

# Decision Support Systems Research in Korea (1985-1998) : An Empirical Investigation through Exploratory Factor Analysis

Sangjin Yoo\* · Sean B. Eom\*\*

## ■ Abstract ■

This study applies factor analysis of an author cocitation frequency matrix derived from a database file that consists of a total of 1095 *cited* reference records taken from 95 *citing* decision support systems articles published in Korean journals. This study identified the influence of social psychology, cognitive psychology, management information systems, strategic management, and organizational behavior/organizational design to the development of group support systems, user-interface, and executive information systems research subspecialties. This research establishes a benchmark to be used in the future research, which is necessary to account for the ongoing changes in the intellectual development and structure of DSS research in Korea before solid conclusions can be reached about the maturity and on-going development of the DSS field in Korea.

## 1. Introduction

Since the term "decision support systems"(DSS) was coined in the early 1970s, there has been a growing amount of research in the area of DSS over the past two decades. As Keen(1980) indicated in the early 1980s, it is necessary for information systems research to clarify reference disciplines and to build a cumulative tradition to become a coherent and substantive field. This is

necessary for DSS research as well. Since Eom, Lee, and Kim(1993) conducted an initial study to identify two areas of contributing disciplines (management science and multiple criteria decision making) and five subspecialties of DSS research(foundations, group DSS, database management systems, multiple-criteria DSS, marketing DSS, and routing DSS), many subsequent research papers have been published to trace the ongoing developments in the DSS area(Eom

\* Department of MIS, Keimyung University, Daegu, Korea

\*\* Department of Management, Southeast Missouri State University, Cape Girardeau, MO. 63701, U.S.A.

1995, 1996, 1998a, 1998b).

This study applies factor analysis of an author cocitation frequency matrix derived from a database file that consists of a total of 1095 cited reference records taken from 95 citing decision support systems articles published in Korean journals. This research empirically investigates major themes, intellectual developments, and structure of decision support systems research in Korea. We establish a benchmark to be used in future research, which is necessary to account for the ongoing changes in the intellectual development and structures of DSS research in Korea. This study fosters a better understanding of how DSS research in Korea has evolved to its present state. Using factor analysis of author cocitation matrix, this study attempts to identify the intellectual structure, reference disciplines, and major themes in current DSS research in Korea and provide important groundwork for future theoretical development in the DSS area and for future scientific inquiry.

## 2. Data and Research Methodology

This study is based on the assumptions that "cocitation is a measure of the perceived similarity, conceptual linkage, or cognitive relationship between two cocited items (documents or authors)" and "cocitation studies of specialties and fields yield valid representations of intellectual structure"(McCain 1986, p.111). For an indepth overview and the continuing relevance of this topic, see White(1990).

The primary data for this study were gathered from a total of 95 articles in the DSS area over

the past 13 years (1986-1998). A database file was created consisting of a total of 1095 cited reference records taken from the 95 citing articles from the following journals and proceedings. The journals are *Business Education Review*, *Daehan Association of Business Administration*, *IE Interfaces*, *Journal of Information Systems*, *Journal of Information Technology*, *Journal of KIISS*, *Journal of KISS*, *Journal of KORMS*, *Journal of MIS Research*, *Journal of Management Studies*, *Journal of the Korean Society for Quality Management*, *Korea Information Science Society Review*, *Korean Management Review*, *Korean Management Science Review*, and *The Psychological Review*. Also, proceedings of the following conferences are included : 1993-1998 *Spring and Fall KMIS Conferences*. We did not assign weights to the journals since there is no objective criteria to rely on.

The raw cocitation matrix of 70 authors was analyzed by the factor analysis program of SAS (statistical analysis systems), using the principal component analysis with varimax prerotation method. The latent root criterion(eigenvalue 1 criterion) and screen test was applied to obtain an intial 14 factor solution. Most factor analysts seem to agree that other important considerations in determining the number of factors include the ability to assign some meaning to the factors. Due to the limited number of citing articles, 7 meaningful factors are used as a terminal solution. The seven extracted factors account for 78.18 percent of the total variances of the data set.

### 3. Results

Factor analysis extracted seven factors consisting of 3 major areas of DSS research(GSS, user interface, and EIS) and 5 reference disciplines(social psychology, cognitive psychology, MIS, strategic management, organizational science/organizational design).

<Table 1> presents each factor and its corresponding authors for each factor with factor loadings at .40 or higher. McCain(1990) suggested that only authors with factor loadings greater than 0.7/less than -0.7 are likely to be useful in interpreting the factor, and only factor loadings above 0.4 or 0.5/ below -0.4 or -0.5 are likely to be reported.

Factor 1 seems to represent group support systems and social psychology. Since the mid - 1980s we have witnessed an emerging DSS research theme : group decision support systems. GSS researchers in Korea have conducted empirical GSS research, as well as non-empirical research. The empirical GSS research results have been published in several Korean journals to investigate :

- groupware user satisfaction
- the effect of the group factors on the efficiency of the group decision as well as on group communication patterns.
- effectiveness of GDSS in idea-generation
- the effects of group interaction on the performance of group decision making in a GDSS environment
- the effect of GSS on job characteristics and organizational effectiveness
- the factors for the inconsistent findings in GDSS research

- the effects of conference culture on the development of Korean GDSS
- the characteristics of group decision making in Korea
- the factors affecting the adoption of GDSS by the cultural types of organizations

In the non-empirical GSS research area, several group decision support systems or subsystems of GDSS have been developed, including a prototype International GDSS, GDSS using object-oriented modeling techniques, a voting method selection support systems for GDSS, web-based multi user quality function deployment (QFD) as a tool for GDSS, and an idea categorizer for GDSS.

Some researchers have examined analytic hierarchy process (AHP) usage pattern as a GDSS toward the various task types, conducted a preliminary analysis of the group decision making for the development of a Korean GSS, surveyed the organizational infrastructure for adaptive workgroup DSS, designed network-based GDSS for information sharing and user management, explored GDSS research areas by reviewing "groupthink" literature, performed a multilevel model integration for collaborative decision making, designed a multiple criteria DSS for measuring and analyzing group consensus to facilitate consensus building.

There are several comprehensive reviews of major GDSS research(Benbasat and Nault 1990, Dennis and Gallupe 1993, Dennis et al 1990, Dennis et al 1988). Readers are referred to Eom (1995, 1996, 1998a, 1998b) for some of the important recent developments in the GSS area and other subspecialty areas from an author co-citation analysis perspective.

<Table. 1> Author Factor Loadings(Varimax Rotation) at .40 Or Higher

Factor 1 GSS/Social Psychology	Factor 2 Userinterface/ Cognitive Psychology				Factor 3 MIS/EIS				Factor 4 Unnamed				Factor 5 Unnamed				Factor 6 Strategic Management				Factor 7 Organizational Science										
	X39	X42	X35	X38	X46	X67	X10	X1	X40	X45	X33	X3	X49	X49	X51	X52	X53	RAINER	X40	0.955	X54	0.910	X53	0.889	X54	0.889	X61	0.880	X54	0.889	X61
VOGEL	X36	0.929	LUSK	X39	0.951	NELSON	X46	0.903	MACKKEY	X40	0.955	RAINER	X49	0.889	RAISINGHANI	X54	0.889	DAFT	X9	0.704											
GAILLITE	X19	0.927	MCBRIDE	X42	0.947	WARSHAW	X67	0.903	NAULT	X45	0.955	PAYNE	X49	0.889	THEORET	X61	0.880	LENGEL	X36	0.688											
DESANACTIS	X13	0.904	KERSNICK	X35	0.947	DAVISED	X10	0.857	KLETKE	X33	0.953	FINSONNEAULT	X51	0.860	MINTZBERG	X44	0.861	COURTNEY	X8	0.521											
DENNIS	X12	0.886	SCHREODER	X38	0.876	ADAMS	X1	0.832	BARRSH	X3	0.883	POOLE	X52	0.753	LIBBY	X37	0.425	SANDERS	X57	0.487											
HUBER	X35	0.848	LUCAS	X38	0.894	KOHCCE	X34	0.760	CONNOLLY	X7	0.546	OLSON.M.	X48	0.745				IVES	X27	0.445											
GEORGE	X20	0.847	HOGARTH	X25	0.770	CERVENY	X6	0.751	JESSUP	X29	0.535	KASPER	X31	0.510																	
ZIGLRS	X70	0.839	DEXTER	X14	0.734	WATSON.HJ	X68	0.742	DAVIS.JH.	X11	0.483																				
HILTZ	X24	0.838	EINHORN	X17	0.730	TURBAN	X63	0.709	BENBASAT	X5	0.473																				
WATSON.R.T.	X69	0.834	BENBASAT	X5	0.728	IVES	X27	0.615	LIBBY	X37	0.479																				
RAO.V.S.	X35	0.842	TODD	X62	0.633	TODD	X62	0.571																							
VALAGICH	X65	0.802	DICKSON	X15	0.526	SANDERS	X57	0.453																							
KONSYNSKI	X35	0.800	IVES	X27	0.526	COURTNEY	X8	0.435																							
HENNINGER	X23	0.797	JARVENPPA	X28	0.443	OLSON.M.	X48	0.423																							
TUROFF	X64	0.735																													
STEEB	X60	0.784																													
GRAY	X21	0.783																													
JOHNSTON.S.C.	X30	0.780																													
HACKMAN	X22	0.782																													
APPLFGATE	X2	0.761																													
MCCUIRE	X43	0.746																													
MARTZ	X41	0.742																													
SEGEL	X19	0.724																													
DICKSON	X15	0.731																													
JARVENPAA	X28	0.703																													
DI.BROSKY	X16	0.693																													
JESSUP	X24	0.687																													
CONNOLLY	X7	0.699																													
DAVIS.JH.	X11	0.615																													
BASTIANUTTI	X1	0.381																													
ELLIS	X18	0.533																													
LENGEL	X36	0.527																													
DAFT	X9	0.500																													
POOLE	X52	0.442																													
Eigen Value		22.06						7.295			5.069			4.177						2.429											
% of Variance		31.5%						10.4%			7.3%			6.0%						3.5%											

Social psychologists such as Siegel, Dubrovsky, and McGuire (1986) constitute an important element of factor 1. Social psychology is concerned with the study of causes, types, and consequences of human interaction, including the effects of group pressure (i.e., conformity), the individual as part of a social group (social loafing tendency, brainstorming, groupthink, and prejudice and discrimination), the formation of impressions, and the development of attitudes.

Siegel et al (1986) conducted experiments to investigate the effects of computer-mediated communication on communication efficiency, participation, interpersonal behavior, and group choice. In doing so, groups of three members were asked to reach consensus on career choice problems via three different communication modes (face-to-face meeting, e-mail conferencing, interactive computer-mediated discussions). Group processes in computer-mediated communication produced fewer remarks and took longer to reach consensus when compared to that of face-to-face meetings. Computer-mediated groups participated more equally in discussions and also exhibited uninhibited behavior, such as strong and inflammatory expressions in inter-personal interactions.

Social psychologists have influenced the Korean DSS researchers in investigating the effect of the group factors on the efficiency of the group decision, analyzing the group decision making for the development of a Korean GSS, probing the impacts of GDSS in the ideation phase of group decision making, assessing the effects of group interaction on the performance of group decision making in a GDSS environment, and identifying the effects of group factors on group communication patterns.

Factor 2 appears to represent *User Interfaces and Cognitive Psychology*. DSS researchers in Korea have conducted a variety of user interface research to :

- establish a framework for DSS Interface development,
- investigate effects of information presentation modes on decision accuracy and time,
- probe the effect of information representation style and quantity on decision-making performance, cognitive trails in linking theories of personalities and cognitions in the strategic decision-making process,
- examine the effect of psychological types of decision makers and advanced modes of information presentation on the task performance, and
- establish the relationships between decision maker's personality type and risk attitude.

Recently, Web-based DSS approaches have been investigated to coordinating production/marketing conflicts. Further, the Internet agent technology was applied to design web-based decision support systems. Readers are referred to Eom(1995, 1996, 1998a, 1998b) to overview some of the important recent development in the user-interface area and other subspecialty areas from an author cocitation analysis perspective.

Factor 3 appears to present the management information systems(MIS)/executive information systems(EIS) areas. DSS researchers in Korea have surveyed EIS literature, empirically investigated EIS utilization on the basis of technology acceptance model (TAM), compared the systems development life cycle and prototyping methodologies with an emphasis on the prioritization of development procedures for EIS, designed an

architecture for implementing EIS using data warehouse, conducted an empirical study of factors influencing EIS usage, and examined synergistic impact of integrating EIS and DSS for small and medium size firms.

In conducting this EIS research, four papers on the technology acceptance model (Adams et al 1989 ; Davis 1989 ; Davis et al 1989 ; and Watson et al 1991) have been widely referenced. The technology acceptance model addresses longstanding issues in information systems research -- what factors are affecting systems use and user acceptance of technology.

Numerous individuals have investigated the interrelationships between system use and individual/organizational/technological variables. Of this numerous research, Davis(1989) hypothesized that two specific variables, perceived usefulness and perceived ease of use, were fundamental determinants of user acceptance of technology. Davis also developed and validated new scales for the two variables. His research concluded that both perceived usefulness and ease of use were significantly correlated with indicators of system use. A significant finding of his research was that usefulness was significantly more strongly linked to usage than was ease of use. Later that year, the initial model of Davis was replicated by Adams, Nelson, and Todd (1989). Their study produced results that usefulness and ease of use are important determinants of system use and that results were consistent with previous study by Davis. A longitudinal study by Davis et al(1989) addressed the ability to predict people's computer acceptance from a measure of their intentions and ability to explain their intentions in terms of their attitudes, subjective norms, perceived

usefulness, perceived ease of use and other related variables. The fourth paper that has significantly influenced the EIS research in Korea was that of Watson et al(1991). It reported the results of EIS usage practice in the late 1980s and provided a framework for EIS development, as well as a number of promising changes and future directions.

Factor 4 is an unnamed factor. The factor contains four authors with factor loading greater than .7. Mackey, Barr, and Kletke(1992) investigated the effects of decision aids on problem solving processes in a semistructured problem using protocol analysis. Their results show that the problem-solving processes are influenced by decision aids. Their effects are found to be contingent on familiarity with the decision aid, task familiarity, and the interaction of these two factors.

Factor 5 is also another unnamed factor. Finding a common thread among those three authors in factor 5 was extremely difficult in that Rainer is a coauthor of an EIS article with Watson and Koh(1991), Payne is a cognitive psychologist, and Pinsonneault is a GDSS researcher. We believe that a smaller sample size could produce a result that would be very hard to interpret. Author cocitation analysis(ACA) is a supporting tool for examining a possible existence of intellectual structure of an academic discipline.

Factor 6 appears to represent strategic management. Mintzberg, Raisinghani, and Theoret (1976) conducted a field study of 25 strategic decision processes to suggest a basic structure of these unstructured processes. The strategic decision process is comprised of the identification phase(decision recognition routine, di-

agnosis routine), the development phase(search routine, design routine), and the selection phase(screen routine, evaluation - choice routine, authorization routine). Using the elements of the strategic decision process(3 phases and 7 routines), Mintzberg et al(1976) developed a general model of the process that could be used to illustrate the structure of each of the 25 decision processes compiled by the field study.

The strategic decision process model of Mintzberg et al has provided conceptual guidelines and theoretical frameworks for Korean DSS researchers in developing mid- and longrange investment planning DSS, designing the strategic decision making support systems using simulation model, and developing a DSS generator for problem structuring.

Factor 7 can be labeled as organizational behavior/organizational design in that Daft and Lengel(1986) are the only two authors with factor loadings greater than .7. Daft and Lengel reviewed and synthesized a number of threads from the organizational literature to answer the question, "Why do organizations process information?" The synthesis of the literature on organizational theory has led them to identify two forces that influence information processing in organizations -- uncertainty and equivocality.

They proposed a model to illustrate how organizations can be designed to meet the information needs of technology, the environment, and interdepartmental relations in order to minimize uncertainty(absence of information) and equivocality(the existence of multiple and conflicting interpretations about organizational situations).

Organizational design researchers, such as Daft and Lengel, have provided a foundational

concept for designing a model for the successful implementation of DSS in Korean large business organizations, designing and implementing EIS in Korea, and designing and interpreting an empirical study of factors influencing EIS usage in Korea.

#### 4. Conclusion and Implications for Future DSS Research

This research is limited by the number of citing articles. A reasonable number of source articles is necessary to assess the intellectual development of an academic discipline. The bibliometric database used here was a relatively smaller one, which could produce unstable, hard-to-interpret results. Our databases are significantly different from those commercial databases in terms of size of records. Besides, the cocitation matrix generation system used here gives access to cited coauthors, as well as first authors, unlike the method used to analyze other commercial bibliographical databases. Due to these differences, we could not follow the suggested criteria in the literature(e.g., McCain, 1990). Rather, we had to invent a new criterion through the method of trial and error.

Despite its weakness, this research establishes a benchmark to be used in the future research, which is necessary to account for the ongoing changes in the intellectual development and structure of DSS research in Korea and necessary before solid conclusions can be reached about the maturity and ongoing development of the DSS field in Korea. This study identified the influence of social psychology, cognitive psychology, management information systems, stra-

tegic management, and organizational behavior/organizational design to the development of group support systems, user-interface, and executive information systems research sub specialties.

Future research is necessary to assess the ongoing changes in the intellectual development and structure of the decision support systems, as well as the computer-based information systems as a whole. We plan to conduct future research to present more reliable and stable results based on a larger bibliometric database, so we can make solid conclusions about the maturity of the MIS field and its subfields.

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