

DSS Model Usage in Public and Private Sectors: Differences and Implications

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This research explored differences in DSS model usage between public and private sector organizations at the strategic, management control, and operational levels. Model usage was found to be greater in the private sector than the public sector, except at the operational level. This was supported by evidence that DSS models are used mostly at the lower levels of the managerial hierarchy in public sector organizations. In contrast to this, model usage in the private sector was greater at the upper levels. In addition, differences in modeling techniques and applications between the public and private sectors were more pronounced at upper hierarchical levels. These differences lend credence to the notion that senior decision makers in the private sector are autonomous, focus on well-defined objectives, and rely more on "rational" techniques. Senior decision-makers in the public sector are less autonomous, face complex objectives, and expend more energy in dealing with extraneous stakeholders such as supervisory agencies and the public. The implication for DSS designers is that decision models developed for the two sectors need to be different in terms of weights attached to various criteria.

Advances in information technology are creating turbulent environments in which individual events have shorter and faster cycles (Alberthal, 1995). Such events require rapid organizational responses. Managers at all hierarchical levels are increasingly turning to decision support systems (DSS) for assistance in solving problems. Although DSS were originally meant to provide interactive solutions for complex, nonrecurring decisions made by senior managers, they have evolved and are being increasingly used for semi-structured, recurring decisions such as periodic budgeting (Gallupe, 1991). What sets DSS apart from other kinds of information systems is their combined use of data and models (Sprague, 1980). DSS contribute to organizational effectiveness in many ways, such as cost effectiveness, improved decision quality, increased productivity, and enhanced competitiveness (Udo, 1992).

The research reported herein explores potential differences in the use of DSS models between the public and private sectors. These two sectors differ inherently in their objectives, processes, priorities, task environment, and success measures. Differences in the overall decision-making environments of the two sectors make it very likely that they also differ in their use of computerized decision support models, both in terms of modeling techniques as well as in the applications of these techniques. Therefore, our study focuses on differences in DSS model usage between the public and private sectors, seeks to make an important contribution to the literature, and has the potential to yield important implications for both practitioners and researchers. For example, DSS designers could use the knowledge of differences between the two

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sectors to better tailor their development efforts to the needs of organizations in the respective sectors. Management practitioners and consultants could use this knowledge to help organizations understand their needs and target resources in a more appropriate manner. For management researchers, sectoral differences in DSS model usage would serve as further validation of the theory that decisions and decision processes of public and private sectors are different.

Literature Review and Research Hypotheses

Public and Private Sector Decision-Making Environments

The rationale for exploring differences between the public and private sectors' use of DSS models stems from inherent differences between the two sectors. There are many differences between public and private sectors in terms of goals, decision-making, fund allocations, job satisfaction, accountability, and performance evaluation (Hickson, Butler, Cray, Mallory, and Wilson, 1986; Kenny, Butler, Hickson, Cray, Mallory, and Wilson, 1987; Ross, 1988; Kingsley and Reed, 1991). According to Woodrow Wilson, the purpose of the government is to be an "instrument of humanity, of social betterment." Ronald Moe of the Congressional research Service states that "the measure of good administration is ... the effectiveness with which legislative intent, however wise or unwise, has been fulfilled" (Pegnato, 1995). The public sector's goal, then, is social amelioration or the identification, assessment, control, and improvement of social conditions (Rainey, Backoff, and Levine; 1976; Wamsley & Zald, 1976; Lachman, 1985). Typically, public organizations have little flexibility in terms of fund allocations and very little incentive to be innovative. Budgeting for different activities are predetermined and managers must follow rigid procedures in spending these budgets. Decision-making is relatively structured and rule-oriented. Managers must consider public opinions and be politically correct as they are constantly scrutinized and monitored from people within and outside their agencies. Public, special interest groups, congress and administration demands high level of accountability. There is endless scrutiny from inspector general audits. Top managers are "temporary" and "political appointees," and in many cases have little or no management experience (Pegnato, 1995). Public managers have less autonomy and fragmented authority and organizational decisions are often opposed or influenced by congress. Personnel decisions and merit system limits public manager's human resource management capabilities.

Private sector organizations, on the other hand, seek to enhance shareholders' value and maximize profits. They are more flexible than public organizations in terms of budget allocation, personnel decisions and organizational procedures. Job satisfaction is higher (Lachman, 1985). Merit and award systems are well defined and new ideas that maximize firm's value are encouraged. Their emphasis on producing results and meeting bottom-line results in efficiency and effectiveness. Managers have more control in terms of reward and punishment structure. Some attempts have been made to study the differences in public and private sectors in terms of their policies, missions, goals, rewards, job satisfaction and decision-making environment (Rainey, Backoff, and Levine, 1976). These studies have clearly shown the differences in needs, decision-making, focus, and constraints among the two environments.

DSS Model Usage Literature

Despite the potential value of uncovering differences in DSS model usage between the two sectors, there has been little empirical research on this subject. One study that focused on the use of computer modeling in the public sector was published a few years ago (Wood and Smith, 1988) and recently there have been isolated examples of system development in the public sector (Watson, Houdeshel, and Rainer, 1997). Much of the research literature on DSS models has focused on assorted issues such as specific tools and methodologies (e.g., Aggarwal, 1990; Raghunathan, 1996) and specific applications (e.g., Schutzelaars, Engelen, Uljee, and Wargnies, 1994; Madu, Kuei, and Chen, 1995; Chen and Sinha, 1996; Kusters and Groot, 1996; Sena and Olson, 1996). Other researchers have offered prescriptions for DSS design (e.g., Bonczek, Holsapple, and Whinston, 1980; Dutta and Basu, 1984; Elam and Konsynski, 1987; Angehrn, 1991; Banerjee and Basu, 1993), assessed DSS performance (Gardner, Marsden, and Pingry, 1993), and explored associations of performance with different variables (Le Blanc and Kozar, 1990; Alavi and Joachimsthaler, 1992; Guimaraes, Igbaria, and Lu, 1992; Ramamurthy, King, and Premkumar, 1992; Kivijarvi and Zmud, 1993; Igbaria and Guimaraes, 1994; Udo, 1994; Palvia and Chervany, 1995). Yet others have focused on the development/implementation of DSS (Salmela and Ruohonen, 1992; Kaula, 1994; Hoch and Schkade, 1996) and the roles of humans and computers in DSS applications (Te'eni and Ginzberg, 1991; Todd and Benbasat, 1992).

Research Hypotheses

All the differences between the decision-making environments of public and private sectors logically imply that the two sectors are also likely to differ in their applications of computerized decision support systems. Since the "workhorses" of DSS are widely acknowledged to be their mathematical modeling components (Dutta, 1996), DSS model usage in the two sectors is expected to differ both in terms of modeling techniques incorporated in these systems (e.g., forecasting) as well as applications of these models (e.g., financial analysis). The general research question for our study may therefore be phrased as follows: Do public and private sector decision makers differ in their use of DSS models? To address this question, we adopted Anthony's classic framework in which decision processes are classified into three organizational levels: strategic, management control, and operational control (Anthony, 1965). The strategic level relates to or long-term planning issues. Management control relates to tasks "which assure that resources are obtained and used effectively and efficiently to the accomplishment of the organization's goal." Finally, operational control is the "process of assuring that specific tasks are carried out efficiently and effectively" (Gorry and Scott Morton, 1971).

Accordingly, our research question was expressed separately for decision makers at the strategic, management control, and operational levels, as well as for all three levels combined. Thus, four null hypotheses were generated:

Null Hypothesis 1: Public and private sectors do not differ in the use of DSS models.

Null Hypothesis 1a: Public and private sectors do not differ in the use of DSS models at the strategic level.

Null Hypothesis 1b: Public and private sectors do not differ in the use of DSS models at the management control level.

Null Hypothesis 1c: Public and private sectors do not differ in the use of DSS models at the operational control level.

Research Methodology

Data Collection

Data were collected using a cross-sectional survey of DSS users in the public and private sectors. A questionnaire was developed for data collection. The general thrust of the questions was to capture the nature of the respondent's task environment and the use of DSS models. Specifically, it gathered the following information:

- Nature of Industry
  - user's task environment
  - job title
  - description of duties
  - nature of task activities

- DSS Usage
  - modeling techniques used
  - applications or functions

- Respondent Characteristics
  - age
  - highest educational degree
  - years in current job

The questionnaire was pre-tested with 40 decision makers in various government and private organizations and several changes were incorporated in the final version. The modified questionnaire was mailed to 500 decision makers in various government agencies and private businesses. Public sector users from the federal, state, and city governments were selected from the respective government directories. Since decision makers are spread across organizations, it was decided to mail the survey to the top three or four people of the agencies, e.g., the Secretary of Health and Human Services, the Director of FAA, the Director of EPA, and the Assistant Director of FCC etc. In addition, a cover letter was included requesting them to distribute the questionnaire to decision makers at various levels in their agencies. The cover letter also explained what we were trying to measure and the kind of respondents we were looking for. Recipients were requested to contact us if they had any questions. Since the questionnaire had already been pre-tested and modified, very few people contacted us for clarification. Efforts were successful since we received responses from various levels in the agencies.

Private sector users were selected from a corporate directory listing businesses in Maryland, Washington, D.C., and Virginia. This area has many manufacturing, financial and consulting companies. Since most federal and state agencies are medium to large size, medium and large size private sector companies were selected to make comparisons meaningful. Once again, decision makers at different levels were targeted and responses from different levels were received.

After a reminder, 120 respondents (78 from public sector and 42 from private sector) completed and returned their questionnaires, resulting in a response rate of 24%. In general, the respondents were well-educated, many with master's degrees and some with doctoral degrees as well. On the average, they had been in their current jobs for 5 - 6 years, and public sector respondents tended to be older than their private sector counterparts. Table 1 summarizes these respondent characteristics.

Each respondent was classified into one of three managerial levels - strategic (S), management control (MC), and operational control (OC) - based on the reported job title, job description, and nature of job activities. Job description was captured by means of an open-ended question which was answered in a narrative form by the respondents. Job activities were captured by means of two structured questions. The first such question asked respondents to rank three activities (from a list of five, plus a sixth, "other" activity) which best described the aspects of decision-making they were involved with. The list provided to the respondents consisted of the following activities:

- To capture data (data entry, etc.)
- To monitor (order status, inventory level, etc.)
- To retrieve specific information
- To analyze data
- To project, and/or conduct "what-if" analysis
- Other ___________________

The second of the two structured questions asked respondents to indicate, using two five-point Likert scales, (a) whether there existed a clearly defined body of knowledge

User Characteristic	Public Sector	Private Sector
Age (years)		
-30	4	1
31 - 40	6	14
41 - 50	40	17
> 50	16	8
No response	12	2
Highest Educational Degree		
High School	6	0
Bachelors	23	16
Masters	31	20
Doctorate	4	4
No response	14	2
Years in Current Job (Mean)	4.9	6.1

Table 1: Respondent Characteristics

which guided them in the activities they had identified in the previous question, and (b) in the course of these activities, how often they encountered specific problems which they were unable to solve immediately.

Using the answers to these structured questions, two expert raters first independently classified each respondent into the S, MC, and OC categories. The initial inter-rater agreement was found to be 69%. Following this exercise, the two raters jointly reassessed the 31% of cases on which their opinions differed. This second round resulted in resolution and complete agreement on the classification of the respondents.

Operationalization of DSS Model Usage

Using three questions, the following information was collected regarding the respondents' use of DSS models:

i) Whether or not respondents used DSS models.

ii) Specific DSS modeling techniques used. Respondents were asked to indicate whether they used the following modeling techniques: analysis of variance, dynamic programming, forecasting, frequency tables, inventory modeling, linear programming, materials requirement planning, queuing, regression, and simulation modeling.

iii) Specific applications or functions for which DSS models were used. Respondents were asked to indicate the top five application areas from the following list: corporate planning, engineering/scientific analysis, financial analysis, inventory control, marketing analysis, monitoring, production planning/scheduling, report generation, and statistical analysis.

Results

Overall DSS Model Usage

Respondents were asked whether or not they used DSS models. It was found that the majority of public sector respondents at each of the three managerial levels do not use DSS models. Moreover, organizational hierarchy is inversely correlated with usage in this sector. DSS models are more likely to be used at lower levels than at upper levels. By contrast, most private sector respondents at the strategic and management control levels use DSS models. In the private sector, the relationship between hierarchy and usage is exactly the opposite, i.e., DSS models are more likely to be used at upper levels than at lower levels.

Chi-square tests indicate that the differences in overall DSS model usage (use vs. do not use) between public and private sectors are statistically significant at the strategic level (p=.01) but not at the management control and operational control levels. Differences between public and private sector are also significant when all three levels are considered collectively (p=.03). Table 2 summarizes the relevant statistics.

Specific DSS Modeling Techniques

Respondents were asked to list all specific modeling techniques they are using in model building. In the public sector, forecasting is the most popular modeling technique when all three levels are considered together. Other popular techniques in this sector are regression, analysis of variance,

Managerial Level	Public Sector		Private Sector		Chi-Square	p
	Yes	No	Yes	No		
All	27	51	23	19	4.55	.03
Strategic	2	7	7	2	5.55	.01
Management Control	14	27	13	10	3.02	.08
Operational Control	11	17	3	7	0.27	.60

Underlined p values are associated with chi-square values significant at the .05 level.

Table 2: Number of Respondents Using DSS Models in Public and Private Sectors, by Managerial Level

Technique	Public Sector Yes	Public Sector No	Private Sector Yes	Private Sector No	Chi-Square [1]	p [2]
ALL MANAGERIAL LEVELS COMBINED						
Linear Programming	6	72	4	38	0.11	.72
Dynamic Programming	3	75	0	42	-	-
Simulation Modeling	6	72	10	32	6.13	.01
Inventory Modeling	1	77	3	39	-	-
Materials Requirement Planning	4	74	5	37	1.80	.17
Regression	12	66	6	36	0.02	.87
Forecasting	15	63	19	23	9.09	.00
Frequency Tables	9	69	7	35	0.62	.43
Analysis of Variance	10	68	11	31	3.38	.06
Queuing	2	76	2	40	-	-
OPERATIONAL CONTROL LEVEL ONLY						
Linear Programming	3	25	1	9	-	-
Dynamic Programming	2	26	0	10	-	-
Simulation Modeling	3	25	1	9	-	-
Inventory Modeling	0	28	1	9	-	-
Materials Requirement Planning	2	26	2	8	-	-
Regression	5	23	0	10	2.05	.15
Forecasting	7	21	3	7	0.09	.75
Frequency Tables	6	22	2	8	0.00	.92
Analysis of Variance	5	23	1	9	0.34	.55
Queuing	1	27	1	9	-	-
MANAGEMENT CONTROL LEVEL ONLY						
Linear Programming	2	39	2	21	-	-
Dynamic Programming	1	40	0	23	-	-
Simulation Modeling	3	38	6	17	4.29	.03
Inventory Modeling	1	40	2	21	-	-
Materials Requirement Planning	2	39	3	20	-	-
Regression	6	35	5	18	0.52	.46
Forecasting	5	36	10	13	8.03	.00
Frequency Tables	3	38	4	19	-	-
Analysis of Variance	4	37	8	15	6.05	.01
Queuing	1	40	1	22	-	-
STRATEGIC LEVEL ONLY						
Linear Programming	1	8	1	8	-	-
Dynamic Programming	0	9	0	9	-	-
Simulation Modeling	0	9	3	6	-	-
Inventory Modeling	0	9	0	9	-	-
Materials Requirement Planning	0	9	0	9	-	-
Regression	1	8	1	8	-	-
Forecasting	3	6	6	3	-	-
Analysis of Variance	1	8	2	7	-	-
Queuing	0	9	0	9	-	-

[1]Chi-square statistic not reported for analyses where 2 or more of the 4 cells have observed frequencies of less than 5.
[2]Underlined p values are associated with chi-square values significant at the .05 level.

Table 3: Number of Respndents Using Specific DSS Modeling Techniques in Public and Private Sectors, by Managerial Level

and frequency tables. In the private sector, forecasting is overall the most popular technique as well, followed by analysis of variance and simulation modeling. The use of forecasting is significantly higher in the private sector (p = .01).

When the strategic level is analyzed separately, forecasting is again found to be the most popular modeling technique in both the public and private sectors. At the management control level, the most popular techniques are regression and forecasting in the public sector, and forecasting and analysis of variance in the private sector. The private sector's use of these two techniques at the management control level is significantly higher as compared to the public sector (p = .05). At the operational control level, the most popular techniques in the public sector are forecasting, frequency tables, and regression. Forecasting and frequency tables are also the most popular techniques in the private sector.

Table 3 summarizes the use of specific DSS modeling techniques, by sector and managerial level. The data indicate that differences between the public and private sectors are concentrated at higher levels. At the operational control level, none of the four feasible chi-square tests yielded statistical significant results, indicating an absence of major differences between the two sectors. At the management control level, the results of three of the four feasible chi-square tests were statistically significant, implying major differences. At the strategic level, a casual perusal of the numbers suggests major differences as well. For instance, forecasting, the most popular technique, is used by six out of nine respondents in the private sector, but only three out of nine respondents in the public sector. However, the small number of observations made it impossible to conduct any meaningful chi-square tests at this level.

Applications of DSS Models

Respondents were asked to rank the top five applications from a list of nine potential application areas of DSS models. Based on these assigned ranks, a weighted score was computed for each application area by multiplying the ranks assigned (1 to 5) by the number of respondents assigning the respective ranks and then adding the resulting totals. A rank of 6 was assigned whenever a respondent did not include an application in his/her top five list. The resulting weighted scores thus indicate the relative overall popularity of each application area. Lower scores indicate more popular applications. Next, an overall "computed rank" was given to each of the nine application areas based on these weighted scores (rank 1 and rank 9 signify the most popular and least popular application areas respectively). This two-step analysis was conducted at each sector and hierarchical level. Computed ranks for the application areas were compared across public and private sectors using Spearman's rank correlation coefficient.

Table 4 summarizes the results of these analyses. When all three levels are considered together, report generation, statistical analysis, and financial analysis are found to be the three most popular applications in the public sector. In the private sector, financial analysis, report generation, and corporate planning are the top three applications.

The correlation between the computed ranks in the public and private sectors is highest at the operational control level and decreases upward in the hierarchy. In fact, the correlation is not even statistically significant at the strategic level, suggesting that public and private sectors differ greatly in their applications of DSS models at this level. At the operational control and management control levels the correlation is significant, implying that similarities in applications of DSS models exist between the two sectors. For instance, popular application areas at the operational control level in both sectors are financial analysis and report generation. Dissimilarities in applications become pronounced upward in the hierarchy. At the management control level, financial analysis ranks topmost in the private sector but third in the public sector. At the strategic level, financial analysis ranks first in the private sector but fifth in the public sector, and monitoring ranks 2nd in the public sector but sixth in the private sector.

The results depicted in Tables 2, 3, and 4 imply that the use of DSS models differs between the public and private sectors. While these differences are apparent and often significant at the strategic and management control levels, they are not so at the operational control level. Differences between the two sectors are also apparent when all three managerial levels are considered together. Thus, it may be concluded that Null Hypotheses 1, 1(a), and 1(b) are rejected. However, Null Hypothesis 1(c) cannot be said to be rejected.

Implications

The usage of DSS models was found to be greater in the private sector than the public sector, and within the private sector, greater at the upper hierarchical levels. There are several implications of these results. First, the computing literacy levels of mid- and top-level managers in the private sector are probably greater than those of their public sector counterparts. Moreover, the nature of decisions and decision processes may be quite different in the two sectors. The widespread use of DSS models at the upper hierarchical levels of the private sector indicates a heavy reliance on "rational" techniques for decision-making, which suggests a focus on a small set of well-defined objectives such as optimized resources and returns. It also suggests that there are few extraneous or political factors influencing their decisions.

In contrast, decision-makers at the upper levels of the public sector may be less autonomous, expending more of their energy in coping with extraneous stakeholders such as the general public and supervisory agencies. Their decisions often require the use of multiple and complex criteria that go beyond purely "rational" considerations. Indeed, it has been claimed that corporate management approaches are not very effective when applied to the public sector because the latter is more open and accountable to the general public, and

Application	Weighted Score Public	Weighted Score Private	Computed Rank Public	Computed Rank Private
ALL MANAGERIAL LEVELS COMBINED				
Financial Analysis	380	141	3	1
Marketing Analysis	461	229	9	7
Corporate Planning	412	198	5	3
Statistical Analysis	369	198	2	3
Production Planning/ Scheduling	445	228	7	6
Engineering/Scientific Analysis	448	235	8	8
Report Generation	342	160	1	2
Monitoring	400	220	4	5
Inventory Control	437	236	6	9
(Spearman's Rank Correlation Coefficient $r_s = .79$, $p = .01$)				
OPERATIONAL CONTROL LEVEL ONLY				
Financial Analysis	137	33	2	1
Marketing Analysis	163	60	8	9
Corporate Planning	147	48	5	4
Statistical Analysis	138	40	3	3
Production Planning/Scheduling	162	57	7	8
Engineering/Scientific Analysis	164	55	9	6
Report Generation	117	38	1	2
Monitoring	146	51	4	5
Inventory Control	155	56	6	7
(Spearman's Rank Correlation Coefficient $r_s = .86$, $p = .01$)				
MANAGEMENT CONTROL LEVEL ONLY				
Financial Analysis	199	82	3	1
Marketing Analysis	246	125	9	7
Corporate Planning	222	116	5	4
Statistical Analysis	188	113	2	3
Production Planning/Scheduling	232	117	8	5
Engineering/Scientific Analysis	230	126	7	8
Report Generation	187	93	1	2
Monitoring	211	123	4	6
Inventory Control	228	131	6	9
(Spearman's Rank Correlation Coefficient $r_s = .71$, $p = .05$)				
STRATEGIC LEVEL ONLY				
Financial Analysis	44	26	5	1
Marketing Analysis	52	44	7	4
Corporate Planning	43	34	2	3
Statistical Analysis	43	45	2	5
Production Planning/Scheduling	51	54	6	8
Engineering/Scientific Analysis	54	54	8	8
Report Generation	38	29	1	2
Monitoring	43	46	2	6
Inventory Control	54	49	8	7
(Spearman's Rank Correlation Coefficient $r_s = .52$, not significant)				

Table 4: Applications of DSS Models in Public and Private Secotrs, by Managerial Level

because few government officials have the right to make unilateral decisions (Ross, 1988). It has also been said that extraneous influences such as central agencies and the general public often confront this sector with unique internal management decisions that are not clearly operational, management control, or strategic in character (Montague, 1986).

Differences in specific modeling techniques between the two sectors also support these conclusions. When all three levels were considered together, eight of the ten techniques were found to be used more in the private sector than the public sector. At the operational level, the private sector's usage exceeded that of the public sector for only three of the ten techniques. At the management control level, the private sector's usage exceeded that of the public sector for all but one of the ten techniques. Although data at the strategic level were too sparse for such comparisons, the trends in these numbers also support the overall sense that the criteria for decision-making at the upper levels of the private sector are more "rational," whereas the use of such criteria in public sector decision-making is mostly at the lower levels.

Differences between the two sectors in their applications of DSS models also yield implications consistent with the preceding discussion. The popularity of financial analysis and corporate planning applications in the private sector is congruous with the "rational" decision-making notion. The widespread application of corporate planning models in this sector also supports the results of a European study of large organizations (McAleer and Wightman, 1993). In the public sector, the high popularity of report generation and statistical analysis applications implies that the considerations for public sector managers are more complex and transcend typical private sector objectives such as optimized resources and returns. Examples of complex objectives for public sector organizations include the shaping and enforcement of policy (Kraemer and King, 1986) and program analysis (McGowan and Lombardo, 1986). In addition, the public sector's accountability to taxpayers fosters the production and general availability of all kinds of reports containing information pertaining to the use of public funds. The implications for DSS designers are that decision models developed for the two sectors need to be different in terms of the importance or weights attached to various criteria. In particular, designers of systems for public sector decision-making need to take into consideration a higher complexity of decisions resulting from the presence of multiple criteria. This is particularly true of enhanced or "intelligent" systems whose outputs may include recommendations on specific courses of action.

Conclusion

Technological advances in information technology are creating a turbulent environment forcing both public and private sector organizations to respond in multiple ways. One way they are responding is through the effective use of DSS models. However, this usage varies because of differences in organizational goals and decision processes. Our study has documented some of these differences. Though the sample size is not large, our study provides an excellent starting point. It is our hope that future studies will provide more insights into differences in information technology usage between public and private sectors.

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