development, Production, Finance, Marketing and Market Analysis) overall reported of a higher level of performance, use and satisfaction. The nature of the developed systems also contributed to their success as diverse systems, using several spreadsheets and regressions, were more effective. Nevertheless, we

did not find evidence that the use of interactive systems or graphics significantly added to the success of the DSS.

To summarize, it can be claimed that differentiated companies emerged from the game. The differences cannot be artifacts of the environment, which is common to all. Thus, the business game permits the analysis of differences in DSS in organizational contexts unhindered by uncontrollable external environmental influences.

(Insert Table 6 here)

5. Discussion

Simulated companies were formed in this study. Although the general environment was mutual to all participants, the companies became differentiated. Each assumed considerably different strategy, different operating decisions, and a different approach to DSS. Leaving to the companies the decision on areas of DSS development resulted in a variety of applications, utilizing an array of models, programs, and modes of operation. It appears that these companies reflect most real life business approaches to DSS.

In addition to the creation of simulated companies with differentiated approach to DSS, this study also tested four hypotheses. The first two hypotheses pertain to success and association with DSS indicators were confirmed, replicating a number of previous findings. However, the two other hypotheses examining relationships between success and association with DSS indicators and company differentiation were only partially confirmed. Nevertheless, overall, results at both the individual participant level and the company level (with reservations regarding the relatively small sample size) give face validity to the application of conclusions to be derived from simulations to real businesses. The business game may be used as a vehicle to implementation research into the DSS domain.

Given that business games are acceptable as vehicles for DSS research, their greatest advantage would be in controlled experimentation. In this context, the game environment has the dual advantage of greater reality than most laboratory situations while maintaining greater simplicity than real-life organizations.

As real-life organizations grow to be increasingly complex, analysis becomes extremely difficult and the significance of data collected in the field is often blurred. In the business game environment, the complexity is somewhat reduced and many of the variables are controllable, at least to some extent. Methodical variation of the controllable variables would permit much easier examination of relationships between variables. Those relationships, depicted in a business game outline, might then be more confidently identified in real situations. Thus, business games would be used as laboratories for discovering new relationships and a better understanding, which can be then projected in real-life organizations. As more data from real-life organizations is available, it will also become easier to determine the extent to which game situations replicate reality. This information is needed in order to validate reasoning about real-life situations based on business game results.

6. Conclusions

Simulated operating companies were created in this study, each assuming considerably different approach to DSS. Findings related to success indicators and associations with DSS were reproduced in this study. Results at both the individual participant level and the company level (with reservations regarding the relatively small sample size) give face validity to the application of conclusions to be derived from simulations to real organizations.

Furthermore, as more data from real situations become available, it will also become easier to determine the extent to which game situations replicate reality. However, there is a

need to determine how business games can be applied in studying various aspects of the DSS domain: the success and failure measures of DSS pose the same problems in the game that they present in reality. Use and performance can be easily measured, but the cost/benefit, return on investment or degree of success of a specific DSS is as elusive in the game as it is in real life.

Appendix A

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 DSS 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.	Do benefits from the system meet your expectations before it was developed?	1	2	3	4	5	6	7

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Company	System Area	Nature of System	Interactive	Graphics
1	Production, Finance, Market Analysis	Electronic Sheet	No	No
2	R&D, Production, Finance, Marketing	Electronic Sheet	Yes	Yes
3	Production, Finance, Market Analysis	Electronic Sheet	Yes	No
4	R&D, Production, Finance, Marketing, Market Analysis	Electronic Sheet, Regressions	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	Yes	No
10	Production, Finance, Marketing	Electronic Sheet	Yes	No
11	R&D, Production, Finance, Marketing	Electronic Sheet	Yes	No
12	R&D, Production, Finance, Market Analysis	Electronic Sheet, Regressions	No	No
13	R&D, Production, Finance	Electronic Sheet	No	Yes
14	Marketing, Market Analysis	Electronic Sheet, Regressions	Yes	No
15	Finance, Marketing, Market Analysis	Electronic Sheet	No	Yes
16	Production, Marketing	Electronic Sheet	No	Yes
17	Production, Finance	Easy Plan, Electronic Sheet	No	No
18	Finance, Marketing	Electronic Sheet	Yes	No

Table 1. Characteristics of Systems Developed by Companies.

Variable	Individuals (n=90)		Companies (n=18)	
	Mean	S.D.	Mean	S.D.
Familiarity	5.53	1.29	5.48	0.76
Usefulness	5.46	1.10	5.32	0.87
Use	5.12	1.47	5.04	0.90
Contribution	5.17	1.46	4.98	1.07
Satisfaction	5.05	1.37	4.83	1.10
Use by colleagues	5.00	1.11	4.96	0.61
company success	5.12	1.30	4.99	1.07
Participation	4.64	1.93	4.67	1.02
Disturbance	2.93	1.95	2.91	0.76
Met expectations	4.71	1.60	4.48	1.36

Table 2. Means and Standard Deviations of Responses for Individual and Companies.

	Use		Contribution		Satisfaction
	Own Use	Use by Colleagues	Functional area	Company success	
Usefulness	0.408	0.439	0.64	0.661	0.717
	p=0.001	P<0.001	p<0.001	p<0.001	p<0.001
Use: own use		0.033	0.656	0.369	0.283
		P=0.403	p<0.001	p=0.002	p=0.015
Use: colleague use			0.271	0.418	0.385
			p=0.019	p<0.001	p=0.001
Contribution: to functional area				0.603	0.564
				p<0.001	p<0.001
Contribution: to company success					0.691
					p<0.001

Table 3. Relationships between Criteria of DSS Success for Individual Respondents.

Table entries: Spearman's rho correlation coefficient

Significance level

	Use		Contribution		Satisfaction
	Own Use	Use by Colleagues	Functional area	Company success	
Usefulness	0.402	0.628	0.7	0.73	0.802
	p=0.052	p=0.003	p=0.001	p<0.001	p<0.001
Use: own use		0.287	0.56	0.318	0.267
		p=0.124	p=0.008	p=0.099	p=0.142
Use: colleague use			0.409	0.449	0.457
			p=0.046	p=0.031	p=0.028
Contribution: to functional area				0.583	0.631
				p=0.006	p=0.002
Contribution: to company success					0.792
					p<0.001

Table 4. Relationships between Criteria of DSS Success for Companies

Table entries: Spearman's rho correlation coefficient

Significance level

Criterion of Success	Individuals (n=90)		Companies (n=18)	
	Familiarity	Participation	Familiarity	Participation
Usefulness	0.326	0.219	0.13	0.15
	p=0.012	p=0.293	p=0.604	p=0.604
Own Use	0.772	0.686	0.75	0.626
	p<0.001	p<0.001	p<0.001	p<0.001
Use by colleagues	0.111	0.217	0.051	0.18
	p=0.403	p=0.098	p=0.841	p=0.475
Contribution	0.477	0.349	0.37	0.13
	p<0.001	p=0.007	p=0.129	p=0.618
Company Success	0.173	0.16	0.134	0.11
	p=0.189	p=0.225	p=0.294	p=0.350
Satisfaction	0.167	0.114	0.10	0.091
	p=0.296	p=0.428	p=0.478	p=0.514

Table 5. Relationships between Measures of Association with DSS and Criteria of DSS Success for Individuals and Companies

Table entries: Spearman's rho correlation coefficient

Significance level

Variable	F value	Sig. of F
Familiarity	0.995	0.482
Usefulness	2.029	0.033
Use	1.261	0.265
Contribution	2.034	0.032
Satisfaction	3.534	0.000
Use by colleagues	0.859	0.621
company success	3.483	0.001
Participation	0.918	0.559
Disturbance	0.354	0.988
Met expectations	3.757	0.000

Table 6. Analysis of Variance of All Variables by Companies