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# Using Decision Support Systems in Chinese Enterprises: A Study of Managerial Information Behaviour

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## **Abstract**

Decision making is a fundamental activity for managers; however, satisfying the information needs of Chinese managers for decision making remains a challenge. In recent years, academic research on the development and application of Decision Support Systems (DSS) in China has grown quickly, but relatively little is known about the adoption and use of DSS in Chinese enterprises. In this paper, we explore the information behaviour with respect to decision making, drawing on data obtained from qualitative interviews with 18 Chinese managers and a large scale survey of 296 managers. We find that DSS is not extensively used in Chinese enterprises. Most managers show little interest in or need for using formal DSS tools in their management decision making, instead choosing either to rely on existing Information Systems (IS) applications with similar functionality considered to be adequate for decision support or to eschew formal IS tools altogether, simply relying on their own mental faculties. We discuss the reasons for this non-extensive-use of DSS in the Chinese context and then make recommendations for how DSS could be effectively used by managers who are familiar with both principles of information management and the decision context so as to contribute to a firm's long term success.

## **Keywords**

information behaviour, decision making, decision support systems, DSS use, China

## **Introduction**

In recent years, China's continued economic expansion has been paralleled by a sizable increase in the application of Information Systems (IS). IS applications were first introduced in China in the early 1980s when the Government invested massively in the State Economic Information Systems initiatives, which consisted of more than 100 separate information systems (Tian, J. et al., 2007). These first applications were the result of senior leaders realising that IT had an important role to play in the industrialisation and informatisation processes associated with nation building. The first undergraduate programmes in IS were developed in the mid-1980s (Martinsons and Westwood, 1997) but more widespread acceptance of IS, particularly in the private sector, only followed in the 1990s, some two decades later than in Western countries. As the economy was transformed towards a more market-driven situation, so the enabling power of IT was increasingly realised (Davison, Sia and Dong, 2008; Martinsons, 2005). Most of the early research was predominantly technical in focus. Rather less attention was paid to the management of the technology, and less still to the complex socio-technical and cultural analysis of the impacts of these systems on organisations and people. In the last few years however, more socially and culturally sensitive research has started to emerge, focusing less on the technology and more on the way the technology is used – and not used (e.g. Martinsons and Westwood, 1997; Newman and Zhu, 2008; Voelpel and Han, 2005;

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Westrup and Liu, 2008; Zhang, Sarker and Sarker, 2008). Thus, researchers have now started to pay more attention to the users of IS and information as well as the users' characteristics and behaviour.

Decision Support Systems (DSS) are deployed today in organisations as a key component of the decision maker's tool box. DSS were first developed in the 1970s and have seen wide application in the last 30 years or so. Major sub-fields in DSS include: Personal Decision Support Systems (PDSS), Group Support Systems, Negotiation Support Systems, Intelligent Decision Support Systems, Knowledge Management-Based DSS, Data Warehousing, Executive Information Systems (EIS) and Business Intelligence (such as Online Analytic Processing (OLAP), Data Mining) (Arnott and Pervan, 2008). In the current paper, we focus on the following DSS applications: EIS, Data Warehousing, Data Mining and OLAP since it has been suggested that these types of DSS applications have seen more application in practice (Arnott and Pervan, 2008; Ramamurthy, Sen and Sinha, 2008). In general, DSS can be described as "computer-based systems that help decision makers confront ill-structured problems through direct interaction with data and analysis models" (McNurlin and Sprague, 2004, p.428). DSS were intended "to increase the speed and accuracy of data analysis, while reducing costs, enabling the effective and efficient analysis of large volumes of quantitative data" (Martinsons and Davison, 2007a, p.287).

Given the increasing need to deal with an uncertain business environment in conditions of economic globalisation, more effective and efficient ways of data analysis are needed. As described above, a DSS is an analytic system and has the potential to facilitate this kind of data analysis so as to help managers better understand their competitive environments. This paper explores the current information behaviour of managers with respect to decision making and DSS use in Chinese enterprises, drawing on data obtained from qualitative interviews with 18 Chinese managers and a large scale survey of 296 Chinese managers. The topic is important because in an era of Chinese expansion, it is critical that we understand the information behaviour relating to how and why Chinese managers use (or don't use) sophisticated information systems such as DSS to support their decision making (cf. Martinsons and Davison, 2007a). Following this introduction, we review the relevant literature on DSS and its application in the Chinese decision making context before introducing our research context and method. Our proposition development and discussion forms the central section of the paper, leading to our recommendations and conclusions.

## **Literature Review**

Academic research on the development and application of DSS in China is growing quickly. Tian, J. et al. (2007) present an extensive analysis of scholarly research into DSS applications in a variety of different sectors of the economy, including: macroeconomy and public sector; water resources planning and management; agriculture, fisheries, forestry, ecosystems protection and public health; and enterprise management. However, while information systems in general have been widely accepted by Chinese organisations, particularly for transaction processing and communication functions, decision support is an area where although there are undoubtedly areas of great success, there is also considerable resistance to the technology (Todd and Benbasat, 1999). This is intriguing since "it is widely acknowledged that decision making is a fundamental activity for managers" (Martinsons and Davison, 2007a). It is suggested that decision making is synonymous with managing (Simon, 1960) and "in the decision-making view, the essential features of organizational structure and function may be derived from the characteristics of human decision-making processes and rational human choice" (Choo, 1996, p331). Given the frequency with which managers encounter unstructured and semi-structured decision making contexts, it is not

surprising that considerable energy has been devoted to the development of DSS in a wide variety of sectors (Tian, J. et al., 2007; Van Schaik and Sol, 1990) and DSS research in general (Pervan and Arnott, 2005).

DSS was first developed as a concept and discipline in the 1970s, and by the 1980s, as DSS analytical models were not being directly used by executives, EIS was developed (Tian, J. et al., 2007). The purpose of EIS is to scan and monitor the internal and external environments so as to improve the quality of senior managers' decision making (Warmouth and Yen, 1992). In the last decade, much of the development focus has turned to web-based decision support applications (Bhargava, Power and Sun, 2007) and data warehousing applications (Ramamurthy, Sen and Sinha, 2008), which support a "subject-oriented, integrated, non-volatile and time-variant collection of data in support of management's decisions" (Inmon, 2002, p31). Indeed, by shifting research agendas "towards the effective development and deployment of data warehouse and business intelligence systems", it can be argued that DSS research could become more organisationally relevant (Arnott and Pervan, 2008). "Data warehouses are designed to answer business questions that require analytics such as drill-downs, roll-ups, pivoting, slicing and dicing, and aggregation of data, which are best supported by OLAP tools" (Ramamurthy, Sen and Sinha, 2008, p.819). The design of a data warehouse does not need to follow the strict norms that are required in database design since the purpose of a data warehouse is primarily analytical. "At the front end [of a data warehouse], multi-dimensional databases (MDDDB) or cubes allow users to perform advanced OLAP, data mining, and advanced reporting functions" (Ramamurthy, Sen and Sinha, 2008, p.819). The analysis of tremendous volumes of historical data in a data warehouse has the potential to effectively support management decision making, therefore optimising company strategy (Alshawi, Saez-Pujol and Irani, 2003).

In China, DSS have been adopted since the mid-1980s, when the former leader, Deng Xiaoping, launched the National Hi-Tech R&D Programme, dubbed the 863 Programme in Chinese. Some of the early research is documented in Gu, Tang and Dong (1994) and Tian, J. et al. (2007). More recent applications of DSS technology in China include: the operation of the Three Gorges Dam and Reservoir (He, Chen and Dai, 2008); environmental issues associated with railway construction (Liu, Wu and Li, 2008); data warehousing in greenhouses (Wang et al., 2008); a data warehousing approach to e-government (Wang, 2006); water resources management (Feng et al., 2007); oil exploitation (Jia, 2008); port selection (Lin, Dai and Lin, 2008); DSS implementation in petrochemical enterprises (Xie, 2008); and R&D project selection (Tian, Q.J. et al., 2005). In addition, Chinese government ministries strongly encourage social and decision informatisation, i.e. reliance on information rather than hearsay or personal opinion as a basis for decision making. All of these factors promote the development of and reliance on DSS in China.

"The term information behaviour has now become a recognized term within the field of information science" (Nikoi, 2008, p.44). "Managers' information behaviour reflects a relationship with their work settings and information environment that highlights a need to understand problem situations as a precursor to understanding how they seek and use information" (Alwis, Majid and Chaudhry, 2006, p.364). In general, managers' information needs are at two levels: one is associated with the immediate business or task environment to guide them in their operational decision making, the other is associated with the broader business environment for long term strategic planning (Alwis, Majid and Chaudhry, 2006). At present, information advantage has become one key advantage of organizations. With the help of DSS, managers should have the potential to collect data from the internal and external environments, analyze data and models so as to find useful information and knowledge that would enhance long term strategic decision making. This kind of advantage is hard for competitors to simulate and would bring a high

payback to the organization.

“Skills in information selection, organisation and handling are no longer confined to information professionals, but have become the concern of almost everyone” (Webber and Johnston, 2000, p.387). In recent years, due to the successful implementation of different kinds of IS in enterprises, Chinese managers have undertaken a certain kind of digital transition from traditional management work. But satisfying the information needs of Chinese managers for decision making, especially long term strategic decision making, still remains a challenge, as decision making is a very special cognitive process. It is suggested that an “individual’s ability to use information for decision-making ultimately depends, not only on the availability of the appropriate information, but also – and even more importantly – on his or her ability to evaluate that information, to put it in context, and to use his own judgment as to how, when and where – and to what extent – it should be applied” (Parker, 2000, p.236).

A recent study (Martinsons and Davison, 2007a) compared the decision styles of American, Japanese and Chinese managers, using an instrument adapted from a model developed by Rowe and Boulgarides (1994). This decision style model suggests that an individual’s decision style can be classified on four dimensions, viz.: Directive, Behavioural, Analytical and Conceptual (Rowe and Boulgarides, 1983).

The 88 Chinese managers in Martinsons and Davison (2007a)’s population had an average age of 43, an average of 24 years work experience (6 at top management level). They all worked for large Chinese firms, with about 75% at state owned enterprises (SOEs) such as Brilliance China, China Everbright, China Overseas Shipping Company (COSCO), China Unicom, CITIC Pacific, and Shanghai Industrial and about 25% at family or privately owned firms. The Chinese managers were significantly more directive than the Japanese and American managers. They also demonstrated an analytical decision style to a moderate degree, but were weakly conceptual and behavioural. In their analysis, Martinsons and Davison (2007a) suggested that Chinese managers have a strong need to maintain and exercise power. Further, “IT applications that focus on the bottom-up aggregation of data and the top-down communication of decisions will be appropriate” (Martinsons and Davison, 2007a, p.298). In consequence, DSS applications like EIS could be expected to appeal to directive decision makers in China, even though they would appear to be more relevant to analytical decision makers. This distinction is important because although the Chinese managers were primarily directive, they also demonstrated a moderate inclination towards the analytical style. The recent flourishing of MBA and other executive education programmes in China may in part explain this shift from directive to analytical, since the programmes are generally rooted in the North American educational and managerial context, which is primarily analytical (and also conceptual).

## **Research Context, Methodology and Data Collection**

With the continuous progress of economic globalisation, the concept of environmental uncertainty has changed from one that is primarily local in focus to one that encompasses regional and international forces. Dealing with this uncertain environment is more likely to require more effective and efficient ways of data analysis. In such circumstances, in order to observe current information behaviour in decision making and assess current attitudes towards DSS technology by Chinese managers we firstly undertook a qualitative investigation into the current practices and attitudes of 18 managers in Chinese enterprises. We used semi-structured interviews using 14 open-ended questions. This style of interview ensures that respondents are free to describe their opinions about and knowledge on key issues that are related to this project. The 14 interview questions were themselves elicited from the conversations we had with 3 senior executives and 5 middle managers from different organizations (not part of the focus data set). As a primarily

exploratory study, the questions were neither theory driven nor connected to formal hypotheses, but were designed to be relevant to the decision making concerns of Chinese managers. The complete set of questions can be found in Appendix A.

In order to identify suitable respondents, i.e. people who would either already be using DSS technology or at least be familiar with the concept, we drew on our network of personal contacts. Firstly, we contacted a number of current Master of Engineering students who study part-time in Wuhan and work full time in a variety of firms. Secondly, we contacted managers currently working in the Iron/Steel industry where the first author of this paper previously worked, and where the whole firm's business process is well supported by its ERP (Enterprise Resource Planning) application. Thirdly, we contacted a manager in a Wuhan supermarket chain which is well known for its application of IS. Fourthly, we contacted one manager in China Mobile Group Hubei and three managers in China Mobile Wuhan Branch which operate powerful IS applications. Lastly, we contacted one manager in Jiangsu Shagang Group Ltd and one manager in Jiangyin Xingcheng Iron and Steel Co., Ltd. In this way, we were able to interview managers at different levels and from a variety of different organisations in the manufacturing and service sectors (see Table 1 for a list of the interviewees, their positions and affiliations). We believe that this population, which includes people at both middle-management and senior levels, is appropriate since although systems like EIS may have been designed to satisfy senior executives' information needs, in reality they are also used by people at the middle management level (Poon and Wagner, 2001).

**Table 1. Managers interviewed, ranks and affiliations**

<b>Managers Interviewed</b>	<b>Organisation</b>
One top manager	Jiangsu Shagang Group Ltd.
One top manager	Dongfeng Auto Gas Company
One top manager	Guangzhou South China Information Technology Company
One vice division head, four middle managers	Wuhan Iron and Steel (Group) Corp.
One division head	Jiangyin Xingcheng Iron and Steel Co., Ltd
One vice head of a franchiser	Wushang Bulksale Chain Corp. Ltd
One middle manager	Dongfeng Auto Commercial Vehicle Company
One middle manager	Dongfeng Peugeot Citroen Automobile company Ltd
Three middle managers	China Mobile Group Hubei Company Limited Wuhan Branch
One middle manager	China Mobile Group Hubei Company Limited
One middle manager	China Railway Siyuan Survey and Design Group Corp. Ltd
One middle manager	Wuhan Think Tank Company

After the qualitative interviews, we found that only one vice division head said that he used DSS in his management. All the remaining 17 managers said they didn't use DSS at all. Analysis of the interview data, however, suggested that DSS use is a sensitive issue and it is not appropriate to reach a conclusion on the extent to which DSS is used if the views of only these 18 respondents are taken into consideration. Therefore, and in order to obtain more evidence, we undertook a larger scale survey of managers on DSS use. We invited participation in the survey using our own networks of personal contacts.

The first author of this paper formerly worked in Wuhan Iron and Steel for 10 years. Most of her

university classmates still work in steel companies around China. Therefore, it was appropriate to ask these classmates to complete the survey. Secondly, she asked 10 current managers working in companies to help collect data from their colleagues. Thirdly, she asked two teachers to help collect data from classes of PhD or MSc Engineering students who study part-time and work full time in a variety of firms. Fourthly, she attended a training class for managers where she was also able to collect data. In this way, we were able to collect 296 valid data from managers of Chinese firms in different industries. See Table 2 for demographic information of this survey population. All data was collected in Chinese and has been translated for this paper.

**Table 2. Demographic information of survey respondents**

Measure	Items	Frequency	Percent
Industry	Steel manufacturing	177	59.80
	Automobile manufacturing	35	11.82
	Railway freight cars manufacturing	11	4.05
	Electric power	50	16.89
	Service	9	3.04
	Others	14	4.73
Organization size	Under 100	7	2.36
	Above 100 and under 800	36	12.16
	Above 800 and under 2000	28	9.46
	Above 2000	225	76.01
Education	Secondary school or less	8	2.70
	Post-secondary study	55	18.58
	Bachelor level	193	65.20
	Graduate-level study	40	13.51
Gender	Female	62	20.95
	Male	234	79.05
Overall work experience (number of years)	1-5	93	31.42
	6-10	43	14.53
	11-15	52	17.57
	16-20	62	20.95
	21-25	22	7.43
	26-30	20	6.76
	Above 30	4	1.35
Number of years with the current organization	1-5	142	47.97
	6-10	54	18.24
	11-15	41	13.85
	16-20	36	12.16
	21-25	15	5.07
	26-30	7	2.36
	Above 30	1	0.34
Current position	Top manager	16	5.41



	Director of the department	42	14.19
	Middle manager	119	40.20
	Others	119	40.20
Number of years in this position	1-5	220	74.32
	6-10	58	19.59
	11-15	12	4.05
	16-20	5	1.69
	21-25	1	0.34

## Proposition Development

In this research, information behaviour refers to how managers seek and use information in their management decision making. Unlike complex but structured routine transaction processing that has high requirements for precision and correctness in data processing, decision-making is a very special activity, reflecting specific information behaviour. In this section we develop three propositions. The first and second propositions each relate to one kind of information behaviour, while the third proposition covers two kinds of information behaviour, but all are concerned with managers' decision making in Chinese enterprises. In developing arguments to justify the propositions, we rely on prior research, our interviews with current managers and the large scale survey in Chinese enterprises.

Many of our respondents come from the steel industry, which has become extremely competitive in recent years. As one top manager commented "at present, each company faces the pressure of surviving, as from the total annual production of 600 million tons of steel, 100 million tons cannot be sold due to lack of demand". Nevertheless, enterprise informatisation has developed relatively well in the Chinese steel industry.

DSS applications have developed for about 30 years, exerting a strong influence on Chinese people and society. Firstly, Chinese government ministries strongly encourage social and decision informatisation, and an enterprise informatisation ranking exercise has been conducted each year since 2003 in China. The basic indicators of enterprise informatisation include the level of decision informatisation, the level of IT support for important decision making, whether there are data analysis process systems in place, etc.<sup>2</sup>. The final ranking is both prestigious and widely published in the media in March of each year, thus exerting great influence on enterprises and managers. Secondly, academic research on DSS in China has a wide focus and has been supported by many Chinese foundations such as the National Natural Science Foundation of China and the 863 Advanced Technology Project, and many achievements have been reported. In this case, even though some Chinese managers don't have an opportunity to use a DSS, they are at least familiar with it.

DSS is an evolving concept and its core idea is supporting strategic decision making based on analysis of data and model. But, the degree to which DSS could support decision-making is uncertain, since it is difficult to measure it. In this research, we explore the managers' information behaviour in decision making and their attitudes towards DSS technology no matter whether their company has claimed to have adopted it or not. We think this is reasonable as DSS is a well known concept in China and almost all our respondents have received higher education, possessing the ability to answer our interview or

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<sup>2</sup> National Information Evaluation Center (2002), The Scheme of Basic Indicators of Enterprise Informatisation, <http://www.niec.org.cn/qyxxh/zbt02.htm> (in Chinese)

survey questions.

### ***DSS use by Managers in Chinese Enterprises***

In exploring how managers seek and use information in their management decision making, it is appropriate first to relate information seeking in decision making practice to DSS use. As a DSS has powerful analytical functionality, it should constitute an important tool that managers can use as they undertake decision making activities since they “need more effective ways to understand their markets and their competition and guide their operations and their people” (Rai and Bajwa, 1997, p.944).

The 18 managers whom we interviewed in the initial study provided us with rich qualitative data concerning DSS adoption and DSS use. One top manager commented “We have not adopted DSS applications such as EIS, data warehousing and data mining in our firm. For the moment, I don’t feel the need for using DSS in my management decision making, because the market is relatively stable, relatively few major decisions need to be made”. One vice division head in Wuhan Iron and Steel (Group) Corp commented “We have adopted DSS applications such as data warehousing and OLAP, but at present data mining is seldom used. I use DSS in my management decision making. [Overall] DSS is not yet extensively used in my company”. Except for this vice division head, all the interviewees including four managers coming from the same company as this vice division head specified “I don’t use DSS to support my management decision making”. As for the adoption of DSS, several managers commented “I am not clear about this”.

From these qualitative data, and based on our investigation and familiarity with the use of IT in Chinese enterprises, we recognized that DSS may not yet be extensively used. Nevertheless, we considered that these 18 responses are insufficient to determine the extent of current DSS use in Chinese enterprises, so we decided to collect more data about whether managers previously used or were currently using a DSS in a large scale survey conducted in 34 enterprises located in Northern, Eastern, Western, Southern, South-western and Central China.

We listed four concrete DSS applications on the survey form (see Table 3), viz.: EIS, OLAP, Data Mining, Data Warehouse. EIS may be a little harder for Chinese managers to understand since when EIS was extensively used in western countries, DSS applications in general had not been adopted in China. Nevertheless, we included this application since it has been much researched in the Western literature. For Data Warehouse, OLAP and Data Mining, these applications can be easily understood by these Chinese managers, as 97.3% of our respondents received higher education, and these concepts are well known.

We received 296 valid surveys, among which 51 (17.23%) respondents said they previously used DSS or were currently using DSS. The survey data comes from 13 steel enterprises and 21 other enterprises across China. Among these enterprises, two state-owned steel companies and one private-owned steel company are among the top 500 companies in the world. 76% are large companies. Most of them are listed companies. Moreover, enterprise informatisation has developed quite well in some of these enterprises. For example, in the 2008 list of iPower500 of Chinese enterprise informatisation, the State Grid Corporation of China ranks 3<sup>rd</sup> and Baoshan Iron and Steel Co. Ltd. ranks 4<sup>th</sup><sup>3</sup>. In the survey, we described in detail what a DSS is and listed specific examples of DSS applications. We didn’t ask respondents if their companies had adopted DSS but rather if the manager had previously used or was currently using a DSS. We believe that the data collected in this way is more accurate as many managers may not know whether their company had adopted a DSS or not. If a manager had previously used or was

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<sup>3</sup> <http://finance.sina.com.cn/hy/20090329/16526038499.shtml>

currently using one of EIS, Data Warehouse, OLAP and Data Mining, he would tick yes. One respondent didn't tick yes, but rather wrote that he only once tried data mining. For this case, we regard him as once using DSS. In Table 3, we list DSS use statistics in terms of industry and position.

**Table 3. DSS use statistics in terms of industry and position**

Measure	Category		Items	Frequency	Percent
Are you currently using or have you previously used a DSS (such as EIS, Data Warehouse, OLAP, Data Mining)?	Total		Total	296	<b>100</b>
			Yes	51	17.23
			No	245	82.77
	Industry	Steel Manufacturing	Sub-total	177	<b>59.80</b>
			Yes	29	16.38
			No	148	83.62
		Automobile Manufacturing	Sub-total	35	<b>11.82</b>
			Yes	8	22.86
			No	27	77.14
		Railway Freight Cars Manufacturing	Sub-total	11	<b>4.05</b>
			Yes	3	27.27
			No	8	72.73
		Electric Power	Sub-total	50	<b>16.89</b>
			Yes	6	12.00
			No	44	88.00
		Service	Sub-total	9	<b>3.04</b>
			Yes	2	22.22
			No	7	77.77
		Others	Sub-total	14	<b>4.73</b>
			Yes	3	21.43
			No	11	78.57
	Current position	Top Manager	Sub-total	16	<b>5.41</b>
			Yes	5	31.25
			No	11	68.75
Director of the Department		Sub-total	42	<b>14.19</b>	
		Yes	8	19.05	
		No	34	80.95	
Middle Manager		Sub-total	119	<b>40.20</b>	
		Yes	21	17.65	
		No	98	82.35	
Others		Sub-total	119	<b>40.20</b>	
		Yes	17	14.29	
		No	102	85.71	

If yes, how long have you used it for?	1-3 years	37	72.55
	4-10 years	14	27.45

From an industry perspective, we can see that the 51 DSS users are distributed across all industries and the user ratio ranges from 16.38% in the steel industry to 27.27% in railway freight cars manufacturing. From the aspect of position, we can see that the 51 DSS users are also distributed across all levels of managers. We believe that these 296 respondents can be generalised across the population of Chinese managers and indeed suggest that DSS is not extensively used in Chinese enterprises.

It is suggested that defining and understanding the transition from a state of non-adoption to initial adoption is different from defining and understanding the subsequent propagation of the innovation across the population of potential adopters within a given organization (Rai and Bajwa, 1997). From our data collected, we found that for some companies, all their managers we surveyed said they never use a DSS, which can suggest non-adoption. At the same time, for some companies, we found an interesting phenomenon that, within an enterprise, some managers said they once used a DSS, some managers said they never used a DSS. This leads to our concerns for the adoption level of DSS, i.e. the propagation of DSS within a given enterprise after its initial adoption. For example, Wuhan Iron and Steel (Group) Corp. is a large state owned enterprise and ranks the 17th in the 2008 list of iPower500 of Chinese enterprise informatization<sup>4</sup>. It is reported that this company has adopted OLAP and data mining<sup>5</sup>. We can see from our data that DSS is not yet extensively used in this company. The vice division head whom we interviewed said that he used DSS in his management decision making and also commented: “it can be said that ERP is the necessary prerequisite to run the whole company, but DSS is only used to optimize the company’s operations, which is soft, thus hard to control”.

For DSS, many factors would influence its initial adoption and adoption level within a given company. In general, an organization is defined as having adopted DSS “if this system has been developed and installed for at least one executive” (Rai and Bajwa, 1997, p.942). Even though it is claimed that OLAP and data mining have been adopted in this steel company, but we can see in our data collected that its adoption level is still very low, i.e. many managers may not use DSS even if their company has adopted it. As DSS is viewed as a tool for information delivery to all business end users (Rai and Bajwa, 1997), the lower adoption level of a given company would influence the initial adoption in other companies. Thus, that DSS is not extensively used includes two cases, one is that DSS is not adopted; the other is that DSS is not extensively used within an enterprises even if it is adopted.

With regard to information behaviour in management decision making at individual level, some managers showed the behaviour of using DSS to support their decision making, and some showed the behaviour of not using DSS. We are not sure the exact reason why each manager use or don't use a DSS in our large scale survey, but it is reasonable to assume that while some managers may have already made the transition of decision style, from power-oriented directive to data-oriented analytical and at the same time have an opportunity to access and use a DSS; others may have yet to make that transition or may have no opportunity to access to a DSS. In this project, we explore if DSS is extensively used and we argue that the ratio of DSS use by Chinese managers also show certain information behaviour in decision making at the national level. The data we collected indicates that there is a phenomenon of non-use or non-extensive-use of DSS in practice in Chinese enterprises.

**Proposition 1:** DSS is not extensively used in Chinese enterprises, given current information behaviour

<sup>4</sup> <http://finance.sina.com.cn/hy/20090329/16526038499.shtml>

<sup>5</sup> [http://www.sasac.gov.cn/2007rdzt/2007rdzt\\_0009/02/200704270151.htm](http://www.sasac.gov.cn/2007rdzt/2007rdzt_0009/02/200704270151.htm)

with respect to decision making at the national level.

### ***Using Existing Information Systems to Support Decision Making***

As our interview data indicates, there are a variety of reasons why Chinese managers may choose not to use a DSS. Some of these reasons relate to a perceived lack of need for advanced decision tools or to the availability of other information systems that already include functions that can be adapted to the decision making context and so which emulate a DSS to some extent.

In this project, we explore how managers seek and use information in decision making. This behaviour related with information must be connected with managers' work settings and information environment. To some degree, the information environment has much been improved in Chinese enterprises as information systems in general are widely accepted. But "as companies seek to automate more of their processes, they are finding that decision support requires a significantly different data management approach than day-to-day operations" (Fong, Hui and Jha, 2002, p.9). The influences on IS adoption and use are many, and include "a wide range of institutional, social, and political factors" (Khalifa and Davison, 2006, p.277). In this project, we don't explore what factors influence the adoption and use of information system in general or DSS in specific; rather we explore the current practice with regard to decision making no matter which information system is used. So, in our interviews, the first three questions we asked were: "What information systems are you currently using in your firm? For what purposes?", "What functionality do these information systems have? Who uses them?" and "Do these systems help your decision making processes? Please give examples". In this way, we obtained rich data about the existing information systems and their relation with decision making.

All the respondents gave positive comments about how existing information systems support managerial decision making. One senior executive commented "We use a self-developed enterprise management system to manage materials, warehouse, contracts and finance. All employees use it. This system facilitates our decision making processes. For example, in selecting suppliers, it is easier to search this system to find [relevant] information". One middle manager commented "My company has adopted an SAP system for finance, manufacturing and sales, aiming at optimizing business processes. I can use the system to analyze the export transaction status and understand transaction progress. This helps me to make market decisions".

In recent years, due to the successful implementation of different kinds of information systems in enterprises, Chinese managers have experienced a transition at work, from paper based processes to digitally driven processes. In general, existing information systems are based on database and can automatically accomplish powerful transaction processing and communication functions, successfully liberating managers from complex and routine work. At the same time, these information systems can deliver the functionality of simple search and analysis. Consequently, the functionality of these information systems can be relatively easily felt by managers in their work practice. For example, Wuhan Iron and Steel (Group) Corp.'s implementation of ERP included two phases from 2003 to 2008. For a long time, two systems (ERP and manual record) coexisted. Only in 2008 did the ERP gradually start to replace traditional manual records<sup>6</sup>. Interview data shows that managers in this company felt that they couldn't work without the ERP. One vice division head commented "We use an ERP system in my company for production planning, quality control, logistics, sales, finance, etc. All transactions are tracked in this system which can help management decision making. This system can enable the analysis of technical

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<sup>6</sup> [http://www.sasac.gov.cn/2007rdzt/2007rdzt\\_0009/02/200704270151.htm](http://www.sasac.gov.cn/2007rdzt/2007rdzt_0009/02/200704270151.htm)

parameters and results so as to optimise the technique; this helps management decision making”. He also commented “ERP is the necessary prerequisite to run the whole company”. One middle manager in this company commented “We use a production sale information system [ERP]. It is very important and useful in supporting my management decisions. It can judge contracts, technical agreements and grades of steel automatically. It can combine parameters that we control in the production process. Different employees have different levels of authority (in using it). It can produce many intelligent report forms; it could analyse data quickly, precisely and truly”. One top manager in a privately owned steel company, which is among the top 500 companies in the world, commented “my company first adopted an Oracle database system early in 1996, but this system is only used to manage the warehouse. A few years ago my company adopted a system called MES (Manufacturing Execution System), developed by Baoxing, an affiliate member of the Baoshan Iron and Steel Co. Ltd. The MES could efficiently manage information flows from purchase to selling. All employees in the sheet steel and hot coil plants use MES. The traditional manual work doesn’t exist at all. Using manual method is impossible now. In MES, processes must occur in a strict sequence. Without this system, the management efficiency would be very low as processes in the steel industry are very complex”.

To some extent, this suggests that Chinese managers are more likely to be accustomed to operational decision making based on simple search and analysis procedures in existing information systems. This also suggests that being satisfied with existing information systems would make it hard for Chinese managers to feel the need for DSS and further become accustomed to complex and deep data analysis and mining in DSS so as to create long term strategic information value. This is consistent with previous research in China which suggested that even when DSS is used, it is generally only for operational control rather than to support the strategic decision making (Martinsons and Davison, 2007a).

In other cases, managers believe that their decision making is influenced by a wide variety of other factors, many of which are informal, implicit and non-quantifiable, such as their emotions, experience, knowledge, discussions with peers/subordinates that are not readily incorporated into formal decision models. So, it is easy for Chinese managers to believe that the positive impact of DSS on decision making is hard to obtain even if a DSS includes a variety of powerful components that have the potential to produce benefits through effective analysis. Chinese managers may not easily perceive how a DSS adds value and thus not trust DSS, preferring to trust the existing information systems to which they are more accustomed.

**Proposition 2:** Chinese managers are more likely to be used to operational decision making based on simple search and analysis, and existing information systems are considered to be adequate for their decision support.

### ***Reliance on Personal Experience and Knowledge as well as Informal Information Sources to Make Decisions***

It was suggested that “the decision to adopt an EIS may simply be an outcome of the decision maker’s style, decision environment, and the time frame for decision making” (Rai and Bajwa, 1997, p.941). Returning to Rowe and Boulgarides’ (1983, 1994) decision styles model and following Martinsons and Davison (2007a)’s analysis of decision styles, it was suggested that while a DSS may fit relatively well with the decision style of an analytical manager, it is likely to fit much less well with the decision style of conceptual, behavioural and directive managers. Analytical managers are characterised by a need to solve challenging problems by means of rigorous statistical analysis that demands large volumes of data. Considering the analysis of Chinese executives’ decision styles, we should not be surprised at Chinese

managers' apparent preference for a directive decision style. This is illustrated by the respondent comment: "I tend to rely on my personal experience in management decision making. In most cases, I have to balance a number of different factors. In some situations, emotion plays a more important role than objective reality".

When asked "do you tend to rely more on a DSS or more on your mind? In which situations? Why?", one middle manager whose work relates to foreign commercial vehicle market exploration commented: "My work mainly involves collecting basic information about targeted countries. Combining my company's internal resources and using my own previously accumulated knowledge, I analyze and judge the market, but make decisions primarily based on my personal view". One top manager commented "I trust my mind more, as most problems encountered by my company need to be judged by experience". One vice division head commented "I mainly rely on my experience and accumulated knowledge to make decisions while encountering the things I am familiar with". One middle manager commented "In my management decision making, I use the actual data, and then I process the data artificially [based on my experience]".

When asked "in general, how do you make management decisions? Please describe in detail", one top manager commented "generally, I assign the corresponding department to put forward a plan and then organize a discussion. Finally I decide to modify or approve the plan". Another top manager commented "I would like to survey experts and engage employees in brainstorming so as to make decisions". One vice division head commented "The senior heads (of my company) are used to listening to the (oral) report (on the conference)". This preference for human reporting is premised on the preference that senior executives prefer to obtain the information they need directly from the personnel involved (cf. Elam and Leidner, 1995).

Our respondents provided some indication of the complexity of their decision making context, noting that a wide variety of factors, internal and external, objective and subjective, structured and unstructured, have the potential to influence decisions. These factors include: national policy, the price of materials, enterprises' internal management quality, entry of similar foreign products, internal structural adjustments, customer demand, personal emotions, experience and accumulated knowledge, orders from superiors, and habits. The complexity of the decision making context greatly influences Chinese managers' preference for their own mental faculties rather than DSS in their management decision making. One division head commented "experience is very important. I created the foreign trade department in my company in 1998. The trade volume grew from 0 to 700 thousand tons of steel per year. DSS is a tool, but it can't predict this trend. While doing foreign trade, I analyze the foreign market such as automobile and ship production that are related to steel. The information is delivered to me in the form of printed reports which I think are very clear. Based on these reports, I can see a trend through my experience. The environment is too complex. Today the price increases, but tomorrow the price may decrease. I make decisions based on the trend".

The complexity of the decision making context also greatly influences Chinese managers' preference for other information sources. One top manager commented "in my company, before a big decision is made, generally, an idea often lingers in the CEO's mind, and then we discuss it in a conference". One vice head commented "I prefer to investigate the market first, analyze the data, then discuss inside our team and finally make a decision". Such a preference for the implicit and informal is consistent with prior research in China (Martinsons and Westwood, 1997). It is also consistent with research which claimed that "informal sources within the business and customers are significantly more used" (Chiwari and Dick, 2008, p.30) and Alwis, Majid and Chaudhry (2006, p.365) who claimed "managers' information source preferences have not seen much change over the years and their primary source of information continues to

be people sources and informal social networks”. At the same time, it suggests a degree of discomfort with data-driven analysis, which may be seen as too simplistic or unsophisticated.

**Proposition 3:** Informal social networks are still Chinese managers’ information source preferences in their management decision making and most Chinese managers tend to rely on their personal experience and knowledge, given the complexity of their decision making context.

## Discussion and Recommendations

In this project, we have explored the information behaviour associated with managers’ decision making practices in Chinese enterprises. We found four kinds of behaviour. Firstly, we found that Chinese managers make very little use of DSS in their management decision making even though the aim of a DSS is to help managers make better decisions. Secondly, we found that Chinese managers trust their existing information systems which can be easily used for simple searching for and analysing of information. Thirdly, informal social networks are Chinese managers’ preferred source of information. Fourthly, most Chinese managers tend to rely on their personal experience and knowledge in their management decision making. These four kinds of information behaviours reflect their work settings and information environment, leading us to a better understanding of the behaviour of Chinese managers as they seek and use information in their decision making. Given the low levels of DSS use by Chinese managers, it is important to try to explain this phenomenon, considering both the previous research literature and our qualitative interviews with current managers.

Propositions 2 and 3 provide two reasons explaining why DSS is not extensively used. The availability of other information systems that already include functions that can be adapted to the decision making context means that Chinese managers are satisfied with their existing information systems, and thus lack the need for advanced decision tools. Moreover, it is well recognised that cultural differences can hinder the adoption of information systems. For instance, it has been suggested that “often, the receiving society did not embrace the technology because of culture. There is little doubt that many specific applications of IT, such as Group Decision Support Systems (GDSS), EIS etc., are designed with embedded cultural values. Trouble occurs when these embedded values conflict with the values of the adopting culture” (Calhoun, Teng and Cheon 2002, p.293). It was also suggested that values influence decision styles and Chinese managers who were more inclined to use rules and intuition were significantly more directive than their Japanese and American counterparts (Martinsons and Davison, 2007a). We can see from our data that Chinese managers tend to rely on their experience and knowledge to make decisions, and this reflects the directive decision style that further reflects their culture and their values.

In general, the IT professionals who build a DSS model and the managers who use the DSS may exhibit significant differences in terms of specifying and understanding the purpose of the DSS. Decision making is a special activity, yet DSS “developers have often found it difficult to identify user requirements since the clientele they are dealing with (i.e., executives) often face uncertain environments” (Rai and Bajwa, 1997, p.941). It has been suggested that using a DSS requires both considerable mental effort (Ramamurthy, Sen and Sinha, 2008) and the exercise of a new way of thinking, since while a DSS assists “human decision makers in the exercise of judgment ... [it] does not itself make the decision” automatically (Hersh, 1999, p.395). Thus “DSS exist to complement and support decision-makers rather than replace them” (Parker and Sinclair 2001, p.449). Indeed, “decision-makers often resist the use of models that are based on complex procedures” (Todd and Benbasat, 1999, p.356). Effective DSS use, therefore, requires that users develop new skills and competences to enable comprehension of the



underlying formal theory of decision models (Bello, 1997). Unfortunately, these new skills are undeveloped in Chinese managers and so cause gaps between what users expect a DSS should be able to achieve and the reality. Such expectation-reality gaps, particularly at the senior management level where applications like DSS may unfortunately be seen as ‘silver bullets’ (Garbellotto, 2007), clearly illustrate how managers may be confused about the intended functionality of DSS and so may severely constrain the extent to which they are actually used. Compared with other information systems, effective use of DSS is more complex. An information system may be rejected if using it is too complex (cf. Alwis, Majid and Chaudhry, 2006). The complexity of DSS may mean that it is difficult to experience all the advantages that a DSS offers. As one vice division head aptly observed: “DSS users should be different [from ERP users]. There is a relatively large distance between the functionality of a DSS and DSS users’ expectations. Mismatching [between the DSS model and use of the DSS] is also a barrier to the extensive use of DSS. Consequently, managers at different levels should interact with IT professionals so as to ensure that they can make full use of DSS”.

Furthermore, effective use of a DSS requires that organisations collect and maintain large amounts of data at high quality levels for subsequent analysis. It is usually the case that maintaining large amounts of high quality data for a DSS will be cumbersome since: “Once a data warehouse is built, we need to maintain it consistent with the underlying data sources, which are always subject to dynamic updates” (Elamy, Alhajj and Far, 2005, p.1809). Moreover, “the need to handle such diverse, heterogeneous sources of data leads to considerable complexity” (Ramamurthy, Sen and Sinha, 2008, p.819) of the data warehouse. Consequently, there is often a need to re-engineer and automate business processes (Fong, Hui and Jha, 2002). Such radical changes are likely to be anathema to the older generation of Chinese managers who highly value stability and have more power in firm’s decision, but may be more acceptable to a younger generation that is less risk averse (Davison and Jordan, 1998; Ji, Min and Han, 2004; Martinsons and Davison, 2007b). In this case, large amounts of data at high quality levels can’t be guaranteed, which is sure to negatively influence the effective use of DSS and so further corrode managers’ attitudes towards DSS technology.

In our interviews, we also asked questions in order to explore how managers estimate the value of a DSS. Through such questions as “To what extent do you think that the use of a DSS to interact with the model and large volumes of data would result in the production of useful knowledge” and “Do you trust the data, model and the analysis result in DSS? Why?”, we obtained rich data about if DSS match the tasks. Our interview data indicated that Chinese managers have already formed strong beliefs and attitudes regarding decision making and DSS. It was suggested that analytical models in DSS need to be improved. One top manager commented “Whether I trust the DSS depends on the maturity of the decision model”. One vice division head commented “The analytical models in the DSS need to be improved to a great extent”. The decision making context in China is very complex, and some significant factors cannot be measured quantitatively and do not fit the decision model of a DSS. One senior executive commented “I regard the data and analytical results from the DSS as a reference point, but some marginal conditions and non data factors are more influential in decision making”. One middle manager commented “I don’t trust the DSS, as there are too many other factors in the market that are hard to be expressed in quantitative data. The quality of the final decision could not be solely based on data in a DSS”. These already formed strong beliefs and attitudes towards DSS and decision making are to some degree related with task-technology fit (TTF). TTF theory “focuses on the match between user task needs and the available functionality of the IT” (Dishaw and Strong, 1999, p.9). For DSS, TTF “is based on the cognitive demands of the problem and its relationship to the DSS, combined with the internal problem representation of the decision-maker”

(Todd and Benbasat, 1999, p.358) who needs to develop an appropriate mental model, and these formed beliefs and attitudes are strongly related to a manager's cognitive perception. An inappropriate mental model may lead to managers making incorrect estimations of DSS fit. These estimations may be either excessively pessimistic (DSS can't help me at all), given the already formed strong beliefs and attitudes about decision making and DSS or excessively optimistic (DSS are a silver bullet) just as gaps between what users expect a DSS should be able to achieve and the reality. These two extremities are both detrimental to effective use of a DSS.

Who is an appropriate DSS user? DSS application like EIS were first designed to satisfy senior executives' information needs. But in practice, "the emerging trend is to view EIS as technology for information delivery to all business end users" (Rai and Bajwa, 1997, p.940), which encourages the extensive use of DSS at all levels of management. But even if different levels of managers did use DSS, as we can see in our sample data, due to the factors we discussed above, we find that DSS is not extensively used, with only 16.56% (when combining the survey data and the qualitative interview data together) of our respondents indicating that they are currently using or have previously used a DSS, strongly conflicting with the expectation that DSS should be used by all business managers.

Notwithstanding the large number of unstructured influences on decision making, and assuming that DSS are still considered to be at least potentially valuable tools, we recommend that there is a need to train selected employees to use them effectively, i.e. DSS should be used by managers who have transformed to a data-oriented, analytical style, who have high levels of information literacy, and who are familiar both with the principles of information management and with the decision context.

In general, the extent to which information system is adopted is a key measure of its success. However, this may not be true with DSS implementation and use. It has been suggested that one way in which EIS success can be measured is to consider whether "the number of people using the system increases after the initial users have tried to use the system" (Poon and Wagner, 2001, p.395). Certainly DSS use should be encouraged for all managerial end users. However, more users do not necessarily mean that higher quality analysis will result. High quality analysis can only be guaranteed when a DSS is used effectively. Since DSS is used only for operational control, not strategic decision making, in China (Martinsons and Davison, 2007a), this indicates that DSS is not effectively used yet - its powerful analytic functionality is not fully utilized. The vice division head we interviewed is responsible for production and quality of steel products in his company. His prime area of responsibility is steel rolling and he has not been trained in DSS use. Even though he claimed that he used DSS, he is not expected to use it effectively as this is not his core area of responsibility.

Given the potentially transitory status of Chinese managers' decision style, as discussed above, in general, we found that most senior executives lack both the patience and interest to use a DSS. One vice division head specified: "The senior heads (of my company) are not good at using DSS. They don't have a clear understanding of the functionality of DSS". When asked if he had the interest and patience to use a DSS, one top manager pointed out "I have the interest, but my patience may not be high", while another top manager specified "I have neither the interest nor the patience to use a DSS". Even more, one top manager commented "I have no intention to use DSS by myself. I hope my subordinates can use it and then print and deliver their analytical results to me when I need them. I would like to think based on their analytical reports. When I find a problem, the middle manager should use a DSS and find the detailed problems. A top manager should not focus on the current production line; rather he/she should focus on the outside world, the competitive rivals and the development of the whole industry". This comment is to some extent consistent with the tendency of East Asians to think more holistically and contextually than

North Americans who concentrate on foreground items and specific details (Nisbett, 2004).

However, with some middle managers the situation is reversed, one commenting: "I have not yet used a DSS myself but I have the interest and patience to do so, as a DSS could help me analyse problems objectively based on real data". Another one commented "I feel the need to use a DSS in my management decision making as it could increase the validity of my decisions and reduce decision risks".

Recognising that using a DSS does not necessarily lead to better decision making (Van Schaik and Sol, 1990) and "EIS can disable the executive's creativity and therefore it is better that such systems are not used at the very top of the organizational hierarchy" (Allison, 1996, p.33), and bearing in mind the need for DSS users to develop new skills, we suggest that in order to use a DSS effectively, managers need to possess a number of attributes. These include: high levels of information literacy; familiarity with principles of information management and the decision context; the ability to organize diverse, heterogeneous sources of data around such subjects as customer, product, order, supplier, market, competitive rivals, competitive environment, and competitive strategy; the ability to build and improve analytical models in a DSS, as well as to communicate with IT professionals so as to overcome expectation-reality gaps. Furthermore, such managers need to be able to locate and mine new useful information and knowledge when interacting with the DSS. Subsequently, as "managers are becoming ever more dependent on information on which to base business decisions, but less able to extract this information from the overwhelming amount of data which they receive" (Allison, 1996, p.27), such managers need to be comfortable with the concept of sharing what they have found with other managers at different levels so as to satisfy different levels of their information needs, especially the information needs of senior executives who will forge the enterprise's long term strategic plans. In this respect, so long as managers are comfortable to share information, then they will find that it is more valuable to use a DSS to support their strategic decision making than to engage in operational control. Furthermore, DSS can be regarded as being extensively used within a given company when it can meet the information needs of managers at different levels even though the DSS itself is only used by selected employees. These selected employees possess the above skills and aptitude, thus having much more potential to make full use of the powerful analytic functionality of a DSS so as to find useful information and knowledge on behalf of their colleagues. This suggests that training selected employees to use a DSS effectively is a key measure of its success. At the same time, all managerial end users can be encouraged to use the DSS, as these two kinds of DSS use will inform each other. Finally, these selected employees should have the knowledge and skills to help an organisation align its IT and business priorities (cf. Henderson and Venkatraman, 1993). Only in this way will a DSS contribute to a firm's long term success.

## **Conclusions and Further Research**

In this project, we have explored the current information behaviour of Chinese managers with regard to decision making and specifically their attitudes towards DSS applications. We undertook both qualitative interviews and a large scale survey of managerial employees, finding that DSS is not extensively used in Chinese enterprises. We also find that while most senior managers/executives, as well as most other levels of managers, tend to a more directive style that has little need for formal decision tools, some managers at all levels are becoming more open to an analytical style of decision making where DSS can play a role. Moreover, we find that most managers choose to rely either on existing IS applications with similar functionality adequate for decision support or interpersonal sources and informal social networks or simply their own mental faculties. This study helps us to better understand the status quo of the current application

of DSS tools in China, where there is evidence for use at the more routine and operational level. It also helps us to better understand the information behaviour of Chinese managers in decision making. Clearly a deeper investigation of the socio-psychological characteristics of Chinese managers is called for, with specific reference to their attitudes towards IT-enabled decision support tools such as EIS, data warehousing, OLAP and data mining. At the same time, there is a need to recognise that cultural differences are not easily overcome – we should not expect most Chinese managers, especially senior Chinese executives, to change their values and become avid users of IT-supported decision tools overnight. Instead, the challenge is to develop tools that fit their decision styles and satisfy their decision information need more appropriately. The aforementioned socio-psychological analysis should help to identify the details of this style and this information need in greater depth and so open up new opportunities for DSS application development in Chinese enterprises. Furthermore, following this exploratory investigation into the information behaviour of Chinese managers with respect to their decision making, we plan to undertake a more rigorous investigation of DSS use intention, developing a structural research model, administering a quantitative survey instrument based on existing theory and literature to a larger population of managers in Chinese enterprises so as to find out the key determinants of their DSS use intention, given the nature of the potentially transitory status of Chinese managers' decision style, from power-oriented directive to data-oriented analytical.

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## **Appendix A. Interview questions**

- [1] What information systems are you currently using in your firm? For what purposes?
- [2] What functionality does this/these information systems have? Who uses it/them?
- [3] Does this system help your decision making processes? Please give examples.
- [4] In China, what factors influence the decision making in your firm?
- [5] In general, how are the (critical) decisions made in your firm? Please describe in detail.
- [6] Have you adopted DSS applications such as EIS, data warehousing, OLAP and data mining in your firm? Who uses it/them?
- [7] Do you feel the need for using a DSS in your role as a manager? Why?
- [8] Do you use DSS to support your management decision making? In what way?
- [9] Do you tend to rely more on a DSS or more on your mind? In which situations? Why?
- [10] In general, how do you make management decisions? Please describe in detail.
- [11] To what extent do you think that the use of a DSS to interact with the model and large volumes of data would result in the production of useful knowledge?
- [12] Do you have interest and patience to use DSS? Why?
- [13] Do you trust the data, model and the analysis result in DSS? Why?
- [14] Are there any other issues that you would like to tell us about?

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