Empirically assessing factors related to DSS benefits

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This paper reports the results of a field study surveying 201 US business managers to test the relationship between decision support systems (DSS) benefits and a list of factors expected to affect them. DSS benefits considered are: decision quality, competitive edge, improved communication, cost reduction, increased productivity, time savings, overall satisfaction, overall cost effectiveness and total benefits. The determinants of DSS benefits fall into four broad categories encompassing attributes of the industry (strategic position and degree of competition), the organization (size of organization, task structuredness, frequency of use, quality of training, organization support and vendor support), the DSS (timeliness of output, completeness of output, accuracy of output, relevance of output, flexibility, range of alternatives and user-friendliness) and of the DSS user (age of user, experience with DSS, experience on job, education level, attitude of user and expectations of user). Correlation coefficients and incremental R square measures (stepwise regression) show that much of the variance (52–84%) in each of the benefits can be explained by the factors included in the study. Based on the results, managerial recommendations on how to proceed to increase DSS benefits are presented.

Introduction

The dramatic growth in the use of DSS at various management levels is attributed to the numerous potential benefits of the technology (Keen, 1981; Hopple, 1988b). Thus, organizations are devoting substantial resources to acquire and maintain the necessary resources (King, 1983; Janulaitis, 1984; Porter & Millar, 1985). DSS costs in the form of hardware/software, training, data conversion and maintenance are substantial, forcing investment decisions to be handled in a similar way as other types of substantial investment, requiring appropriate justification, return on investment and a clearer understanding of the cost/incremental benefits of the technology. Since budgets for DSS have increased significantly over time, organizations now seek reliable methods for assessing DSS effectiveness, both in absolute and relative terms. In order to select and manage DSS applications for maximum benefit, it is important that organizations try to understand better the relationships between DSS benefits and the factors affecting them.

The evaluation of DSS success in general, as measured by several surrogate variables such as user satisfaction, system usage, or benefits, is an area many authors cite as lacking in statistically sound research studies (Aldag & Power, 1986; Dos Santos & Bariff, 1988; Hopple, 1988a). Adelman and Donnell (1986) believe that just as researchers have studied the conditions that lead to successful applications of management information systems (MIS), they must study the conditions that lead to successful DSS applications. The majority of the studies of information systems (IS) success (Delone & McLean, 1992) use a surrogate measure such as frequency of use (or usage) or user satisfaction, because IS is difficult to evaluate in more objective terms (Miller & Doyle, 1987; Guimaraes & Gupta, 1988). In the case of DSS, evaluation is even more complex because most of its impact on individuals and the organization is widely known to be long-term, intangible and qualitative in nature. Such benefits have been often overlooked because they are difficult to identify and measure.

A genuine concern about the appropriateness and completeness of measuring IS effectiveness or success by frequency of use and user satisfaction has been expressed because some laboratory experiments (Ein-Dor & Segev, 1982; King, 1983; Goslar *et al.* 1986; Cats-Baril & Huber, 1987; Kottemann & Remus, 1987; Sharda *et al.*, 1988; King *et al.*, 1990) have concluded that frequency of use or user satisfaction does not necessarily reflect DSS effectiveness. In fact, Kottemann and Remus (1987) concluded, after a series of studies, that DSS usage may reduce the variance of task performance without improving decision quality, and boost the confidence of the user without improving decision performance. Although user satisfaction and

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frequency of use are seemingly popular and useful measures, it is unwise to rely solely on them as true indicators of DSS effectiveness.

The purpose of this study is to assess the factors that, according to existing literature, are thought to affect DSS success, which in this case is measured in terms of the benefits to companies and user managers. These factors fall into four broad categories, defined as attributes of the industry, the organization, the system and the user.

Theoretical background and measures

One of the few frameworks for the general evaluation of DSS has been reported by Adelman and Donnell (1986) who defined three alternative methods of evaluation: objective measurement, expert observation and subjective judgement. Given the use of a relatively large field test, for practical reasons, we selected subjective judgement for this research which requires fewer resources and is less time-consuming than the other methods. Subjective judgement requires DSS users to score their experiences by answering a questionnaire. Adelman and Donnell (1986) also identified three phases of DSS evaluation: technical, subjective and empirical phases. The technical evaluation phase addresses the algorithms and input/output procedures in order to identify potential problems prior to actual use. The subjective evaluation phase focuses on evaluating DSS from the users' perspective with the goals of assessing the effectiveness of the system and determining its strengths and weaknesses. The empirical evaluation phase focuses on measuring DSS performance – such as determining whether users make significantly better or faster decisions. The present study represents a combination of the subjective and empirical evaluation phases. It assesses the impact of DSS as experienced (subjective method of assessment) by the users, who in this case are top-, middle- and low-level managers.

Based on an extensive literature review, we have identified a list of eight major potential benefits to be expected from DSS and four sets of factors which are thought to influence whether these benefits are experienced in practice. These four sets of factors are respectively related to the industry, the organization, the system and the user attributes. Before focusing on these factors in more detail, the next section describes the DSS benefits addressed in this study.

DSS benefits

With the growth in competition, managers increasingly rely on and expect a return on DSS investment, a more accurate evaluation of the resources spent on DSS, and benefits derived from such investment. Previously defined lists of potential DSS benefits (Keen, 1981) are impressive and lead one to believe that DSS have the potential to be one of the most powerful computerised tools available to business organizations. In the strategic management area, the use of computerised information to achieve competitive advantage has received renewed attention. Organizations have now widely accepted that information systems may be useful to implement leading edge corporate strategy. Many authors believe that information systems, including DSS, have become a key part of competitiveness in the marketplace (Mason, 1985; McFarlan, 1985; Strassman, 1985). On the other hand, for DSS usage and new implementations to continue to grow, their worth must be demonstrated across organizations at the individual DSS level, where the specific system can be evaluated in terms of benefits, costs, strengths and weaknesses. This way, the overall worth of DSS planning and implementation as managerial activities can be assessed.

For this study, based on the literature available, eight benefits were operationalised: the overall cost-effectiveness of the DSS, the overall user satisfaction with the DSS, and the degree to which the DSS enhanced the decision-making process, company competitiveness, communication within the organization, user productivity, time savings provided and reduced costs. Respondents were asked to rate the DSS they were most familiar with along these eight dimensions using a scale ranging from 'very poor', 'poor', 'fair', 'good' and 'excellent'. The coefficient of internal reliability (Cronbach's alpha) for this construct was 0.99.

Industry attributes

McFarlan (1985) advanced the opinion that the type of corporate strategy being used may significantly influence the effectiveness of information systems. Porter and Millar (1985) have proposed that industry structure can be changed by such systems: 'The question is not whether information technology will have a significant impact on a company's competitive position; rather the question is when and how this impact will strike'. On the other hand, Strassman (1985) concluded that the organization's strategic position influences the effectiveness of information systems. Where strategic position is superior, information systems tend to increase management productivity; where strategic position is poor, management productivity remains unchanged or actually declines with system implementation. He measured strategic position in terms of market share, product quality, utilisation of assets and return on investment (ROI).

In this study, two major industry attributes were investigated: strategic position and degree of competition. The strategic position of the organization in the industry was measured in terms of four items. Market

share, utilisation of assets and investment payoffs were each rated using the scale: (1) very inferior, (2) inferior, (3) about average, (4) superior and (5) very superior. In addition, 'the company's competitive position in the industry' was measured with the scale: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent. The Cronbach's alpha coefficient for this four-item scale was 0.87.

The degree of competition faced by the organization was measured by the question: How would you characterise the external environment within which your firm operates? – (1) very safe, absolutely no threat to my firm's survival; (2) safe, very little threat to my firm's survival; (3) somewhat hostile, some threat to my firm's survival; (4) hostile, my firm's survival is always threatened; (5) very hostile and stressful, very hard to keep afloat.

Organization attributes

Many studies have investigated the influence of organizational attributes on the effectiveness of information systems in general (Cheney *et al.*, 1986; Lind *et al.*, 1989) and DSS in particular (Sanders & Courtney, 1985; Guimaraes *et al.*, 1992). The organization variables found to be significant by one or more of these studies include size, user training, frequency of use, organization support, vendor support and task variety. These six variables were included in this study.

Organization size was measured by the number of full-time employees and the company's average annual gross revenue. User training was measured by asking respondents to rate the quality of training received before starting to use the DSS using the scale: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent. Frequency of use was measured asking respondents to rate how much they use the DSS to obtain the information needed in order to accomplish their jobs: (1) very little, (2) little, (3) some, (4) often and (5) a great deal.

Organization support was measured by asking respondents to rate the quality of support received on a regular basis from other organization units (e.g. the Information System Department) using the following scale: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent. Vendor support was measured by asking respondents to rate the quality of support received from vendors using a similar scale.

Task variety was measured by two items: one asked the respondents to rate the extent to which they perform the same tasks from day to day using the scale: (1) not at all, (2) very small extent, (3) moderate extent, (4) great extent and (5) very great extent; the other asked how similar are the day-to-day situations, problems, or issues they encounter while performing their jobs using the scale: (1) very much the same, (2) mostly the same, (3) quite a bit different, (4) very much different and (5) completely different.

System attributes

As determinants of overall satisfaction with DSS, Fuerst and Cheney (1982) concluded that accuracy of output and its relevance are of major importance. Similarly, Sanders and Courtney (1985) found that length of DSS use and its user-friendliness are positively correlated with overall satisfaction with the system. Timeliness is another very important characteristic of DSS. According to Ives *et al.* (1983), Reimann and Warren (1985) and Miller and Doyle (1987) it has a positive association with user satisfaction with the system.

Many DSS characteristics have been identified as having major influences on its success. The variables in this study include DSS friendliness, length of use, cost, timeliness of the DSS output, accuracy and relevance of the output, and range of decision alternatives considered by the DSS.

The DSS friendliness was measured by asking respondents to rate it using the scale: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent. Length of use was measured by asking if the DSS has been in use for: (1) less than 6 months, (2) between 6 months and 12 months, (3) between 1 year and 2 years, (4) between 2 years and 4 years, or (5) over 4 years. The total cost of the DSS was measured in terms of: (1) $5,000 or less, (2) between $5,001 and $25,000, (3) between $25,001 and $100,000, (4) between $100,001 and $500,000 and (5) over $500,001. The DSS output timeliness, accuracy, and content relevance, and the range of decision alternatives addressed by the DSS, were measured using the scale: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent.

User attributes

Fuerst and Cheney (1982) and Wafa (1986) found a positive relationship between user experience with the system and its success. However, these findings have been contradicted by Guimaraes *et al.* (1992). Zmud (1979) indicated that more educated users tend to use information systems more, and that more educated and experienced users are less satisfied with their systems. Cheney *et al.* (1986) noted a positive association between user attitudes and expectations from the system and system success. Sharda *et al.* (1988) found users' knowledge of the system to be correlated with system effectiveness.

Several variables were addressed in this study, including user age, educational level, years of experience on the job, user expectations, attitude toward DSS, and the number of years of experience the user has with DSS. User age was measured as: (1) 20–30, (2) 31–40, (3) 41–50, (4) 51–60 and (5) over 60.

Educational level was measured by: (1) not a high school graduate, (2) high school graduate or GED, (3) some college work, (4) Bachelor's degree, (5) some graduate work, (6) Master's degree and (7) Doctoral degree. Respondents were asked to write in the total number of years of experience in the present position. User expectations from DSS in general were measured as: (1) no expectations, (2) very low expectations, (3) low expectations, (4) high expectations and (5) very high expectations. Overall user attitude toward the DSS when working with the system was measured as: (1) very negative, (2) somewhat negative, (3) indifferent, (4) somewhat positive and (5) very positive. Lastly, users were asked to write in the total number of years of experience working with the particular DSS.

Research method

Sampling process

We randomly selected from three directories (*Standard & Poor Industrial Index, Moody's Industrial Manual* and *Polk's World Bank Directory*) 700 firms. Within each firm, a manager who used DSS was identified as a target for the questionnaire. The survey was limited to business managers who used DSS to support their daily tasks. To simplify the study, we did not include clerical or IS personnel. To ensure an appropriate level of respondent knowledge, only participants meeting the following criteria were included in the study: (1) at least six months of DSS use by the organization and (2) at least six months of DSS experience by the individual user participant. Before mailing the questionnaire, we obtained an endorsement from the top manager involved through a letter and/or telephone call. Follow-up letters, telephone calls and personal contacts were also used in an effort to improve the response rate. Since respondents were managers who used DSS on a regular basis, it was expected that they could answer most of the questions without any references, and that they could readily access any necessary documents. In a cover letter, DSS was defined as any computer application that aided in semistructured and unstructured decision-making processes, and the managers were urged to take part in the study only if the study requirements stated above were met. Table 1 shows descriptive information for the participating companies and managers.

Questionnaire construction and data analysis

The DSS benefit measures and their expected determinants were compiled from the literature. The sources of the questionnaire items are indicated in Table 2. To improve its readability, the instrument was pre-tested with eighteen experienced DSS users, managers with many years of experience with DSS. Based on their remarks, further changes were made before the instrument was mailed to participants. A factor analysis screening for principal components yielded five factors. The loadings resulting from a varimax rotation were evaluated on two criteria: significance of item loadings and simplicity of factor structure. By the first criterion, only items with at least 0.30 were retained. By the second criterion, each factor had to have a set of items with loadings close to 1.0 while the remaining items should have loadings close to 0 for that factor. The five resulting factors (DSS benefits, and factors related to industry, organization, systems and user attributes) support the evaluation model proposed in the literature. Stepwise regression analysis was used to determine which of the individual variables (in each of the four groups of variables) were most significant in explaining each of the benefit measures.

Discussion of results

We received 214 responses (30.6%), of which thirteen were discarded, eight because they were not completely filled out and five because the respondents indicated insufficient experience with DSS. There remained 201 (28.7%) usable responses which were included in the study. Table 3 shows the Pearson correlation coefficients for the eight benefits, as well as the total benefits (dependent variables), and each of the 21 factors thought to affect them (independent variables). Table 4 shows the incremental R^2 measures which represent the percentage of the variance in each dependent variable explained by the particular independent variable in the presence of other significant variables.

Industry attributes

Table 3 shows that, consistent with McFarlan's (1985) suggestion, the company's strategic position is directly related to total DSS benefits, as well as to each of the eight individual DSS benefits. On the other hand, the degree of competition in the industry is inversely related to these benefits, except for decision quality and time savings in which case there is no significant relationship. Based on the strength of the correlation and the incremental R^2 for the total benefits shown in Table 4, the firm's strategic position is by far the most influential industry attribute for deriving DSS benefits.

These correlation results support the notion that organizations with a strong strategic position are more likely to derive greater benefits from their DSS than firms in a weak strategic position. Thus, one can infer that the implementation of DSS does not necessarily improve an organization's strategic position in a given industry, but can help sustain a leadership position. The results also impy that unless an organization is

Table 1 Descriptive statistics for the participating companies and managers.

Variable	*Frequency*	*Percentage*
Industry type		
1. Manufacturing	93	46.3
2. Financial services	105	52.2
3. Retailing	0	0
4. Construction	0	0
5. Other	3	1.5
Number of full-time employees		
1. 100 or less	23	11.4
2. Between 101 and 200	6	3.0
3. Between 201 and 500	32	15.9
4. Between 501 and 1000	15	7.5
5. More than 1000	118	58.7
6. I do not know	7	3.5
Average annual revenue		
1. $100,000 or less	2	1.0
2. $100,001–$500,000	0	0
3. $500,001–$1 million	3	1.5
4. $1 million–$5 million	39	19.4
5. Over $5 million	147	73.1
6. I do not know	10	5.0
Length of time DSS has been in use		
1. Less than 6 months	0	0
2. 6–12 months	14	7.0
3. 1–2 years	29	14.4
4. 2–4 years	93	46.3
5. Over 4 years	55	27.3
6. I do not know	10	5.0
Managers' age		
1. 20–30 years	45	22.4
2. 31–40 years	78	38.8
3. 41–50 years	59	29.4
4. 51–60 years	19	9.5
5. Over 60 years	0	0
Years of experience on the job		
1. Less than 1 year	0	0
2. 1–3 years	76	37.8
3. 4–7 years	59	29.4
4. 8–15 years	53	26.4
5. Over 15 years	13	6.5
Years of experience with DSS		
1. Less than 6 months	0	0
2. 6 months–1 year	22	10.9
3. 1–2 years	61	30.3
4. 3–5 years	59	29.4
5. Over 5 years	59	29.4
Educational level		
1. Non-high school graduate	0	0
2. High school graduate or GED	14	7.0
3. Some college courses	45	22.4
4. Bachelor's degree	92	45.8
5. Some graduate courses	14	7.0
6. Master's degree	34	16.9
7. Doctoral degree	2	1.0
Overall classification of education		
1. Technical	37	18.4
2. Non-technical	67	33.3
3. Both technical and non-technical	91	45.3
4. Other	6	3.0
Job description		
1. Top management	38	18.9
2. Middle management	77	38.3
3. Lower level management	52	25.9
4. First level supervisor	29	14.4
5. Other	5	2.5
User attitude		
1. Very negative	0	0
2. Somewhat negative	7	3.5
3. Indifferent	11	5.5
4. Somewhat positive	87	43.3
5. Very positive	96	47.8
Frequency of use		
1. Very little	7	3.5
2. Little	18	9.0
3. Some	72	35.8
4. Often	66	32.8
5. A great deal	38	18.9

Table 2 Potential factors affecting DSS benefits and their source.

Variable	*Literature source*
Strategic position	Strassman (1985)
Degree of competition	Strassman (1985)
Size of organization	Van De Ven & Ferry (1980)
Task variety	Van De Ven & Ferry (1980)
Frequency of use	Miller & Doyle (1987)
Quality of training	Bailey & Pearson (1983)
Organization support	Ives *et al.* (1983)
Vendor support	Ives *et al.* (1983)
Size (cost) of DSS	*
Timeliness of output	Miller & Doyle (1987)
Completeness of output	Miller & Doyle (1987)
Length of time in use	Sanders & Courtney (1985)
Accuracy of output	Miller & Doyle (1987)
Relevance of output	Bailey & Pearson (1983)
Flexibility	Bailey & Pearson (1983)
Range of alternatives	*
User-friendliness	Bailey & Pearson (1983)
Age of user	Sanders & Courtney (1985)
Experience with DSS	Sanders & Courtney (1985)
Experience on job	Van De Ven & Ferry (1980)
Education level	Sanders & Courtney (1985)
Attitude of user	Ives *et al.* (1983)
Expectations of user	Bailey & Pearson (1983)
Decision quality	*
Competitive edge	*
Improved communication	*
Overall satisfaction	Sanders & Courtney (1985)
Cost reduction	*
Increased productivity	*
Time savings	*
Overall cost-effectiveness	Miller & Doyle (1987)

*Items added by the authors.

Table 3 Pearson correlation coefficients of benefit measures with predictor variables (n = 201).

Predictor variables	*Benefit measures*								
	B1	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*	*B8*	*B9*
A. Industry attributes									
1. Strategic position	0.50	0.57	0.50	0.52	0.49	0.47	0.63	0.53	0.65
2. Degree of competition	−0.13	−0.27	−0.18	−0.31	−0.19	−0.08	−0.27	−0.28	−0.27
B. Organization attributes									
1. Size of organization	0.28	0.19	0.28	0.24	0.28	0.16	0.29	0.34	0.31
2. Task variety	−0.19	−0.11	−0.19	−0.07	−0.12	−0.05	−0.23	−0.24	−0.18
3. Frequency of use	0.31	0.39	0.25	0.32	0.11	0.23	0.17	0.10	0.30
4. Quality of training	0.35	0.29	0.36	0.38	0.44	0.41	0.39	0.52	0.48
5. Organization support	0.39	0.36	0.45	0.33	0.49	0.33	0.51	0.56	0.53
6. Vendor support	0.20	0.33	0.23	0.32	0.41	0.29	0.45	0.30	0.39
C. System attributes									
1. Timeliness of output	0.53	0.39	0.47	0.34	0.38	0.40	0.49	0.47	0.53
2. Completeness of output	0.55	0.42	0.46	0.38	0.47	0.42	0.54	0.58	0.59
3. Accuracy of output	0.54	0.48	0.41	0.42	0.47	0.44	0.55	0.50	0.58
4. Relevance of output	0.51	0.59	0.57	0.41	0.41	0.44	0.51	0.52	0.61
5. Flexibility	0.36	0.48	0.29	0.46	0.28	0.35	0.43	0.40	0.47
6. Range of alternatives	0.47	0.60	0.29	0.50	0.37	0.37	0.56	0.40	0.55
7. User friendliness	0.46	0.45	0.37	0.41	0.35	0.36	0.47	0.41	0.50
D. User attributes									
1. Age of user	0.12	0.05	0.10	0.04	0.09	0.05	0.10	0.09	0.06
2. Experience with DSS	0.03	0.04	0.02	0.08	0.22	0.05	0.38	0.29	0.14
3. Experience on job	0.06	0.04	0.02	0.04	0.07	0.14	0.08	0.01	0.55
4. Education level	0.24	0.14	0.17	0.07	0.03	0.05	0.06	0.00	0.12
5. Attitude of user	0.34	0.25	0.14	0.33	0.16	0.24	0.21	0.11	0.27
6. Expectations of user	0.30	0.22	0.15	0.24	0.21	0.32	0.08	0.18	0.26

B1: Decision quality.
B2: Competitive edge.
B3: Improved communication.
B4: Cost reduction.
B5: Increased productivity.
B6: Time savings.
B7: Overall satisfaction.
B8: Overall cost-effectiveness.
B9: Total benefits.
Correlations ≥ 0.17 are significant at $p \leq 0.01$.

already strategically positioned, DSS implementation may produce an adverse impact on all the benefit measures in a highly competitive industry.

Organization attributes

All of the organizational attributes are related to at least some of the benefits. Three organization attributes (quality of training, organizational support and vendor support) are related to all the benefit measures at the 0.01 significance level or better. Task variety is inversely related to all the benefits; however, only relationships with decision quality, improved communication, increased overall satisfaction, increased overall cost-effectiveness and total benefits are statistically significant at the 0.01 level or better. Apparently, as the variety of tasks supported by the DSS widens, the support tends to lose focus and the benefits are lower. As discussed by Guimaraes *et al.* (1992), 'certain task characteristics (uncertainty, difficulty, interdependence, and variety) are expected to require higher levels of user involvement' to produce effective DSS.

The organization size, frequency of use, quality of training, organization support and vendor support were found to be influential variables in this group. The larger organization size is likely to mean more resources, more sophisticated tools and know-how for DSS construction and implementation. The results corroborate previous findings regarding organization support and support from vendors (Fuerst & Cheney, 1982; Vincent, 1984; Sanders & Courtney, 1985; Cheney *et al.*, 1986; Wafa, 1986), and regarding frequency of use (Strassman, 1985; Kottemann & Remus, 1987; Trice & Treacy, 1988).

As indicated in Tables 3 and 4, organization support and quality of training turned out to be the most influential organization factors, suggesting that for an organization to derive significant benefits from DSS, top management support and quality training must be

Table 4 Incremental R^2: the percentage of variance in benefit measures explained by predictor variables (n = 201).

Predictor variables	*Benefit measures*								
	B1	*B2*	*B3*	*B4*	*B5*	*B6*	*B7*	*B8*	*B9*
A. Industry attributes									
1. Strategic position	0.01	0.11	0.09	0.10	0.09	0.21	0.40	0.11	0.42
2. Degree of competition		0.01		0.02			0.01	0.04	0.01
B. Organization attributes									
1. Size of organization	0.06		0.01	0.01			0.01	0.01	0.03
2. Task variety				0.01	0.06	0.04	0.01	0.01	0.01
3. Frequency of use	0.05	0.04	0.02	0.01		0.01			0.05
4. Quality of training						0.01	0.01		
5. Organization support					0.24	0.01	0.02	0.02	0.01
6. Vendor support	0.01				0.04	0.05	0.01	0.03	
C. System attributes									
1. Timeliness of output			0.01		0.01		0.06		
2. Completeness of output	0.31	0.01			0.01		0.01	0.34	0.14
3. Accuracy of output		0.01		0.02	0.05	0.09	0.01		0.01
4. Relevance of output		0.03	0.30		0.02	0.04	0.01	0.01	
5. Flexibility		0.01		0.02			0.01	0.04	0.05
6. Range of alternatives	0.01	0.40	0.01	0.29	0.01		0.13	0.01	
7. User-friendliness	0.03	0.01		0.01					0.01
D. User attributes									
1. Age of user	0.05	0.03	0.05	0.01	0.05	0.03	0.01	0.06	0.03
2. Experience with DSS	0.01			0.01	0.03	0.01	0.10	0.07	0.03
3. Experience on job	0.04	0.02			0.02	0.03	0.01	0.04	0.02
4. Education level	0.01				0.01	0.02	0.01	0.02	
5. Attitude of user	0.11			0.02	0.01	0.02	0.01	0.01	0.01
6. Expectations of user		0.22	0.01	0.01			0.01		
Cumulative R^2	0.69	0.67	0.52	0.53	0.67	0.56	0.84	0.79	0.82

B1: Decision quality.
B2: Competitive edge.
B3: Improved communication.
B4: Cost reduction.
B5: Increased productivity.
B6: Time savings.
B7: Overall satisfaction.
B8: Overall cost-effectiveness.
B9: Total benefits.

provided during the DSS implementation. Indeed, organization support is more than twice as influential (incremental $R^2 = 0.24$) than any other factor in explaining the variability in the benefit of increased productivity. The explanation for these results could be that top management support ensures the needed resources, provides a sense of commitment to, and suggests a high importance for the project. Quality training leads to mastery of the system and an increased sense of ownership and accomplishment on the part of the users.

System attributes

All seven system attributes are directly related at the 0.01 significance level or better with every benefit. The results clearly show that the DSS attributes addressed in this study, which represent a surrogate measure of DSS quality, are important determinants of DSS benefits. Collectively, systems attributes are one of the most critical groups of factors. As shown in Table 4, completeness of output was the most influential factor in explaining the benefits of decision quality (incremental $R^2 = 0.31$), and overall cost-effectiveness (incremental $R^2 = 0.34$). Range of alternatives considered by the DSS was the most influential in explaining the benefits of competitive edge (incremental $R^2 = 0.40$) and cost reduction (incremental $R^2 = 0.29$). The relevance of the DSS output (incremental $R^2 = 0.30$) was most important in explaining the benefit of improved communication. The strength of these results suggests that a great deal of attention should be given to DSS application selection and DSS software acquisition to ensure that the DSS will be able to match application requirements and user expectations along the dimensions addressed in this study. Further, it behooves DSS project managers to ensure the quality of DSS along these dimensions by prototyping DSS development and

otherwise promoting user participation, feedback and satisfaction in the DSS development process.

User attributes

Based on the results, user attributes are the least important in terms of the strength and significance level of the correlation coefficients. The age of the user shows no significant relationship with any of the possible benefits. However, user experience with DSS is directly related to increased productivity, overall satisfaction with the system and overall cost-effectiveness. User experience on the job is not related to any individual benefits, but it is significantly related to total benefits. The level of user education is directly related to decision quality and to improved communication within the organization at the 0.01 significance level or better, but is not related to any of the other benefits. User attitude toward the system is significantly related to every benefit except improved communication, increased productivity and increased overall cost-effectiveness. User expectations are also directly related to all benefits except for improved communication within the organization and overall satisfaction with the DSS. The most influential user attributes were user expectations of, attitude toward and experience with the DSS. Consistent with Larcker and Lessig (1980), the more positive the user's attitude about using a DSS, the greater the benefits derived.

Results explaining the variance in benefit measures

Table 4 shows the incremental R^2 for the stepwise regression analysis. For each of the benefit measures, the R^2 represents the percentage of the variance in the ratings for a particular benefit which is explained by the ratings of a particular predictor variable. Improving decision quality is mostly attributable to the completeness of the DSS output which explains 31% of the variance in the ratings for decision quality. Next in importance are: user attitude (11%), organizational size (6%), and frequency of use and user age (5% each). Twelve predictor variables included in this study account for 69% of the variance in decision quality.

Most of the variance in the ratings for enhancing competitive advantage can be explained by the DSS capability to explore a wide range of alternatives (40%), user expectations (22%) and company strategic position (11%). Improving communications in the organization can be attributed to the relevance of the DSS output (30%), the strategic position of the firm (9%) and age of the user (5%). Variance in cost reductions can be explained primarily by the range of alternatives explored by the DSS (29%) and the firm's strategic position (10%). Increases in productivity can be explained by organizational support (24%), the strategic position of the firm (9%), the degree of variety in the task being supported by the DSS (6%), and by the DSS output quality and the age of the user (5% each). Time savings can be primarily attributed to strategic position of the firm (21%), the accuracy of the DSS output (9%) and vendor's support (5%). Eighty-four per cent of the variance in overall satisfaction with the DSS can be explained by the 19 predictor variables in this study. Most of it is explained by the strategic position of the firm (40%), the range of alternatives explored by the DSS (13%), user experience with the DSS (10%) and the timeliness of the DSS output (6%). The variance in overall cost-effectiveness is explained primarily by the degree of completeness of the DSS output (34%), the strategic position of the firm (11%), the user experience with DSS (7%) and the age of the user (6%). Finally, the variance in total benefits from the DSS is explained by the strategic position of the firm (42%), the completeness of the DSS output (14%), and the frequency of DSS use and its flexibility (5% each). Overall, in terms of its ability to explain the variance in each of the nine benefit measures, the strategic position of the firm is by far the most influential. Second place is shared by completeness of the DSS output, the relevance of the DSS output and the range of alternatives addressed by the DSS.

Conclusions

The objective of this study was to assess the benefits of DSS from the user's perspective which represent a more objective measure of system effectiveness than 'frequency of use' and 'user satisfaction'. Results provide several insights for researchers and practitioners. Those conducting research into DSS benefits should consider the four groups of attributes regarding the industry, the organization, the system and the user as potential predictors of DSS effectiveness.

This study has some limitations common to survey studies. It is based on the subjective perception of the respondents; therefore, one should be careful when generalising the results. However, we have taken several steps to ensure that respondents were accurate and consistent: (1) they were asked to evaluate DSS with which they were most familiar; (2) people's opinions about specific benefits are likely to be more 'objective' than opinions regarding how they 'feel' about the system; and (3) respondents were ensured anonymity by returning the questionnaires directly to the researchers. It would be interesting to conduct a study which uses an even more objective approach to DSS evaluation. For example, the researcher could directly observe the use of each DSS. However, such a data collection process would be very expensive and require a lengthy period of observation. Furthermore, techniques such as value analysis (Keen, 1981) may provide a more 'objective' framework, as well as be

useful in accounting for the intangible benefits of the DSS.

Given the absence of a theoretical basis, it may be difficult (or unwarranted) to surmise why any given factor explains different amounts of the variance for different benefits. However, in the presence of intuitive observations, one may justifiably venture out and interpret the ability of the factors to affect benefits in general. Based on that, several practical implications can be drawn from the results. A company's strategic position has a widespread impact on the benefits derived from DSS. A likely interpretation is that if the basic components of strategic position (market share, asset utilisation, investment payoffs and competitive position) are not favourable, managers tend not to provide the resources and political support for effective DSS development. On the other hand, DSS providing most benefits, i.e. cost reductions, overall user satisfaction with the DSS, etc., are likely to be the ones which received adequate attention and resources during the various stages of development. That suggests it would be a serious mistake to allow a weak company strategic position to dictate inappropriate levels of resources for DSS development because many organizations have found DSS capable of effectively supporting strategic decision-making. Before cutting support for important DSS projects owing to the firm's poor strategic position, managers must ensure that they are not restricting part of the solution to the problem.

Similarly, organizations facing a high degree of competition tend to suffer reduced DSS benefits, possibly for the same reasons, as discussed above. Again, managers are cautioned to remember numerous case studies showing DSS as effective tools to gain competitive advantage. When facing fierce competitive pressure, managers are encouraged to renew their efforts to identify DSS applications useful as vehicles to stabilise and win the conflict. By the same token, three of the six organization attributes (quality of training, organization support and vendor support) are directly related to every benefit. All three require a commitment from management to provide adequate resources for effective DSS development, operation and maintenance.

The importance of the system attributes for the organization to derive DSS benefits calls for several things: competent DSS developers, appropriate DSS development tools, and a quality assurance process targeting user satisfaction with DSS output completeness, timeliness, accuracy and relevancy, as well as the DSS friendliness, flexibility to addressing specific problems and the ability to explore a wide range of alternative courses of action. Furthermore, project managers must raise user expectations of DSS in general and induce a positive attitude about the new DSS. Contrary to the opinion that computer technology may be oversold, our results show that higher user expectations are directly related to many DSS benefits. One may argue that this conclusion is biased since most managers in the sample have a positive attitude toward their DSS. However, this 'bias' is relative to the learning curve regarding DSS technology implementation in organizations. In this study, organizations and managers with DSS experience and know-how were deliberately sought out so the results relate to DSS benefits 'when it is done right'. There would be little purpose in studying the benefits of DSS which were poorly developed and implemented, or managers who are inexperienced or have negative attitudes about DSS. Based on these results, one may conclude that DSS are not disappointing experienced business managers and that project managers should consider increasing user expectations in an effort to improve user cooperation in the DSS development process.

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