A Critical Review of Decision Support Systems Foundational Articles
Full Paper

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Abstract

Decision Support Systems (DSS) is a mature field of study with an extensive conceptual and empirical literature. This research study provides a starting point for learning and reviewing the foundation literature of the field. Decision support and analytics researchers can benefit from revisiting the methodologies, identifying under-explored ideas, and hopefully identifying visionary concepts from thought leaders who established the DSS research stream. This article reports a systematic examination of the DSS foundational literature published in *MIS Quarterly* during its first fifteen years of publication -- 1977-1991. In addition to examining the relevance of these articles to current and future research, the findings of the study provide a reference point for DSS research categories. Articles were categorized in terms of theory, methods, concepts and perspectives about computerized decision support that enrich research and encourage future exploration.

Keywords

Decision support systems, DSS, Decision Support, DSS History.

Introduction

Decision Support Systems (DSS) or more generally Decision Support is a mature field of study. As early researchers began to formalize the field of MIS and to discriminate between its many subfields, decision support systems were recognized as significant computerized tools that could improve decision making. A number of terms have been used for information systems supporting management decision making including management decision systems (Scott Morton, 1971), management decision aids, problem-solving systems, and planning systems. The most widely used phrase or term is Decision Support System.

Mature fields of study have an extensive conceptual and empirical literature. Those new to research about DSS can benefit from having a starting point for learning and reviewing the literature that serves as a foundation for more recent research. An early, and perhaps the earliest, use of the term 'decision support system' was in Gorry and Scott Morton's (1971) article titled "A Framework for Management Information Systems." Gorry and Scott Morton identified two categories of Management Information Systems (MIS), i.e., Structured Decision Systems (SDS) and Decision Support Systems (DSS). In 1971 from their perspective, most of prior examples of MIS had been SDS. Examples of SDS included budget analysis, inventory management, and short-term forecasting. Gorry and Scott Morton's (1971) article was written against the backdrop of a negative perception of MIS expressed in such papers as Russell Ackoff's (1967) seminal "Management Mis-Information Systems" article where he reflected on the deeply inadequate nature of MIS to support management decision making. Gorry and Scott Morton targeted DSS to semi-structured/unstructured decisions and management tasks like production scheduling, budget preparation, merger and acquisition analysis, and sales and production planning. Arnott and Pervan (2005) argued that the managerial nature of DSS was axiomatic or self-evident in Gorry and Scott Morton's (1971) description.

In its early years, articles in *MIS Quarterly* (*MISQ*) defined the information systems sub-field known as 'Decision Support Systems'. The initial editors-in-chief, Gary W. Dickson (1977-1982) and William R. King (1983-1985), encouraged the submission of high quality articles related to a new subcategory of Management Information Systems identified as Decision Support Systems. *MIS Quarterly* remains one of the most prestigious information systems journals.

This literature review is narrowly focused on DSS articles published in the first 15 volumes of *MIS Quarterly* from 1977 to 1991. The first volume of the specialized journal titled *Decision Support Systems* edited by Andrew B. Whinston was published in January 1985. Gradually it replaced *MIS Quarterly* as the premier journal for decision support research. We would argue, however, that the Decision Support field of study is anchored in the foundation articles that appeared in *MIS Quarterly*. These foundational DSS articles provide an underlying basis or set of premises for this research area. Understanding this corpus or body of knowledge is fundamental to establishing a coherent stream of research. Some articles remain, to this day, particularly interesting and relevant to understanding the field and conducting new studies. The most accomplished and visionary articles remain compelling exemplars of the potential impact of DSS and of what DSS researchers still need to understand.

The remainder of this article is organized as follows. We begin with a discussion of our motivation and research questions and follow this section with a research methodology summary and a discussion of results. We conclude this article with an overall summary and a discussion of the contributions and limitations of this research study.

Motivation and Research Questions

Decision Support System (DSS) artifacts and research have evolved and matured over the past forty years along with other types of information systems (IS). Contemporary terms associated with DSS include 'big data', 'business intelligence,' and 'analytics'. One indicator of the changing nature of the field is found in the content of the nine AMCIS 2017 mini-tracks sponsored by the AIS Special Interest Group on Decision Support and Analytics (SIGDSA). The titles of all nine mini-tracks include either the term 'analytics' or 'big data'. Similarly, all seven SIGDSA mini-tracks at AMCIS 2016 used these same terms. This shift in terminology and focus has led some DSS researchers to debate the relevance of the early DSS literature to current and future research. This article represents an initial attempt to address the continuing relevance of early research in DSS to future studies related to current and future computerized systems intended to support decision making.

Rather than investigating the thousands of DSS articles published between 1969 and 2001 (Eom, 2003), we choose to narrowly investigate articles published in *MIS Quarterly*, one of the earliest IS academic journals and one of the recognized premier journals in the IS field, during its first 15 years. The first issue of *MIS Quarterly* was published in 1977, and much of the formulation of Management Information Systems (MIS) can be found in its pages. Although conferences and other journals were publishing DSS research during this time period, we argue that many of the most rigorous, impactful and novel DSS research articles would have been submitted to *MIS Quarterly* and would have been rigorously peer-reviewed. We choose the timeframe from 1977-1991 since the number of quality DSS publication outlets increased in the late 1980s with the publication of the journals *Decision Support Systems* and *Information Systems Research* (*ISR*). Although one might expand the number of journals surveyed including *Management Science*, *Interfaces* and *Decision Sciences* to identify more foundational articles, or expand the number of years, the current effort critically evaluating 30 DSS articles provides useful and actionable information.

In addition to assessing relevance, we are motivated to provide a reference point in terms of theories, concepts and perspectives about computerized decision support that can enrich current research and encourage future exploration. As Mason, McKenney and Copeland (1997, p. 307) suggest, a field's history: "provides a backdrop from which to determine what is novel in the current situation and which factors serve to distinguish the present situation from any others in the past … helps one understand the sources of contemporary problems … identifies the solutions that worked in the past and those that did not .. reminds us of … the broad degree of complexity, intricacy, and unpredictability that surrounds any real circumstance." An MIS historical perspective offers a basis for inductive reasoning to suggest future studies and inspiration for new research hypotheses (Mason et al. 1997).

Overall this project strives to provide a more understandable foundation for the increasing DSS research literature and to enhance our understanding of the literature. A systematic review by experts is one tool for providing scientifically useful evidence. Our research questions include:

- What are the foundational articles for DSS published in MIS Quarterly during 1977-1991?
    - What methodologies were used in early DSS literature?
- How relevant are foundational DSS articles to contemporary research and practice?
    - Which individual articles are relevant to what specific DSS topics?
    - What is the linkage between early DSS research and contemporary topics such as 'big data' and 'analytics'?

Methodology

The DSS research domain is sufficiently mature to encourage us to systematically go back and flag what is relevant for future research. Such a study should provide a firmer foundation for future literature reviews and for designing doctoral programs' reading lists. Initially, to identify the corpus of relevant DSS articles the search engine in the *MISQ* Journal archive (http://misq.org/archive/) was used. Forty articles were identified using the search term DSS and 70 articles with the search phrase Decision Support Systems. After reviewing those results, it was concluded that a comprehensive manual review of each issue of *MIS Quarterly* in the years 1977 to 1991 (Volumes 1 to 15) using explicit criteria would provide a more complete and accurate set of articles to critique since we wanted to narrowly focus on DSS foundations. Any article with either 'decision support systems', 'decision support' or 'DSS' as part of the article title was selected for review. Our premise was that authors using these terms in the title of their article self-identified as part of the emerging DSS research field. Thus, using this criteria, the authors themselves, reviewers and editors were defining the body of decision support knowledge in *MISQ*. We excluded all editorials, interviews, overviews and papers categorized in the section titled 'Issues and Opinions' on the basis that the review process applied to those is typically different from that applied to research papers. This does not imply that we excluded research papers where authors proposed a well-supported vision of the future of DSS or other aspect of the field – our concern was with the rigour and consistency of the review process and not with the content of the paper per se. In addition, we excluded articles identified as 'group decision support systems' or 'GDSS' since this is a branch of DSS research that likely warrants a separate investigation. Ultimately, thirty articles were selected for analysis based on the selection criteria.

Each of the 30 articles was read by the four academic researchers who collaborated in this study. All four co-authors are experts in the Decision Support research field and have been research-active in recognized DSS journals, conferences and organizations for over 10 years and up to 40 years. All of them have written their doctorates in the area of DSS and have, therefore, the requisite background not only for evaluating the DSS papers they read, but also to be able to properly place them in the general context of DSS research from its origins to the current day. We also balanced the expert team with two US-based researchers and two European-based researchers to include a wider perspective from two major contributor groups to DSS research. This is important in appreciating the credibility of the ratings reported in this paper.

To develop a taxonomy for DSS articles, we began with articles describing DSS research by Elam, Huber, and Hurt (1986) and Hurt, Elam, and Huber (1986) as a starting point for a contemporary taxonomy for categorizing DSS research articles. They developed their taxonomy to "provide data that will help determine trends in the DSS field, that will prompt more informed discussion and debate, and that will help researchers direct their efforts in the widest manner possible" (p. 2). The taxonomy was used by Elam et al. (1986) and Hurt et al. (1986) to categorize more than 200 DSS articles and conference papers from a wide number of sources published prior to 1986. They do not present definitions for their categories.

In this study, the 4 authors read and independently categorized a sample of articles to clarify and update the schema and to develop category definitions to reflect current research areas. This discussion led to a clarification of the categories and in some cases to a revision of some of the category definitions so that they could be applied systematically in determining the reliability of the process. We wanted to connect the past foundational articles with modern topics to aid identification of relevance, one of our research goals. After reaching consensus, each expert independently categorized each article. Table 1 provides an overview of the final categories, identifying the type of article, the methodology used by the author(s) and the decision support research area. This three-part schema is consistent with that used by Elam et al. (1986) and Hurt et al. (1986), although the specific categories have been modified. A comprehensive definition of the categories is also provided in Table 1, and these were developed by the current authors.

Type of article	Definition
Application (practitioner article)	Written for a management audience so that relationship to the workplace is immediate
Conceptual oriented toward practice (theory)	Describes concepts that are based on theory and can be applied to the workplace at a future date
Conceptual oriented toward research (theory)	Describes concepts that are based on theory and require further theory development
Description of an actual artefact	Describes an existing or proposed item
Opinion / perspective	Commentary expressing an opinion
Review	Overview of a topic based on integration of the literature
Tutorial (skill oriented)	Explanation of an artifact or method describing how it works
Methodology	**Definition**
Case study	In-depth description of one or several instances for the purposes of illustration or to draw inferences
Experiment (e.g. lab, quasi-experiment, field testing)	Discussion of a particular treatment(s) in a lab or in field setting
Interviews	Person-to-person structured or semi-structured discussion for the purpose of obtaining data
Literature review	Analysis of prior research articles on a topic usually over a long timeframe
Survey	Method of collecting data using questionnaires
User observation	Observation and recording of people's actions for a specific purpose to collect data
Decision support systems topic	**Definition**
Individual use	Use of the information is at the individual level (e.g. HCI)
Design, development, implementation process	Process of designing, developing and implementing a DSS
Evaluation of DSS	Method or criteria used to evaluate the impact of a DSS
Human decision making	Focus on human psychological or physiological decision making processes
Intelligence in DSS	Artificial intelligence methods and techniques in DSS
Model	Algorithms, qualitative or quantitative methods in a DSS
Organizational use	DSS uses at organizational level such as strategic decision making / impact on organizational structure & human resources
Systems management (post implementation)	Management of DSS as a system that impacts the organization or other systems

Table 1. Categories and definitions used to evaluate DSS articles.

The categorization task facilitated and informed assigning a relevance score to each article. For the purposes of this research, relevance is circumscribed to relevance to current and future research. A relevance score of 0, 1 or 2, a nominal scale, was assigned by each reviewer, again independently, for each article. A relevance score of 0 indicates 'not relevant', a score of 1 indicates 'somewhat relevant' and a score of 2 indicates 'relevant'. This rating is analogous to a reviewer rating of strongly accept/accept/reject that is prevalent for journal article review processes. Furthermore, the reliance on four raters provides

sufficient confidence that each article has been properly assessed, and this is a strength of our approach that the overall ratings are the product of over 100 years of accumulated experience in DSS research.

Discussion of results

MIS Quarterly published 342 scholarly research articles in Volume 1 to Volume 15 (1977-1991). We identified 30 of these as DSS articles using criteria discussed previously for an approximate percentage of 8.8%. The mean and standard deviation of the relevance ratings are shown in Table 2. Each of the articles is numbered from 1 to 30 in Table 2 and those numbers are used in the table in Appendix 1.

	1978	1978	1979	1979	1980	1980	1981	1981	1981	1981
	Alter	Ginzberg	Davis	Locander, Napier, Scamell	Barbosa, Hirko	Sprague	Hackathorn, Keen	Huber	Keen	Vierck
Article	1	2	3	4	5	6	7	8	9	10
Mean	1.75	1.5	0	0.5	0	1.5	1.5	1.75	0.75	1
Std Dev	0.500	0.577	0.000	0.577	0.000	1.000	0.577	0.500	0.957	0.816
	1982	1982	1983	1984	1984	1984	1985	1985	1986	1986
	Alavi	Robey, Taggart	Hogue, Watson	Mann, Watson	Meador, Guyote, Keen	Meador, Mezger	Henderson, Schilling	Sanders, Courtney	Meador, Guyote, Rosenfeld	Remus, Kottermann
Article	11	12	13	14	15	16	17	18	19	20
Mean	0.875	1.25	0.875	1.25	0.5	0.5	0.75	1.5	1.125	1.8
Std Dev	0.854	0.957	0.854	0.500	0.577	0.577	0.500	0.577	1.031	0.500
	1986	1987	1987	1987	1987	1987	1988	1988	1990	1991
	Turban, Watkins	Houdeshel, Watson	O'Keefe, Wade	Pieptea, Anderson	Remus, Kottermann	Todd, Benbasat	ElSherif, ElSawy	Money et al	LeBlanc, Kozar	Silver
Article	21	22	23	24	25	26	27	28	29	30
Mean	1.25	0.25	0.625	0.75	0.75	2	1.5	0.75	1	2
Std Dev	0.957	0.500	0.479	0.957	0.957	0.000	0.577	0.957	0.000	0.000

Table 2. Relevance Ratings (mean and standard deviation).

Table 3 shows a summary of the relevance rating results. As can be seen ten articles, or 33%, were judged to have a relevance rating >=1.5 (out of a possible 2.0). This indicates high relevance for the articles to current and future research. Fourteen articles were judged to have moderate relevance with scores >0.5 and <1.5. Finally, six articles had little or no relevance as judged by the four experts.

The standard deviation between raters in all three categories was close, ranging from 0.21 to 0.28. Five articles exhibited a standard deviation of 0 in ratings indicating complete agreement. A further fourteen papers showed a standard deviation of 0.5 or 0.6, indicating mild disagreement. Eight articles showed a standard deviation between raters >0.957 indicating substantial disagreement. Disagreement may indicate differing perceptions of future research and, therefore, a different basis for judging the "relevance" criterion. This could be analysed as a weakness of our approach, but we take the opposite view, considering that the reliance on four independent visions of DSS research, two from US-based researchers and two from European-based researchers, is a richer combined perspective than the blind application of overly constraining criteria would deliver.

Nonetheless, in order to quantify the inter-rater agreement among the four raters in a more systematic fashion, the Fleiss Kappa test (Fleiss, 1971) was computed across the sample and showed a kappa value of 0.145. According to Landis and Koch (1977), this indicates "slight agreement" but to us, it reflects that the raters generally agreed on which articles were still relevant or no longer relevant. Raters may have been drawn to features that reflected their own research orientation more closely than that of other raters. This is in keeping with our perception that the "relevance to future DSS research" construct is somewhat subjective and is not one which can be precisely defined or measured. Overall this simple 3 category measure seems valid and reliable.

Relevance Rating	Number of Articles	Standard Deviation of Ratings
>=1.5	10 (33%)	0.28
>0.5 and < 1.5	14 (47%)	0.21
<=0.5	6 (20%)	0.26

Table 3. Summary of Relevance Ratings Results.

There was generally good agreement on the relevance or lack of relevance to future research of the earliest articles, particularly articles numbered 1, 2, 6, 7, and 8. As can be seen in Table 2, other articles with a relevance rating >=1.5 are articles #18, 20, 26, 27, 30.

Although the sample is small and the period is limited to a 15 year span, it is evident that the majority of the papers deemed relevant were published in the early and late years of the period. Five out of eight of the papers from the 1978 to 1981 period were deemed very relevant, and three out of five papers identified for the 1987 to 1991 period were deemed very relevant. For the period 1982 to 1986, only two papers out of seventeen were found to be very relevant by the four raters.

Whilst this chronological pattern seems significant, an examination of the classification of the papers in terms of methodology, type of article or DSS topic does not reveal any clear correlation with the period when the papers were published. It can be hypothesized that the early papers are foundational in their orientation and, therefore, are still very pertinent, whereas the later papers are more mature and, therefore, have more pertinence to our current understanding of what the field of DSS requires in order to pursue its progression. The period in-between, on the other hand, is more likely to be characterized by papers focusing on narrower issues which yielded either a negative rating from raters or a lower level of agreement amongst raters. A closer examination of the papers deemed very relevant themselves bears this out to some degree but adds another dimension to our analysis: all of them pertain to either the development or implementation of DSS applications in organizations and seek to understand and theorize about the impact of DSS on managerial decision making or the work of managers. These issues, to our minds, are universal and timeless, which explains why these papers were scored as very relevant.

Interestingly, the list of the articles identified as very relevant in our study does not contain only frequently cited papers. Despite the dates of these publications, a number of them have been cited less than 100 times, for example, Ginzberg, 1980; Todd & Benbasat, 1987; and El Sherif and El Sawy, 1988. Only one of the articles, Sprague (1980) has been cited more than 1000 times. The rest have been cited between 113 (Alter, 1978) and 513 times (Sanders and Courtney, 1985). While these are substantial citation counts, they do not indicate that these articles have attained the status of seminal works that have strongly

influenced later developments. This anomaly confirms the fluid nature of the concept of relevance and its possible evolution over time where articles that were published many years ago in a premier journal may take on additional relevance as research and practice progress.

The list of highly relevant articles does contains many of the names associated with the founding of DSS as an area of research, with one notable exception: Herbert Simon, who, as noted by Pomerol and Adam (2006), made a critical contribution to the establishment and development of the DSS discipline, directly as well as indirectly. This is due to a simple fact: Herbert Simon never published in *MIS Quarterly*. Thus, our selection of *MIS Quarterly* as a primary forum for understanding the foundation of DSS has limitations. We believe it is an appropriate and coherent choice nonetheless, in view of the critical role played by *MIS Quarterly* as a forum and by the authors who published their work in it in the early years of the Information Systems discipline.

In relation to the five papers identified as less relevant to future research and practice, three of those were practitioner papers, meaning that among the total of six practitioner articles published in *MIS Quarterly* between 1978 and 1991, only one, Alter (1978) was deemed to be currently relevant, whereas three were found to be irrelevant (and they are actually the three papers having received the lowest relevance scores in the sample of 30 papers), with the remaining two found to be marginally or somewhat relevant. This may indicate that there is more variability in practitioner themes than in academic themes, whereby issues that are very critical to practice at one point, become less important at another, whereas academic theoretical articles are more likely to have enduring relevance, at least from the perspective of academic researchers.

One of our research questions involved the linkage between early DSS research and contemporary topics such as 'big data' and 'analytics'. We found that highly relevant papers raised issues that either are similar to those of big data and analytics or could provide a new approach to study this area. Although a thorough examination of this question is the topic of a future paper, we suggest the following big data and analytics questions based on the early literature we examined: What implementation pattern is best for big data and analytics? Alter (1978); How do big data and analytics affect organizational design? (Ginzberg, 1978); What is the role of big data and analytics in improving the performance of knowledge workers in organizations? (Sprague, 1980); How do big data and analytics affect organizational culture related to decision making? (Huber, 1981); What is the influence of a user's task environment on the success of big data and analytics? (Sanders and Courtney, 1985); How can big data and analytics help a user decide how to decide? (Remus and Kottemann, 1986); How do big data and analytics affect problem solving, and would process tracing methods be useful? (Todd and Benbassat, 1987); Do big data and analytics provide decisional guidance, and is it restrictive? (Silver, 1991).

The table shown in Appendix 1 shows the categorization of articles based upon a consensus between expert raters. The Totals column shows a number of patterns. First, the articles are predominantly conceptual articles. Second, 25% describe an actual artifact. Third, the dominant methodology in the 30 articles (43%) was case study information. Fourth, the most common decision support topic was design, development, and implementation process. Finally, evaluation became an important topic beginning in 1987.

Summary, Contributions and Limitations

In this study, thirty articles published in *MIS Quarterly* from 1977-1991 were identified as potentially foundational to future DSS research. *MIS Quarterly* was chosen for analysis because it is one of the premier journals in the field of Information Systems, it was one of the earliest MIS journals, and its standards for peer-review and quality publications set a high standard for other Information Systems journals. Articles were self-identified by the author as decision support articles in the title. We eliminated Group DSS articles from consideration in the review. Articles were categorized and assessed for relevance to future DSS research by four experts. Ten articles were rated as highly relevant to current and future research.

The contributions of this critical review to the literature are threefold:

1. The study used expert opinion to review DSS articles published in *MIS Quarterly* to guide researchers to understanding decision support theories, identifying under-explored topics, and inspiring new research in DSS;

2. The study provides a conceptual bridge to connect contemporary terms such as 'big data' to prior research; and,

3. This study provides a partial reading list related to specific DSS topics to help inform future researchers.

This research study does have some limitations. The research data set is narrow since we limited our study to *MIS Quarterly* articles over its first 15 years. We also used only four expert raters, although it is not clear that additional expert raters would have improved inter-rater reliability. In fact, more raters might decrease reliability. Our future research will focus on a closer evaluation of articles rated as highly relevant with the goal of identifying specific characteristics of these articles that connect them to relevant to current and future research

In conclusion, the most relevant MISQ articles related to future conceptual oriented research (theory) are Alter (1978), Ginzberg (1978), Sprague (1980), Huber (1981), Sanders and Courtney (1985), Remus and Kottemann (1986), Todd and Benbassat (1987), and Silver (1991). The most relevant MISQ articles related to future research for design, development, implementation processes are Alter (1978), Ginzberg (1978), Strague (1980), Hackathorn and Keen (1981), Sanders and Courtney (1985), Remus and Kottemann (1986), ElSherif and ElSawy (1988), and Silver (1991).

In general, the most relevant MISQ articles related to future research are Alter (1977), Ginzberg (1978), Sprague (1980), Hackathorn and Keen (1981), Huber (1981), Sanders and Courtney (1985), Remus and Kottemann (1986), Todd and Benbassat (1987), ElSherif and ElSawy (1988), and Silver (1991).

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Appendix I: Categorization of articles.

Type of article /Article number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
application (practitioner article)	X		X		X										
conceptual oriented toward practice (theory)	X	X		X	X		X		X	X	X		X	X	X
conceptual oriented toward research (theory)	X	X				X		X	X			X		X	
description of an actual artefact			X		X										
opinion / perspective								X	X	X					
Review															
tutorial (skill oriented)															
Methodology															
case study	X		X	X	X								X	X	
experiment (e.g. lab, quasi experiment, field)															
Interviews											X		X		
literature review						X	X					X			
survey (data from surveys)		X													X
user observation															
Decision Support Systems Topic															
design, development, implementation process	X	X		X	X	X	X			X	X	X	X	X	X
evaluation of DSS									X						
human decision making												X			
individual use				X		X									
intelligence in DSS															
Model															
organizational use		X	X			X	X			X					
systems management (post implementation)							X						X		

Type of article / Article number	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
application (practitioner article)		X					X	X								6
conceptual oriented toward practice (theory)	X		X	X	X	X			X			X	X	X	X	21
conceptual oriented toward research (theory)			X		X	X			X	X	X		X	X	X	16
description of an actual artifact		X					X	X				X		X		7
opinion / perspective	X														X	5
review																1
tutorial (skill oriented)																0
Methodology																
case study		X		X			X	X				X	X	X		13
experiment (e.g. lab, quasi experiment, field)										X						1
interviews				X												3
literature review					X	X			X		X				X	8
survey (data from surveys)			X													3
user observation																0
Decision Support Systems Topic																
design, development, implementation process	X	X	X	X	X	X	X	X	X	X		X			X	24
evaluation of DSS			X						X		X		X	X		6
human decision making					X										X	3
individual use	X											X			X	5
intelligence in DSS					X	X										2
model		X														1
organizational use			X	X			X	X				X				10
systems management (pi)									X							3