DECISION SUPPORT SYSTEM
— RESEARCH ON THE APPLICATION
OF DSS IN CHINA’S BANKS

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**Abstract**

Information system is widely used in financial area all around the world today, and business intelligence systems has draw more and more attention from both academia and business circles. Based on this situation, we carried out our research. The main purpose of our research is to find out how Decision Support System (DSS) is used in China's banks. As there are more than five hundred banks in China, we choose the four biggest commercial banks(which has cover more than 85% of financial activities in China's banking area) as examples to study. We sent Emails and made telephone calls to different roles in these four banks, from chief information officer, managers of business to normal staff. Before carried out interviews, we did literature study to set a scientific background for our interviews. After the collection and analysis of data from both interview and literature study, the result is presented in three chapters. The theoretical study part introduces the theory background of DSS and how it is used in banks, the framework of the DSS and the basic model of the DSS, also new techniques in DSS. The Empirical results part introduces the results got from interviews. In Analysis part the results from the former chapters will be combined and analyzed, in this part we presents the application situation of DSS in China's banks, the affection of DSS on banks employees and improvement and drawback DSS brings to China's banks. Also new technology of decision support system and its application. And the last part we would draw conclusions for this thesis and summarize results from the interviews and theories and evaluate the whole research process. And the introduction of our research and the methods used to achieve the research goal will be introduced in the first two chapters.

**Keywords:** Decision support system, DSS, China, Banking industry, Decision making, Business intelligence
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Boras
March 2011

Jinzi Gao
Ying Zhao
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1 Introduction

The introduction part describes the research area and explain our research purpose and introduces research questions which laid the foundation for the theoretical study and empirical study.

1.1 Background

The world is full of choices for people, from study to work, from shopping to entertainment. About choice, the really good news is that we have quite a lot of options which could make life rich and colorful, while the bad news is that it is hard to make a decision from different choices. Sometime we do not know which one is the best choice just based on our knowledge. If the decision is not only about trivial matter in life, it is concerned about our work. For example, we have to make a choice to maximum the benefit or at least gain a better result for a company, especially in business area, which will be a real challenge for us.

We are facing the swift growth of the information. In 2005, there are 150 EB (Exabyte) digital information created while in 2010 there will be eight times information as much as that in 2005 (John F. Gantz, 2007). How to deal with the tremendous amount of information is a tough problem. Many types of information systems has provided different ways to manage the information and data, as well as decision support is designed to cater for the requirement of decision makers.

Decision implies the end of deliberation and the beginning of action( Buchana & Connell, 2006). So the deliberation is critical important for the decision. The term of Decision Making can be traced back to the middle of the past century. Chester Barnard, a retired telephone executive and author of The Functions of the Executive, imported the "decision making" from the lexicon of public administration into the business world (Buchanan & Connell, 2006). In the business environment, it is becoming more and more complex. It requires the organizations to be agile and make frequent and quick strategic, tactical and operational decisions (Harris, 2009). One of the major objectives of computerized decision support is to facilitate closing the gap between the current performance of an organization and its desired performance, as expressed in its mission, objectives, and goals, and the strategy to achieve them.(Turban, Aronson, Liang & Sharda,2007).

It is hard to define what is exact meaning of Decision Support System (DSS), because it is a content-free expression. Therefore, DSS is normally used as an umbrella term to describe any computerized system that supports decision making in an organization. It encompasses support system for marketing, finance and accounting; a supply-chain management system for production; and several expert systems for product repair diagnostics and help desks (Turban,Aronson,Liang & Sharda,2007).
DSS are designed, built and used to assist in the activities of supporting the decision-making process. And the potential benefits of DSS can be concluded as that improves personal efficiency; expedites problem solving; facilitates interpersonal communication; promotes learning or training; increases organizational control; generates new evidence in support of a decision; creates a competitive advantage over competition; encourages exploration and discovery on the part of the decision maker; reveals new approaches to thinking about the problem space (Turban, Aronson, Liang & Sharda, 2007).

Meanwhile, finance area develops rapidly and produces a large quantity of data and information around their business. They need a system to manage information and moreover fetch valuable information in order to yield more profits and reduce the losses. However, the current system cannot sufficiently satisfy the growing demands. As in the field of banks, besides the traditional banking business, they also do trading and investment business, for which they need analysis the history data to deduce a more wise decision to obtain higher profit.

Specially, Business Intelligence (BI) contribute more effort in the financial and banking services. BI is an umbrella term that combines architectures, tools, databases, analytical tools, applications, and methodologies (Raisinghani, 2004). By analyzing historical and current data, situations and performances, decision makers get valuable insights that enable them to make more informed and better decisions (Zaman, 2005). The decision makers can find the needed and appropriate information from existing systems and derive answers from composite, incompatible data-without waiting for daily or monthly batch loads into a centralized data warehouse. Organizations are filled with decision makers at various levels (Ireland and Miller, 2004). With the development of the Internet, the business which based on Internet also increase, Web-based DSS techniques is widely used in current environment. On-line Analytical Processing (OLAP) and On-line Transaction Processing (OLTP) are two popular tools widely used in the banks.

Although the decision making is supported by various of systems, we have to admit that it is becoming harder and harder to make proper, strategic and tactical decisions with necessary knowledge to maximize profit, minimize risk and improve the competitive strength in the market. It becomes a challenge for the decision makers.

1.2 Research area in informatics perspective

Informatics is the science of information, the practice of information processing, and the engineering of information systems. Informatics studies the structure, algorithms, behaviour, and interactions of natural and artificial systems that store, process, access and communicate information. It also develops its own conceptual and theoretical foundations and utilizes foundations developed in other fields. (Wikipedia 2011)
Decision support system is the type of information system which information is collected, arranged and analyzed to provide help in decision making. In business area, organization can be benefit by decision support systems since DSS can provide help in processing business data and provide efficiency response. Information techniques is used to provide help in business information processing and business decision support.

**1.3 Problem Statement**

As the second largest economy in the world, China's financial industry has drawn more and more attention. While in financial industry, bank especially commercial bank is the most important component. For banking industry in modern society, vast amount of information make it hard to make a proper business decision. And the competition among China's banks is becoming increasingly "hot", the computerized of the common routine business of banks could not satisfied the business development of banks, so banks need correct and timely response and decision to ensure the running and expansion of their business. More and More banks in China have realized that they have to fully utilize the resource they already have and find out the deep connection between the data, in order to ensure the stable and effective developing of their business and reduce the risk.

The basic work of DSS can be described as: interrelated data is collected to be manipulated and then analysis step to find the relationships between variables and events, then modeling the problem and solve the problem. DSS has been widely used in financial areas of China, while what extends the DSS's using in the bank sectors? In the different kinds of business which one usually uses DSS as a tool to support itself? How DSS works in a bank? What is the improvement and drawback DSS brings to banks? What are the future areas of DSS in finance industry?

Above are the problems we are interested in, especially when we set the background on China which is an economy with the fastest growing speed in the worldwide. With all these problems to be solved, our research is focus on the application of DSS in China's banks

**1.4 Research Purpose and Question**

The purpose of our research is to find out the application situation of DSS in China's banks, how decision support system is used by banks and what does DSS do in China's banks, and the improvement DSS brings to China's banks and banking industry. Meanwhile, the drawback. And the developing trends of DSS in banking area.

After a series of literature study and investigation, we generate our research questions. Our research is based on the following questions:
Main question: How is DSS applied in China's banks?
Sub question 1: Which type of DSS is applied in China's banks and how it works?
Sub question 2: What are the improvements and drawbacks DSS bring to banks?
Sub question 3: How does DSS facilitate bank staff on their works?
Sub question 4: Future trends of DSS in banks and new techniques

1.5 Limitations

Decision Support Systems is quite a broad field which involved many industries and it is difficult to make a clear definition. So we focus on the partial application which will be helped in the financial sections especially commercial banks. In some certainly area, it is difficult to define whether it belongs to the DSS or not. We use broad definition of DSS in this thesis which means the system could provide decision support not only provide decision support.

The suggestions are not complete. It requires further discussion and verification. And some material is related to the business of banks and organizations keep relevant materials as business secret, it is not easy to collect relevant materials and a lot of materials are intangible for outsiders.

1.6 Interested parties

For academic, researchers and students in relevant area could find this thesis interesting while they want to get an idea on how DSS is used in China's financial area. For organizational and facilities, they could get an idea on how decision support system could affect organizations and facilities in daily work for different layers and also long time planning, and take it as an reference for their own developing strategy.

1.7 Expected Outcome

As mentioned in the former part, information system like decision support system has been brought to China's banking area to improve the work of banks. After the study, we expect to get a deeper understanding on the application situation of DSS in China's banking area and how does DSS facilitate the work of banks, also the drawback DSS brings and the developing trends of DSS in banking area.
1.8 Authors' Own Background and Experiences

The authors' own background and experiences in the field is restricted to the resource from lectures in university, Internet and reading relevant literatures. And before carried out this research. Authors had written a paper about decision support system for the course Human information systems. Therefore, the research is not relied on our own experiences but get support from theoretical materials and empirical findings.

1.9 Structure of the thesis

Chapter 1 Introduction
Introduce information about the problem area, research questions, research purpose and limitation. We can clearly define the scope of the research and explicit problems.

Chapter 2 Method
Describe the methods that is chosen to carry out the research. In this Chapter, we will design how to do the research and how to collect and analyze data, and the method to keep research quality.

Chapter 3 Theoretical study
Introduce the framework of the DSS and the basic model of the DSS in banks and the new techniques of DSS and provide scientific background for empirical research.

Chapter 4 Empirical results
Interview results from four main banks in China

Chapter 5 Analysis
Analyze the application of DSS in China's banks and improvement and drawback DSS brings to China's banks. And introduce future trends and new technology of DSS in banks

Chapter 6 Conclusion and final discussion
Summarize the results and draw conclusions for this thesis. And evaluate the methods and research process.
2 Method

This chapter describes the methods we used to achieve the research purpose. It contains the research process, research perspectives, research strategy, research approaches and data collection process, data analysis and the role of theoretical study and empirical study. The goal of this part is to explain the methods we used in the research process.

2.1 Research process

In order to achieve the research purpose, we made a research plan for our study, and defined the process our study and confirmed the data should be collected.

![Diagram of Research Plan]

Figure 2.1 Research plan
This is the research process we followed in our research. We started the whole process from choosing the topic we are interested in, after a series of investigation we decided to carry out our research on the application of DSS in China's banks. And then we reviewed relevant literature, after the reviewing of exist literature in DSS and its application in financial area, we decided the theoretical framework to be presented in the theoretical study part. Then we chose the samples we were going to study in the empirical results part. As there are more than 500 banks in China and the quality of those banks are quite different. The following four banks have covered more than 85 percent of bank business within China: Bank of China (BOC), Industry and Commerce Bank of China (ICBC), Agriculture Bank of China (AB CHINA), China Construction Bank (CCB), so we taken these four banks as examples to carry out the study. Next step was to define the respondents to interview within the banks, since the purpose of this research is to understand the application situation of DSS in China's Banking area, we defined the interviewees into three types: higher level of bank, managers or middle level of bank, employees in bank's IT department or system developers. After defined the examples, the next step is to collect data. We collected data mainly through writing emails and making phone call to our interviewees in those four banks, also read bank journals and reports, and checked material on-line. During this process, there was a parallel work for us which was to check the reliability of data with the help of theory to achieve a deeper understanding of the application situation of DSS in China's banks. After the collection of data, we analyzed and interpreted all the data and generated our results and began our reporting work in the form of paper.

2.2 Research perspective and purpose

2.2.1 Research purpose type

It is already stated that the purpose of research can be organized into many groups according to what the researcher wants to accomplish in the research, and one research can have multiple purposes and usually among these proposes only one purpose decides the trend of the research.

And the following are different types of research purpose according to wikianswers:

Exploratory: This type of research investigates an area or issue on which little previous work has been carried out. In an organizational setting it may be used to discover whether or not a problem exists.

Speculative: Sometimes research is implemented strategically, where researchers take account of current situations and speculate as to their future implications.
Explanatory: Explanatory research aims to show why relationships, patterns and links occur. Predictive: The purpose of this type of research is to develop a model that predicts the likely course of events given particular intervening variables or circumstances.

Evaluative: To evaluate the impact of something

Descriptive: Also known as statistical research, describes data and characteristics about the population or phenomenon being studied. Descriptive research answers the questions who, what, where, when and how. (Wikianswers 2010)

Since our research is focused on the application of decision support systems in China's banks, it is primarily Explanatory. In other words, our research is to explain how DSS is applied in China's banks through studying the literature and cases.

### 2.2.2 Research perspective: Hermeneutic

There are two main scientific perspectives: positivism and hermeneutic.

Positivist subscribe to a reality through verification by formation of deductive and inductive hypothesis to put forward the findings by independent observers (O'Brien, 1998). And it states that science is based on observation and scientific knowledge is testable. Positivist prefer numerical methods and quantitative measures.

Hermeneutic theory is a member of the social subjectivist paradigm where meaning is inter-subjectively created, in contrast to the empirical universe of assumed scientific realism (Wikipedia 2011). According to hermeneutic theory of Alvesson and Sköldberg (2009), hermeneutic shows an alternation between the pre-understanding and understanding, theory and practice by getting more and more knowledge and understanding of the research in a ‘growing’ process. And it is an interpretation theory which puts emphasis on a holistic approach of presenting the whole picture rather than presenting in broken segments and has an interpretive nature (Klein, 1999). It uses constructivist ontology and could provide a whole understanding of research objectives and makes interpretation and explanation of easier. And it is a good way to investigate people’s experience and perceptions.

Hermeneutics is used in our research. Since our research is focused on the application of DSS in China's banks, it contain both tangible and intangible factors, it is important for use to choose a proper research to deal with the situation and interpret our findings. The main reason we choose hermeneutics is that it has an interpretive nature and it is suitable to our research. The purpose of this research is to explain the application situation of DSS in China's banking area, hermeneutics presenting the whole picture rather than presenting in broken segments and creating understanding of comprehension knowledge through interpretation, which is quite suitable with the purpose of our research. Also, as our research contain both tangible and
intangible factors and hermeneutics can help present the application situation of DSS in China in a whole and provide a comprehensive understanding of the research results. Hermeneutics makes it easier to interpret and explain meaningful concepts and it is a good way to investigate people's experience and perceptions which would help with the interview process. The results can contain subjective component also give us the motivation to choose hermeneutic.

2.3 Research approach

2.3.1 Qualitative and Quantitative Research

Qualitative research is used to explore and understand people's beliefs, experiences, attitudes, behaviour and interactions. It can generates non-numerical data. Qualitative research techniques such as focus groups and in-depth interviews have been used in one-off projects commissioned by guideline development groups to find out more about the views and experiences.

Quantitative research refers to the systematic empirical investigation of quantitative properties and phenomena and their relationships, it generates numerical data or data that can be converted into numbers. The objective of quantitative research is to develop and employ mathematical models, theories and/or hypotheses pertaining to phenomena. Qualitative methods produce information only on particular cases studied, and any more general conclusions are only hypotheses. Quantitative methods are used to verify, which of such hypotheses are true.

In our study, both quantitative research and qualitative research is used consider about the character of our research. Since our research topic is the application of DSS in China's banking area, and data we collected in our research could generate different types of results. Quantitative research is used to study the cases and types of DSS used in different bank, and qualitative research to explore people's understanding about DSS in banks. And qualitative research is more important in this research since we focus on how DSS influence its users in banks, for example improvement and drawback it brings to banks and how does it facilitate the work of different staff within a bank.

2.3.2 Deductive and Inductive Research

Deductive research works from general to specific. It is informally called a "top-down" approach. It begins with thinking up a theory about a topic of interest, then narrows that down into more specific hypotheses that can be tested. It can be narrowed down even further when
researcher collects observations to address the hypotheses. This ultimately leads the way of research and makes it able to test the hypotheses with specific data - a confirmation (or not) of original theories. (Socialresearchmethods)

![Deductive Research Diagram]

**Figure 2.2** Deductive research

Inductive research works the other way, moving from specific observations to broader generalizations and theories. It is called a "bottom up" approach. Inductive research begins with specific observations and measures, and then detects patterns and regularities, formulates some tentative hypotheses that can be explored, and finally ends up developing some general conclusions or theories. (Socialresearchmethods)

![Inductive Research Diagram]

**Figure 2.3** Inductive research

Inductive method is chosen to carry out our research. As we showed in our research plan part we started our research from literature study to get the knowledge background, then combined and checked the results we got from interview with theory. After these process, we need to arrange the data, get a comprehensive understanding of DSS used in banking area and generate our analysis and evaluation, and the whole process is carried out under the instruction of inductive method.
**2.4 Research Strategy**

Research strategy is based on the types of research questions, the degree of control over actual events, or the focus on contemporary or historical events (Merriam 1998), Yin (2003) defined five main research strategies: experiment, survey, archival analysis, history and case study.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Form of Research Question</th>
<th>Requires Control of Behavioral Events?</th>
<th>Focus on Contemporary Events?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>How, why?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Survey</td>
<td>Who, what, where, how many, how much?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Archival analysis</td>
<td>Who, what, where, how many, how much?</td>
<td>No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>History</td>
<td>How, why?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case study</td>
<td>How, why?</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Figure 2.4 Research Strategy

Experimental is commonly used in scientific research which attempts to test a hypothesis through experiments. In our research we do not carry experiments to verify hypothesis, and this type of research strategy separates phenomenon from context that is not proper for our research.

Historical is the research strategy focuses on events that occurred in the past. Since our research focus on the contemporary application of DSS in China's bank, history is not suitable.

Archival analysis analyzes data from previous archival and our research is not rely on previous archival, archival analysis is not suitable for our research.

Yin define case study as "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident " (Yin 2003). Which is clearly not suitable for our study since our research does not have the character that is claimed to be suitable for case study. Another reason why our research is not suitable for case study is that it will be difficult to cover such a broad research area with case study.

Survey is basically used to gather information from different people to resolve the problem (Oates, 2006). Survey comprises of seven activities setting objective for information
collection, study design, preparation of survey instrument, conducting survey, data analysis, report and results (Fink, 2003), that is suitable for our research. The most appropriate research strategy for our research is survey, since in our study deep understanding of the research area is required and survey helps us to keep good balance between the range and depth of research.

2.5 Roles of Theoretical and Empirical part of Research

Explain the role of theoretical and empirical part in a research is necessary for a research. Theoretical finding can be used in many ways. In our research, our research goal is the application situation of DSS in China's banks, the answer to research questions will be mainly generate from survey(mainly from interviewing bank staff also from reading bank journals), and the results we got from interviews will be present in the empirical results part. Although empirical findings is more important, the support from theoretical study still play a significant role in this research. And theoretical part(literature review) will provide the scientific background for empirical study (empirical result) and support the design of empirical study process.

2.6 Data collection

Data collection is the next step after we decided our research purpose and how we are going to do the research also what methods we are going to use during the study. It is the way to find the answers to research questions and achieve our research purpose.

2.6.1 Types of Data

Consider about the scope of our research, the primary and secondary data is the main types of data we use to support our research. And in this part, all the data we used will be listed and presented .

(1)Primary data

The primary data of our research is from interview since our research is about the application of DSS in China's bank. The source which could provide us with the most important information is not literature or text book but those people who working with the systems every day. So our primary data is collected from interviewing bank staff.
A. Interviews with bank staff

Bank of China (BOC)
Industry and Commerce Bank of China (ICBC)
Agriculture Bank of China (AB CHINA)
China Construction Bank (CCB)

(2) Secondary data

Secondary data is used for a research project that were originally collected for some other purpose (Saunders et al., 2006, p.611). And the follow are secondary data we use in our research:

A. Scientific papers
B. Internal documents of banks like journal and bank report
C. Books
D. Internet searching

2.6.2 Empirical study: Interview

In this part, we will present how we carried out our empirical study from sampling to the presentation of result.

(1) Interview sampling process

In this part the main job is to sample interviewees who can be regarded as people that the problem is related to. There are two types of sampling. One is probability sampling and the other one is non-probability sampling. Probability sampling is based on the unstructured and random processes, non-probability sampling has a structure before start action. And in this research, we choose non-probability sampling since it is important for us to obtain useful information and reduce the time spend on processing data from interview.

And in this part, we separate the selection work into 2 processes, the first process is to decide which bank to interview, the second is to decide the respondents to interview within a bank.

A. Selection of Banks

There are 524 banks running their business in China now, but it is impossible for our research to cover such a huge number of cases. According to China Financial Report 2009-2010, there are four banks which covered more than 85 percent of financial activities within China: Bank of China (BOC), Industry and Commerce Bank of China (ICBC), Agriculture Bank of China
(AB CHINA), China Construction Bank (CCB), so we decided to use those four banks as examples of study in our research. We collect the data through interviewing bank staff, mainly by writing Emails and Skype talk, also the other possible source we could get for example Internet and bank journals.

B. Selection of respondent

In order to achieve a comprehensive understanding of our research question, we have to select our interviewees carefully. After basic literature study, investigation also consider about the situation of banks, we define the respondents of our interview into three types to carry out our interview.

i. IT department Employee in bank or System developer

According to investigation, we decided the first interview group should be IT department Employee or System developer since they are the people who know the business intelligence systems in bank best. And they could provide useful information for our research.

ii. Bank staff in middle level and normal staff

The second group is middle level and normal staff. After basic literature study and investigation, we found out that this group does not know a lot about the business intelligence systems from a technique aspect, but they can provide useful information on how DSS facilitate or handicap their work from their own point of view.

iii. Bank higher level

The third group to interview is bank higher level or senior executives. Originally, DSS is designed to helping higher level in making decisions. With the develop of both technology and banks, DSS can help a broader range of people. How DSS helps bank higher level and how they evaluate DSS is still important for us to study.
This is the interview questions form we use:

A. Is there has any web based/software system which could help decision making in your bank?

B. Which kind of Decision Support System is that?

C. What kind of job does the Decision Support System do in your bank?
   (And please send us all the relevant data you can get)

D. Does it benefit the bank and the customers and do you think the work in your bank has been improved by the system? Is there any drawback brings by the system?

E. Does the system work well in your bank and how do you evaluate it?

i. Bank of China (BOC)
   We received Email reply from Liu Xiaoli who work in BOC's Information Center Beijing, Liu mentioned several DSS they use and provide us with her answer to our interview questions. She gave explanations on how DSS works in a bank. Then we arranged a Skype talk with her to get further information. We also found useful information in their journal. We interviewed some normal staff in their bank to get knowledge on how normal staff is helped by this kind of business intelligence system. The result is present in empirical study.

ii. Industrial and Commercial Bank of China (ICBC)
   After sent Emails to interview ICBC's IT Support Center in Shandong province, IT engineer Li Yalin provided us with his answers and recommended us to read their bank journal *ICBC Report* and journal *China Financial & IT* and the website http://www.fcmag.com.cn. We found useful information on the journal and website and decided to dig deeper in their loan decision support system. It is considered under the condition that ICBC is the market leader of bank loans in China. We also interviewed some of their staff to find out the opinion of bank staff.

iii. Agricultural Bank of China (AB China)
   We sent Emails to interview AB China's IT Department, they replied to us and told us to read their journal which would contains information about their business intelligence systems and other systems they use. Their business manager, Cui Zonghe, introduced the business supported by DSS in their bank. A staff Wang Qiang provided us with his experience of using DSS.
iv. China Construction Bank (CCB)
After sent Email to interview CCB's IT Department, they suggested that we can check their IT report and they also provided the information that most their systems are provided by IBM China. They also recommended that we could contact IBM China to get further information. Then we contacted a software engineer in IBM China, Zheng Xiaojun. He provided some cases they did for CCB, and among all those systems their CRM (Customer Relationship Management) has the highest reputation, so we decided read more about their CRM system. And a customer manager of CCB, Gu jian, explain the benefit brings by the DSS from his point of view.

(2) Interview Type

According to Oates (2006), there are three types of interview, and he defined the three types of interview as:

Unstructured interviews are unplanned, non-directed, uncontrolled, unformulated, bilateral communications and flexible. They require skills in questioning and probing.(Oates, 2006)

Semi-structured interviews are pre-scheduled, directed but flexible, major topic areas are controlled and there is a focused flow.(Oates, 2006).

Structured interviews are pre-planned, interviewer directed, standardized, pre-formatted and inflexible. They have a full structure and use highly-designed, closed questions. They assume a consistent format will get consistent responses.(Oates, 2006).

And the structure of an interview is based on the degree of control exerted by the interviewer as to the predictability of what questions are asked and what information is sought. When there is specific informational needs, then a more structured approach may be used(Oates, 2006). In our research, we chose semi-structured interview. Semi-structured interview can help us get the information we need to answer the research questions, and at the same time we can have a good flexibility in interview.

(3) Interview results presentation

Consider about the character of our research, we sent a large number of interview emails to the IT support department of different banks and sub-branches. We got a lot of replies refuse to reveal the relevant information since it is privacy of a bank. And we also got some replies that did not contain useful information we need or not sufficient useful information. We did selection on the data we collected from emails after receive replies. However, we still got the data we needed to implement this research we presents it in the empirical finding part. We arrange the results we got from interviews according to different banks since each bank has their special area. And we try to present it in an original way which could avoid the influence bring by the personal opinion of authors.
2.6.3 Theoretical study: Text analysis

In order to achieve a better understanding the history and present statement, research papers and books and journals refer to this topic are our study references. We should have a comprehensive and profound understanding of decision support system, also we have to acquaint ourselves with the basic conceptions of finance. The book *Decision Support Systems in the 21st century* wrote by George M.Marakas and the book *Decision Support and Business Intelligence Systems* are the main source for us to study the basic conception of DSS. These two books describe clearly the development of DSS, DSS theory and how it is implemented in the business. The materials related to the banks are mainly from scientific journals and journal published by those banks, *European Journal of Information Systems, Journal of Digital Information, Bank Systems and Technology* and so on. Then we analyzed the bank system with DSS theory. Since the background of the paper is China, we also need to do the specific research in China's banking area. The journal, for instance: *BOC journal, CCB journal, ICBC Report, China Financial & IT*, provided us the information we needed. For the future improvement, we study the cloud computing, computer security and distributed system.

We also checked materials from the database, like Springer Link, IEEE Xplore. We also take the library literature as our main literature source.

2.7 Data Analysis

![Diagram of Analysis Process](image)

**Figure 2.5** Analysis process

The analysis in this research is based on data collected from interviews and theoretical study, and the goal of analysis in our research is to obtain a deeper understanding on the application of DSS in China's banking industry, from the types of DSS used by China's banks, opinions from different respondents about DSS in their works, to the development of DSS in the future. What we want to achieve after this research is that we can have a deeper insight into how DSS serves the banks in China. In analysis, resource from literature study and empirical
findings are used, also researchers' own opinion (which should be as objective as possible). The results are mainly generated from interviews and also combined, censored and compared by the results from literature study.

### 2.8 Strategies for validating findings

Evaluation is a significant part of one research. Consider about the character of this research, reliability and validity are main concepts should would be taken into evaluation.

#### 2.8.1 Validity

For hermeneutic research the major problem is validity. As the interpretation in our research is based on hermeneutics, it is important to prove the validity of the research.

The major concern of validity is about whether the findings are really about they appear to be (Saunders et.al, 2007). And there two types of validity: internal and external validity. Concerning the internal validity it is about the interview questions, whether the interview question could get the result to answer the research questions. The external validity is about is the measurement in conformity with reality.

In order to achieve a good internal validity, we design our interview questions according to research questions and we believe our interview questions has well covered the research area, although the limitations in this research still influence the range of our research. Our research purpose is to gain a better understanding on the application situation of DSS in China's banks, this research could show the application situation in a certain degree.

In order to achieve a considerably amount of external validity, many interviews were conducted. We sent emails to different respondents in those four banks as well as some IT companies who developed the bank systems to get the current situation of DSS application. Then all the information we collected was compared and checked with theories and the information we can obtain from Internet to make sure the external validity is good.

#### 2.8.2 Reliability

Reliability is about whether the data collection techniques or analysis processes will yield consistent finding. Will the measures repeatable on other occasions? Will similar observations be reached by other observers? (Saunders et.al, 2007). In our research, we collected data directly from the IT departments and bank staff, then present it in an original way. We use inductive research to generate results and the results cover different aspects about the application situation of DSS in China's banking industry. Our opinion about the reliability of
this research is that we present the results from the interview in the way that could shows the original opinion of interviewees, the findings of our research could keep the best reliability possible.

**2.8.3 Ethic Issue**

Using interviews as a data collection technique requires sensitivity and imposes ethical considerations. We mainly focused on important ethical issues related to our research: informed consent , confidentiality

(1)Informed consent
Informed consent means that the interviewees have to agree with participating in the research, and have an clear understanding of research subject and purpose. And in our research we had informed our respondents about the purpose of our work and how we are going to carry out the research.

(2)Confidentiality
Regarding confidentiality, interviews should not contain personal details that interviewees do not want to be published. The interviewees want to make sure that their answers will be treated with highest confidentiality. Then the interviewees can feel relax and which also helps interviewer get more useful information from the interviewee.

In our research we found it very hard to completely anonymize the interviewees by hiding all related data. For example the banks and the position of respondents within the bank. Many details that are directly linked to the answer of our research questions, and we ask for permit from the respondents and ensure that not involve any message they do not want to reveal.

**2.9 Presentation method and reference technique**

Results of the study will be presented in both description and table in order to get a good presentation. The references is arrange according to Harvard system.
3 Theoretical study

This chapter presents the introduction of the framework of the DSS and the basic of DSS. Explain the process of the decision making. In order to achieve a better understanding the history and present statement, research papers and books and journals refer to this topic are acted as study references. A comprehensive and profound understanding of decision support system act as a lens for addressing this paper's research questions.

3.1 Key concepts

The following definitions are the main concepts concerning in this paper.

Information Technology

Information Technology (IT): It is the use of computers and software to manage information. IT includes that acquire, process, store and disseminate the vocal, pictorial, textual and numerical information.(Longley; Shain1985)

Decision Making

Decision making is the study of identifying and choosing alternatives based on the values and preferences of the decision maker. And decision making is the process of sufficiently reducing uncertainty and doubt about alternatives to allow a reasonable choice to be made from among them. But every decision involves a certain amount of risk.(Dev Verma 2009)

Decision Support Systems

Decision Support Systems (DSS): It describe any computerized system that supports decision making in order to improve the quality of decisions.

Business Intelligence

Business Intelligence (BI): A conceptual framework for decision support, it combines architecture, databases, analytical tools and applications (Turban et.al,2007).

Expert Systems

An expert system is a computer program that uses knowledge, facts, and reasoning techniques to solve problems and make decisions. Expert systems choose between alternative options by weighing the evidence for the options, or the utilities of the outcomes.(Biondo,1990)
Knowledge Management

Knowledge management is the systematic and active management of ideas, information, and knowledge residing in an organization's employees. The structuring of knowledge enables effective and efficient problem solving, dynamic learning, strategic planning, and decision making. (Turban et al., 2007)

On-line Analytical Processing

On-line Analytical Processing (OLAP): It includes the activities as generating and answering queries, requesting ad hoc reports and graphs and executing them, applying traditional or modern statistical analyses, and building visual presentations (Turban et al., 2007).

On-line Transaction Processing

On-line Transaction Processing (OLTP): It refers to a class of systems that facilitate and manage transaction-oriented applications, typically for data entry and retrieval transaction processing (business or commercial transactions). (Wikipedia, 2011)

3.2 Subject areas relevant for the research

![Diagram](image-url)

Figure 3.1 Subject Areas Relevant to Research
In order to explain the topic clearly, the theoretical part can be separated into several subject areas according to the main question. It will assist to illuminate the research questions.

The above diagram (Figure 3.1) shows the relationship between different subject areas. From the theory study, it will describe the revolution of DSS, basic elements of DSS and the structures of DSS. Then DSS applied in the banking area that supports different business of banks. Finally, the subject area future trends is related to the combine the newest technologies with it's application of banks.

The improvements and drawbacks as well as affection to staff's work will be describe after interview and empirical survey. They are the findings of interview and analysis results of interviews.

**3.3 Previous research**

Date back to the 1960s, due to the cost of building large-scale information systems in the big companies, Management Information Systems was developed to reduce the cost and improve the effect. This new type of information system became practical model-oriented DSS. It was an important start to integrate support systems on interactive computerizable systems to assistant managers making a key decision. By the late 1970s, interactive information systems used data and models to help managers analyze problems at any level in an organization. Data could be multidimensional and unstructured documents. Also, Artificial Intelligence researchers worked on management and business expert systems in the early 1980. Beginning in about 1990, data warehousing and on-line analytical processing (OLAP) began broadening the realm of DSS. In the period between end of 20th century and beginning of 21st century, new Web-based analytical applications were introduced. The whole evolution of DSS can be described as Figure 3.2.

The term of DSS can be used as an umbrella term to describe any computerized system. But generally, Decision Support Systems can be defined like that it is a system under the control of one or more decision makers that assist in the activity of decision making by providing an organized set of tools intended to impart structure to portions of the decision-making situation and to improve the ultimate effectiveness of the decision outcome. (Turban et. al, 2007)

Nowadays, DSS is widely used in many areas such as clinical decision support system for medical diagnosis, agricultural production, and business and management area. In this paper, bank decision support system is the main research area.
### 3.4 Relevant Literature Sources

We selected several papers regarding DSS and financial areas for the further research. These papers covered the fields of DSS developing and theory and new techniques of DSS as well as its extensible application of DSS in financial area, also the benefits bring by Business Intelligence. The papers cover from history to the latest developing situation, from theory to application.


The book *Decision Support and Business Intelligence Systems* wrote by Turban, Aronson, Liang, and Sharda (2007), systematically introduced the Decision Support System from theory to application.

Decision making in several fields related to financial management is a complicated and ill-structured task involving the exploitation and evaluation of information, data, and alternative solutions or actions. Managers and individual financial decision makers (portfolio managers, financial analysts, credit managers, investors, etc.) face such problems every day, the existence of a tool that is able to support them in making the appropriate decision is considered important. Zopounidis.C, Doumpos.M and Matsatsinis.N.F (1997) presented the

<table>
<thead>
<tr>
<th>Years</th>
<th>Representative DSS Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s</td>
<td>Scott Morton’s management decision support project</td>
</tr>
<tr>
<td></td>
<td>Interactive systems research organization</td>
</tr>
<tr>
<td></td>
<td>Decision-making theory development</td>
</tr>
<tr>
<td>1970s</td>
<td>BrandAid research</td>
</tr>
<tr>
<td></td>
<td>Alter’s field study</td>
</tr>
<tr>
<td></td>
<td>Holsapple research</td>
</tr>
<tr>
<td>1980s</td>
<td>Key DSS books</td>
</tr>
<tr>
<td></td>
<td>Group DSS prototypes</td>
</tr>
<tr>
<td></td>
<td>Executive information systems (EIS)</td>
</tr>
<tr>
<td></td>
<td>PC expert systems</td>
</tr>
<tr>
<td>1990s</td>
<td>Business intelligence/OLAP</td>
</tr>
<tr>
<td></td>
<td>Data warehousing</td>
</tr>
<tr>
<td></td>
<td>Web-based systems/portals</td>
</tr>
<tr>
<td></td>
<td>Data mining</td>
</tr>
</tbody>
</table>

Figure 3.2 Evolution of DSS
implementation of DSS and ES on several fields of financial management in their paper *On the use of knowledge-based decision support systems in financial management: A survey.*

With the develop of Web-based technology, decision support systems should be able to manipulated under the web-based environment. And the hybrid of DSS with intelligence techniques is also a new trend. Sonar (2005) published one paper *On Application of Web-based Intelligent systems-Focus Banking Applications.* He introduced how to integrate single intelligent technique (For example expert system, neural network, case-based reasoning) with systems to reduce weaknesses, increase the strengths of system and solve complex tasks, which could benefit organizations like banks.

And in the following part, the theory within the research area will be presented.

### 3.5 Decision Making

Decision making is a process of choosing among two or more alternative courses for the purpose of attaining one goal or goals. Decisions can be made by individuals in the small organizations, also by groups or teams in the medium-sized or large organizations. According to different types of the decisions, the method is not the same.

#### 3.5.1 Framework of Decision Support

Decision Support framework is a 3-by-3 matrix proposed by Gorry and Scott-Morton (1977)( Table 3.1). However, computer mainly support for the structured and some semistructured decisions. Operational and managerial control decisions are made in all functional areas, especially in finance and production management(Turban et.al, 2007).
### Table 3.1  Decision Support Frameworks

<table>
<thead>
<tr>
<th>Type of Control Type of Decision</th>
<th>Operational Control</th>
<th>Managerial Control</th>
<th>Strategic Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structured</td>
<td>Accounts receivable, Accounts payable, Order entry</td>
<td>Budget analysis, Short-term forecasting, Personnel reports, Make-or-buy</td>
<td>Financial management (investment), Warehouse location, Distribution systems</td>
</tr>
<tr>
<td>Semi-structured</td>
<td>Production scheduling, Inventory control</td>
<td>Credit evaluation, Budget, preparation, plant layout, project scheduling, Reward system design, inventory categorization</td>
<td>Building new plant, mergers and acquisitions, new product planning, Compensation planning, quality assurance planning, HR policies, inventory planning</td>
</tr>
<tr>
<td>Unstructured</td>
<td>Selecting a cover for a magazine, Buying software, Approving loans, Help desk</td>
<td>Negotiating, recruiting an executive, buying hardware, lobbying</td>
<td>R&amp;D planning, New technology development, Social responsibility planning</td>
</tr>
</tbody>
</table>

### 3.5.2 The steps of Decision Making

According to the decision support frameworks described by Simon (1977), there are four phases of decision making process. The relationships among them are shown in the following figure (Figure 3.3). And it does not include the unstructured decisions.

The process starts with the **intelligence phase** which involves searching for conditions that needs decisions; In the **design phase**, a model is formulated and then validated, and criteria are determined in a principle of choice for evaluation of the alternative courses of actions that are identified. The **choice phase** includes making a choice of a proposed solution to the model, which is tested to determine its viability. And the last phase is **implementation** of the decision. When it is successful, it means a real problem is solved. But failure leads to return to an earlier phase of the process.
Figure 3.3  The Decision Making/Modeling Process
3.6 Decision Support System

3.6.1 Structure and components of DSS

There are four subsystems composed the DSS application. They are the data management subsystem, the model management subsystem, the user interface subsystem and a knowledge-based management subsystem.

(1) The data management subsystem

It is responsible for retrieval, storage and organization of relevant data for the particular decision context. Additionally, it provides the security functions, data integrity procedures and general data administration duties. Database, Database management system, data repository and data query facility are all elements of data management subsystem. What's more, data management subsystems interconnects with data warehouse for corporate relevant decision-making data.

Data warehouse is a collection of integrated, subject-oriented databases designed to support the DSS function, where each unit of data is non-volatile and relevant to some moment in time.(Inmon, 1992).

There are three most important techniques in data management subsystem. The first one is ETL. The ETL consists of extraction, transformation and load. Extraction means reading data from one or more databases. Transformation is converting the extracted data from its previous form into another form fitting different databases. Load means putting the data into the data warehouse. And the transformation of data will affect the Data Mining and OLAP.

The second one is Data Mining. In the past time, decision is hard to make because of less of data. But nowadays massive and redundant information and data are interfering decision making. Data Mining is the process of finding mathematical patterns from usually large sets of data. These patterns can be rules, affinities, correlations, trends, or prediction models (Nemati and Barko, 2001). Data Mining helps in discovering previously unknown relationships among the data by using pattern recognition technologies and statistics.

The third one is On-line Analytical Processing (OLAP). OLAP is used for querying and analyzing data. Usually OLAP includes some activities as generating and answering queries, requesting ad hoc reports and graphs and executing them. It conducts traditional or modern statistical analysis and builds visual presentations.

(2) The model management subsystem

The model management system focuses on the management of quantitative models of DSS. It contains model base, model base management system, model repository, model execution
processor and model synthesis processor. Model base provide business model for the analysis of data, generate useful report to support decision making. The model management subsystem includes financial, statistical and management science.

Here comes the function of the model management subsystem

A. Identification of the problem and environmental analysis.
The problems must be unambiguous and understood by the decision makers. Business analytic tools can help identify the problem (Hall, 2002).

B. Variable identification.
Graphical models of mathematical models and other forms of diagrams provide the decision makers with better understanding of the problems.

C. Predictive analytic.
It is essential for construction and manipulating models. Analysis of the history data with what-if method will bring positive impact on the future. In banks they attempt to predict their potential best customers from their history data.

(3) The Knowledge-Based Management subsystem

It is about problem recognition and generations of interim or final solutions. It is the "brain" of the DSS provided the user with a useful application. Knowledge base stores and provides the business rule to assist in computing and analyzing data and it is supplemented by learning from the banking experiences. It becomes common that dealing with some complex and unstructured problems and forward more instructive proposal by knowledge base. Knowledge components might be provided by Expert System, neural networks, intelligent agents, fuzzy logic, and so on.

(4) The user interface subsystem

It is a window for the DSS to exhibit to its users. User interface covers all aspects of communication between a user and the DSS. Besides hardware and software, it also consists of factors which are usable, accessible, and friendly of human-machine interactions. Since the background processing is transparent for the user, the interface of the system is the whole system from the user's standpoint.

3.6.2 Advantages and limitations of DSS

In this part advantages and limitations of DSS are present, which are the common advantages and disadvantages of DSS shared by DSS served in different areas. Due to computerizing the processes of decision making, it facilitates the decision support.
(1) Speedy computations

Timeliness means efficiency. It shows the high speedy responds. Timely decision is critical in many situations from a physician in an emergency room to a stock trader on the trading floor. It also reduces the extra cost of complex computations. With a computer, thousands of alternatives can be evaluated in seconds.

(2) Improving communication and collaboration

Wherever the decision makers and data material are, the data can be gathered and communicated through the Web-based tools and provided to the decision makers.

(3) Improving data management

There are different formats of data included text, sound, graphics and video. And the quantities of them are huge. All of them will be stored in the database anywhere in the local and even outside the organization. The computers can search, store and transmit the information quickly, securely and transparently.

(4) Quality support

Through the risk analysis and expertise systems, the decisions have a high quality as well as reduced cost of processing.

(5) Agility support

Organizations must be able to change their strategies to confront the furious competition. Therefore it should rapidly change their mode of operation, reengineer processes and structures and innovate in order to adapt to the changing environments. Knowledge engine of DSS will support people with good decisions. (Turban et. al, 2007)

However it is still exiting some limitations of DSS needed to improve.

(1) Cognitive limits:

The managers or the other decision makers have different levels of cognition and background. Their personal experience will affect the results of the final decisions. Furthermore, the expert systems continue learning in order to provide better suggestions.

(2) Collection of the data

Due to most of databases are distributed all over the world, it is difficult to collect all the information at the same time and ensure the correct and safety of information.
3.7 DSS in bank systems

Application of DSS in bank area is a significant and successful branch of DSS. There are two reasons of widely using DSS in financial area. One is that most problems in banks are pretty structured, even the process of decision in management or strategy level is still formal and standard. The other is that the financial organizations want to make more profit and reduce risk. They require more accurate analysis of the situation and reduce the risk. They do not just focus on the current profit, but also the long-term plan and strategies.

3.7.1 Evolution of DSS in banks

In the past, most banks used DSS as illustrated in the figure 3.4, two bases decision support system contains Database, Model base and corresponded with Management system like Database Management System and Model Base Management System. The management system contains user interface to communicate with the user of the system.

![Two Bases DSS](image)

Figure 3.4 Two Bases DSS
Nowadays, three bases decision support system have been developed. It contains Database, Model base and Knowledge base. Sometime it is also called four bases DSS, which contains Way Base. But after literature review, we found Way base is normally combined with Knowledge base nowadays. In the following chapters, we use the term of three bases DSS. Management systems correspond with three bases DSS include Database Management System and Model Base Management System and Knowledge Base Management System. The management system contains user interface to communicate with the user of the system.

Compare with two bases decision support system, three bases decision support system has the support from knowledge base. While DSS is brought into the banking industry, two bases decision support system was once popular. However, with the development of technology and the increasingly need of bank's business, knowledge base has become an essential element of DSS serving in banking industry. Knowledge base and inference tool can provide knowledge support with storing the business rules and provide reasoning under the business rules. For the most important it provides DSS with the ability of learning from the decision making process. Three bases decision support system is becoming increasingly important for banking industry.

### 3.7.2 Current situation of DSS in China's banks

According to statistics information, in China's banks, there are around 700 mainframe and medium computers, 6000 minicomputers and more than 500 thousand units of personal computers and servers. The number of automatic teller machine (ATM) is nearly 30 thousand and the number of point of sale terminals (POS) is 220 thousand. In the securities industry, it establishes a highly efficient and reliable transaction communications network. In Shanghai and Shenzhen Stock Exchange they use two-way VSAT satellite network, high-speed one-way satellite data broadcast network and the National Ground Communication Network to connect around 3000 business security departments. It supports the transmission channels.
with information of commission, stock market and consulting to the securities companies. In the mean time satellite network and terrestrial network are backups for each other. In the national financial institutions, they generally established two high-speed internal network mutual backup systems. Banks can communicate and inter-operate with each other or with securities firms, customers and revenue departments through the networks.

DSS is the cornerstone of reengineering financial business process, which can help the financial institutions to fundamentally rethink and design the existing business processes. The scattered functions in various departments are restructured according to the most conducive to produce value, which can well adapt to the market requirements. Paul.H.Allen, expert reconstruction of American Bank, pointed that the decade from 1980 to 1990, average of 13 big banks of the United States implemented their IT systems every annual. After reconstruction the average return on assets and return on capital increased respectively from 1% and 14% to 1.5% and 20%, while the average cost benefit ratio reduced by about 10% and arrived at 50%~55%.

To satisfy the increasing of the scale and amount and frequency of commodity trading, in 1960s' western developed countries, the bank cards were issued. In contrast, until 1985 the Bank of China had issued first bank card, however the speed of development is was quite quickly. Up to March 2005, bank cards of China have been issued more the 800 million, reaching 827 million. At the same time, Internet also provides modern consumption. More than half consumers often shop on-line. Therefore banks offer Internet banking to meet customers’ requirements, including information retrieval, on-line payment, transfers, loans, payment of various fees, bond trading, management of personal money and other financial services. Every bank is eager to obtain top consumers, so the future development of bank focuses on using information technology to analyze information, management customers in order to provide the best service to the customers and earn the most profits.

The concept of DSS was brought into the banking industry around 1980 in western country. Around 1990, the concept of building decision support system has been introduced into China. In the end of 2003, the first decision support system in China's banking area has been put into use by Bank of China, and then many banks start to use DSS in their decision making. Until 2007, most of China's banks have applied DSS in their IT support systems. And with the developing of new technology and techniques, the functions of DSS have been strengthened which make DSS more helpful. And many banks upgrade their DSS with the development of new techniques. In the future, DSS will be more important to China's banking industry.

3.7.3 The application of DSS in banks

In the decision support systems, subsystems coordinate with each other mutually to provide helpful information and decision service. DSS refine and analyze the original data and provide the managers with different aspects of scientific and accurate statistic data. It
pre-warns the risk and predicts the trend of the stocks. DSS also do the real-time monitor on the working capital. The timely provision of working capital data is used to monitor the abnormal situations such as deposit of funds unstable, occupying a large number of funds and lack of coverage ratio.

According to the banking operations, DSS has been applied in six different ways: Accounting Analysis, Credit Management, Plan and Overall Management, Bank Card Management, System Management, Costumer Management, and Risk Management. The work flow is shown below (Figure 3.6).

As shows in figure 3.6, data from bank business system are stored in the Multidimensional database. And then according different purpose, data will be separated into different models. After analysis of data and mining the new useful relationship, the reports have been transmitted into seven departments of banks.

(1) Accounting Analysis:
i. Statement of business: Generate business report related to accounting department;

ii. On-line Analysis: Inquire the detail statements of internal account related with accounting department; it does statistics on the different subject balance, actual amount and average balance; another function is to access to data on received or paid interest situation of deposits.
and loans; it queries historical profit and loss details; the last one is to analyze the institution's business conditions.

(2)Credit Management:

It includes customer management, contract management, account management, corporate finance, business reports and on-line analysis. Varieties of factors could cause the risk, so the systems should predict the possible rate of risk and then reduce the risk. It needs to build a maturity guarding mechanism to achieve the best balance of risks and profits.

(3)Plan and Overall Management:

It manages the expiration data (to keep abreast of the maturity of the deposit and loan data), business reports, on-line analysis.

(4)Bank Card Management

It responds for business investigation, customer survey, card issuers study and overdraft situation. Classification of the customer and prediction of the marketing efficiency help enhancing the marketing efficiency as well as reducing the marketing costs. The system could forecast the probability of customers’ false pretence to the banks. Effectively reduce the risk of bad debts expense and other malignant overdraft.

(5)System Management

i. User Management: This is for system administrators, and it can be used to add, delete users, set and modify user rights;

ii. Data Maintenance: Boot background process, extract data from database of transaction system, process the data and load the data into the DSS Data Warehouse.

iii. Standard data: provide system administrators with related parameters which are used for maintaining banking services, such as subject dictionaries and institutional information.

(6)Customers Management

i. Classify customers: Customers’ information is collected from all aspects, and the system in-depth studies customer costing behaviour characteristics, and then effective classifies customers in order to identify potential and valuable customer. It will maximal the benefits of the customer as well as minimizing the risk of bank.

ii. Customer churn analysis: Systems carry out deep analysis on consumer behaviour, and analyze the reasons for customer churn and predict the possible loss of customers, in order to guide the bank staff effectively in care and retain their customers.
iii. Improve the customers’ value: Through finding the rules of relationship among the channels, products and customers, search and select the most possible products and services which can be bundled together to sale (also called complementary service offerings). It provides customer with more additional services well, thereby increases the income as well as enhancing the rate of return per customer.

iv. Customer life cycle analysis: By assessing the position of the customers in the life cycle, deeply understand of customer value, niche targeting to carry out customer relationship management and marketing activities.

(7)Risk Management:

It is a complete set of risk management. First step is risk identification, and the second step is risk assessment and determines the risk level and response plans, finally step is monitoring the risk. The system outputs a final report to the managers and the managers make a proper decision to reduce the rate of risk and avoid unexpected loss.

3.7.4 Characteristics of DSS in banks

Although there are differences among different departments in a bank, they still have most characteristics in common.

(1) Adopt advanced technology in financial industry data warehouse model, combined with the database server, multi-dimensional servers and front-end user query tool, to provide close succession, comprehensive decision support solutions.

(2) The system is based on the customers’ requirement and high practicability of the systems is needed. DSS have to meet the needs of the users.

(3) Security of the privacy is considered in two aspects, manipulation security and integrity and confidentiality of data.

(4) The system is universal and portable which ensure that applications can be applied to a variety of platforms or operation systems, for instance, the front-end suitable for window series or Linux systems. System parameters are well setup. When the operation environment changed, rarely confederation parameters can be adapted without modifying the whole program.

(5) The system needs good scalability. After the system is put into operation, it is still possible to add new features. So keep the interface for increasing new functions. System function is assembled in the form of modules; therefore add more functions can be implemented by adding modules or a combination of several existing modules. Modules are compositied by
functions, procedures, classes, etc. So adding more features can also be achieved by adding a small block of code or a combination of existing blocks of code. The control of access to modules is achieved by setting parameters. If adding more models, it also needs to add the appropriate permissions to the control information in the reference of modules. It does not affect any other module in the overall structure of the system.

(6) Maintaining the system. The system requires for maintainability readable program, which is a clear structure appropriate comments. Systems have been increased the independence of program modules and it just needs to deal with only one module when doing maintenance; the whole program is completed by adoption a uniform design specifications, such as comments, file names, global or local naming variables etc.; it contains complete and clear application design documentation, user documentation and maintenance documentation; furthermore systemic reference is also designed well.

(7) System efficiency. A variety of ways is used to optimize the whole system. For instance: transmission of data compressed using the compression algorithm; acquisition the transmission relationship among the data; reducing the number of data query; using a storing procedure as a method of pre-treating, etc..

(8) System usability. It contains friendly user interface and convenient operation. Operation of the system design has always stood in the user's point of view. The system operating standards should be simple, fast, efficient and easy to get help and so on.

(9) The data resource is abundant and comprehensive. Data source is not limited to the access of business data in bank, but also including national laws or regulations and the politics in the system, such as legal standards, credit information of loan customers. The system will make more scientific decision support.

(10) Strong report abilities. System includes the function of making various kinds of reports. For example: fixed format reports which is usually the standard formal of bank reports. However, the bank staff could generate reports according to their own need.

Banks could reflect economic activity through inspection certification, account record books and analyzing business data and a series of processes. What's more, bank is also a thermometer of entire national economy and reflects the situation of national economy. Some decision support system could even generate report like a future investment plan and this has great significance for the implementation of business regulation and the control of macroeconomic.
3.8 Hybrid of Decision Support System

With the develop of new techniques, DSS has been gradually extended and completed. Many new branches of DSS have been emerged and improved DSS to be used in higher level.

3.8.1 Synthetic Decision Support System (SDSS)

SDSS is also an important trend. SDSS means combines DSS with On-Line Transaction Process(OLTP) technique or On-Line Analysis Process(OLAP) technique. OLTP technique can provide DSS with intensive data renews, performance improvement, and system stability. On Line Analysis Process(OLAP) technique focuses on providing DSS with speed and convenience in data analysis, which could ensure the safety and speed in the working of DSS.

The popular model of SDSS is that DW+OLAP+DM=DSS as shows in the following figure 3.7

![Figure 3.7 Model of SDSS](image)

In this type of system, decision-maker use OLAP or DM tools to carry on multi-dimensional analysis on data. DW technology is used in data memory and organization to solve data inconsistent in DSS; OLAP provides on-line analysis model of the data to users; data mining devotes to the knowledge automatic diagnosis. The combination helps to provide effective decisions. The core of OLAP is multidimensional cube. The main concept of OLAP is multidimensional databases and multidimensional analysis. Multidimensional structure is a variation of the relational model that uses multidimensional structure to organize data and express the relationships between data. The technical analytical method of the OLAP includes Slice, Dice, Roll-up, Drill-Down, Pivot and other basic operating measures so as to deeply analyze the multidimensional data, therefore, users can make the data analysis from different perspectives and aspects and friendly statement results can be obtained for convenient understanding and mastering of the users. (Fang, 2009)
DSS combine with On-Line Transaction Process(OLTP) technique is also used in transfer and monitor to ensure the safety of the working of DSS and data, and normally it is combined with real-time monitor techniques to help the working of DSS in a bank.

### 3.8.2 Intelligent Decision Support System (IDSS)

(1) Data Mining (DM) and Artificial Intelligence (AI).

One of the most popular research in this field is the usage and implementation of Artificial Neural Network (ANN). ANN is used to discover the non-linear relationship between financial variables which cannot be carried out by the expert system. ANN has been used for pattern recognition, forecasting, prediction and classification(Chai, Taib, 2010). It is a key component of any data mining tool kit. There are five basic tasks of data mining: relative analysis, clustering, concept description, error monitoring and forecast. Learning in ANN also helps in extending knowledge base and model base.

In banks, application of ANN improves the profit of investment in securities. DM will mine the potential pattern and trend from the history data. Analysis the performance of stock and predict the trend and risk of the stock. The friendly user interface offers the K-Line chart or the bar chart of the stock to the users.

(2) IDSS supported by neural network and data mining

Figure 3.8 shows IDSS supported by neural network and data mining. It is derived from the combination of traditional DSS with data mining technology in order to increase the intelligence of system. It contain human-machine alteration system based on neural network, data mining, reasoning and solutions, data base management, knowledge base management, methods base management and models base management. (Qian, Wang, 2009)
(3) Bank Intelligent Decision Support System (BIDSS)

Bank Intelligent Decision Support System (BIDSS) is the new trend of DSS in financial area. BIDSS will help the decision maker in collecting, storing, processing, modelling, analysing, computing and evaluating the data. BIDSS focus on providing decision makers with information supports. BIDSS should include:

i. Friendly user interface to provide bank decision making with all kinds of data.

ii. The working of BIDSS need real-time monitor to avoid loss in business.

iii. Assist bankers on modelling and design different programs. From quality and time aspect, analyse and evaluate plans automatically or interactively. Forecast the possible consequences of various options. And support decision-makers to make the right decision and track it. Then feed back the solutions to the decision makers to adjust the solution immediately.

iv. Knowledge base is supplemented by the banking experiences learning. Using knowledge base, it will be more effective to deal with some complex and unstructured problems and forward more instructive proposal.
3.9 Summary of theoretical findings

After the theoretical study, we have found out the answers of our research questions, we will summarize the theoretical findings to answer the research questions:

Sub question 1: Which type of DSS is applied in China's banks and how it works?

The structure of DSS in China's bank is based on the three bases and four subsystems, which are database, model base and knowledge base, and the subsystems are data management subsystem, model management subsystem, knowledge-based management subsystem and user interface subsystem. Further more, the DSS in China's Bank contains both Management Information Systems and Management Intelligent Systems, because DSS deals with information as well as intelligence. They are concerned with efficiency and effectiveness.

Data which supports for making decision could be from internal, external or personal sources. Data has been stored in the databases or data warehouses. When data has been extracted, transformed and loaded, it becomes meaningful and useful for the decision making. Then the data will be matched into suitable models and carried out model analysis by statistical or financial method. What's more, knowledge-based subsystem is the brains of DSS, which comprises relevant rules and previous experience in certain area. The user interface is a window to the under in order to obtain better control on DSS and solve problems. It will display a visible chart or report through the user interface to the decision makers.

DSS is applied in banking area could assist different kinds of business in banks. However, for different types of information the working way of DSS is different. The formal working process of DSS is: first the information or data come through the user interface will be checked. If the data are structured or financial information, it will go through a serial analysis and match a model, otherwise the data will be sent to the knowledge-base management system which based on expert experiences or intelligent analysis. Finally the corresponding reports or graph will present to the users through the user interface.

However, the Sub-question 2 and 3 cannot be generalized through the theoretical study. In order to answer these two questions, we need to interview the bank staff. Interview can find out the improvements and limitations as well as the personal experiences of using DSS in their daily work. And the result will be present in next chapter

Sub question 4: Future trends of DSS in banks and new techniques.

With the widely use of network, the demands for DSS to be more efficient and effective are gradually rising. Some data need be processed immediately and accurately. And the space needed to store data is also increased. So from techniques' point view, new types of DSS have been showed up. SDSS which combines data warehouse, OLAP and data mining improve the capability of analysis data and upgrade the database from single database into
multidimensional database. Future more, DSS assisted by Intelligent system and Expert system can deal with the data not only structured or semi-structured but unstructured.

In the bank area, with the help of these new hybrid DSS, works in reducing the risk of investment and loan can be greatly improved, as well as customer management. The Risk Management and Customer Relationship Management are the main sub-areas which should be focused. With the help of IDSS, prediction on the trends of financial activity could be precise and so does the analysis of customer consuming behaviours. Thus reduce the unnecessary loss and risk and optimize the profit.

3.10 Arguments for an empirical study

The results from theoretical study of DSS have answered some of the research questions and help us in understanding the basic techniques of DSS. But the improvement and limitations of DSS in banks and its affection on bank staff have not been illuminated. Further study on the application of DSS in China's Banks is needed. We believe that empirical study could provide more arguments and evidences for our research questions. We interviewed people who work in banks through e-mail and Skype for further study.
4 Empirical Results

In this part, we will present the empirical results of our study. The data used in this part is mainly collected from interview and Internet, especially interview. We search on the Internet and do interview through sending emails to the IT Support Department or staff of the four biggest banks of China: Bank of China (BOC), Industry and Commerce Bank of China (ICBC), Agriculture Bank of China (AB CHINA), China Construction Bank (CCB). According to the China Financial Report 2009-2010, those four banks have covered more than 85% of financial activities within China, and has a significant influence on Asia's financial industry, even all over the world. That gives us a good reason to lay the foundation of our research on those four banks, and takes them as cases of study.

In this chapter, we are going to present the results of interview according to different banks. In each bank, we choose the interview result from different layers including IT support employee in banks and system developer, normal bank staff to bank higher level and present them in an original way to make sure that we show the original idea of interviewees.

Here comes the results from the first bank: Bank of China (BOC).

4.1 Interview results of Bank of China (BOC)

Bank of China Limited is one of the four biggest commercial banks in China. Found in 1912, which is the oldest bank in China. It is the second largest lender in China, and the 5th largest bank in the world by market capitalization value. The Bank's core business is commercial banking, including corporate banking, personal banking and financial market services.

And in Bank of China, we choose three respondents to interview in Bank of China

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<th>Data Resource</th>
<th>Year Report of BOC Information Center</th>
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<tr>
<td>Respondent</td>
<td>Yang Zhiguo</td>
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<tr>
<td>Position in bank</td>
<td>CIO of BOC's Information Center</td>
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The following paragraph is from BOC Information Center's 2010 Year Report written by the CIO of BOC Information Center Yang Zhiguo. He has concluded the report by providing the benefits brought by Credit Decision Support System and BOC's future plan of designing business intelligence systems.
"The testing and using of Credit Decision Support System in the national wide started from the end of 2003. Now the system has been used in the whole state for over seven years, with good stability, and received expected results. It is based on the customer credit work of Bank of China and is a new generation of financial support system which combines with business requirements and system management approach. It is based on NOTES office network platform, which enables the system to satisfy the need of electronic processing of credit business process control, also centralized data processing and promote information sharing. The system improves the efficiency of credit business; it has been proved that the system provides a strong and powerful support to our executives with a timely, accurate and comprehensive hold of the credit information. With the help of the system, we have timely avoided many cases of illegal and non-performing loans. With the aid of the system, we could integrate the data of credit customers also related customers who have more than one account. The system can collect, sort and accumulate all the previously manual, decentralized and disorderly credit information, and increase the sharing of information between monitoring system, rating system and clearing system. The promotion and usage of the system has greatly enhanced Bank of China's level of risk management and overall competitive strength. In the future, we plan to build our Business Intelligence toward a direction of "Customer Centered" and "Risk Centered", which means that the customer management and risk management will be given the priority in our strategy to help enhance the share of BOC in financial market."

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<th>Data Resource</th>
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<tr>
<td>Respondent</td>
<td>Liu Xiaoli</td>
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<tr>
<td>Position in bank</td>
<td>IT employee in Information Center</td>
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We interviewed Liu Xiaoli, she is one IT employee in Information Center of BOC and we interview her through email and talk with her through Skype tel.

We send her interview question table as showed in the second chapter. She mentioned systems which could provide intelligence support in BOC as the following:

(1) Credit decision support system.
Credit decision support system is designed to provide support in credit business.

(2) EIS (Executive Information System),
EIS is brought in to provide support to higher level and senior executives of BOC, facilitate and support their work by providing easy access to both internal and external information§ relevant to meet the strategic goals. It helps analyze, compare, and highlight trends so that high level can monitor the performance of bank and make strategic plan for the future develop of the bank.
(3) Bank Card Evaluation system
Bank Card Evaluation system is a system designed for business related with card business. The system provides functions like Card Issuing Analysis, Transaction Analysis, Customer Analysis, Risk Analysis, Profit Analysis, generate report to support bank staff in card business.

(4) CRM (Customer Relationship Management System)
CRM is used in BOC to managing the bank's interactions with customers.

(5) Ledger Audit System
Ledger Audit System is brought in to reduce the work of accountants and treasurers and provide support in auditing the general ledger.

According to Liu, although there are many systems which provide decision support in BOC, the primary jobs that this type of system does in banks and all the supports they provide can be concluded to three points: process business data, risk control and monitor, generate solutions for financial problems. Normally the system's working is to collect business data from front-ends and then send data into the systems, the systems' model base or inference engine would analysis those data to generate financial problem solutions or risk reports. In fact, credit is the core business for a commercial bank and an important part of bank risk management. So she takes Credit Decision Support System as an example to explain how DSS is helping the most important business credit work in a bank.

In the system, all the functions are divided into two model parts, one is Basic information management which includes the sub-functions of Individual customer information management, Associated customers information management and Group customers information management to provide basic data management. The other function model is Business process management, which includes the sub-functions of Business Application Processing, Risk control and business approval, Audit and storage in the database. And the implementing of all these functions are relied on a three bases structured system as show in the following figure.
The system is a typical three base DSS which contain Model base (Contain financial index generation model, analysis hierarchy process model, financial evaluation model and ANN Analysis model to provide model calculation and evaluation), Database (There are two databases in this system, one is Data Recording Database and the other is Data Summary Database) and Knowledge base and corresponding management systems. Those functional parts are organic combined. The information from user interface will be sent separately to Data Recording Database and model base according to whether it is financial factor or not. The financial information will be sent to model base for a series of analysis like financial index generation model, analysis hierarchy process model, financial evaluation model and ANN Analysis model. Further the results generated here will be sent to Data Summary Database and then inference engine to evaluate the financial status. And non-financial factor information from the front end will be sent to Data Recording Database and knowledge base for logical and business rule analysis. The results generated from this part will be combined with the result from financial analysis part and generate the result of risk classification and report to the risk management or higher level executive staff.

Regarding how those systems benefit the bank and their customers, she said that the fact is that decision support system is not directly known by all people who work in the bank although it does exist and it is widely used in different sections and benefit the daily work of bank in many aspects. Sometimes even the users do not aware of these DSS if they are not IT
professional. She thought that for normal staff in BOC, the system provides a strong data support to save staff from the boring work. And the environment is simple, precise, prioritized, controlled and provable, with good human-computer interaction. Also the system has implemented information collection, aggregation and examination and approval of business information especially credit data. This process could facilitate the work of risk control departments in the collection of information, and in processing the data and providing information in risk control and decision support in a user-friendly form which could make the work of higher level executives easier and reliable.

Regarding the negative side bring by the system, she explained that consider about the situation in China, after the bring in of many intelligence systems, the bank does not need so many staff and this surely would cause the job losing, at the same time less new employee is needed and it will be even harder for a new graduate to get a job. Also some times it brings cognitive bias and miss understanding since people may misunderstand the result generate by the system. Also she thought the bring in of the system may make the executives rely to much on the results generate by the system and lost their own ability of making a decision.

The last problem we ask is the system work well in BOC and how does she evaluate the system. She said that those DSS do help in control the risk and improve the work in BOC and help in processing business data, generate solution for financial problem as she explained in the second question. About the position of DSS in banks she said DSS has mainly played the follow role in their IT system: one is data processor which helps in processing data, other is risk controller to reduce the risk and keep the possible loss at the lowest level, and also a problem solver. But this did not mean DSS can take human's position in making a decision making, but a strong support and rational advice in business.

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<td>Respondent</td>
<td>Yan Wenying</td>
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<tr>
<td>Position in bank</td>
<td>Customer manager in Tianjing Branch</td>
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Yan Wenying is a staff working in BOC Tianjing Branch for three years. We sent her question form to interview her. Her answer to our questions is: she thought the IT systems in the banks did help her in her work. Her job relies on the help of many systems which could provide decision support. As a customer manager, she needs to deal with the requirements of customer every day. And it is not only her duty to sell business product, also control the risk at an acceptable level. In her work, she needs to gather customers' information and consuming habit to make a plan of sell their business product to potential customer, at the same time she needs to control the potential risk at the lowest level. She mentioned that DSS helps her work in two aspects: first is target potential customer, the other is to analyze the risk in the business.
And the analysis results from the system do help her work in targeting the potential customers and control the risk.

4.2 Interview results of Industry and Commerce Bank of China (ICBC)

Industrial and Commercial Bank of China Ltd (ICBC). Found in 1984, had assets RMB 11 trillion (about 11 trillion SEK), 18,000 outlets globally. It has the following product: Finance and insurance, Consumer Banking, Corporate Banking, Investment Banking, Investment Management, Global Wealth Management, Private Equity, Mortgages, Credit Cards. ICBC has 2.5 million corporate customers and 150 million individual customers. And is a bank focus on commerce and loan in industry area.

Industrial and Commercial Bank of China (ICBC) is the market leader in terms of bank loans in China by the end of 2009. According to the latest estimate, ICBC occupies about 14.5% of the market share, leading all the other banks. Other major players include China Construction Bank (12%), Bank of China (11%), Bank of Communication (4.6%), China Merchant Bank (3%) and CITIC (2.8%). At the end of 2004, 19.1% of ICBC's portfolio consisted of non-performing loans, this once has been a heavy burden of bank. April 2005, one Beijing financial company, China Huarong, helped ICBC dispose of its bad loans and improve it's loan evaluating system and bring a new effective system both in management and IT support. In the 2005 annual report records, just under 5% of loans is classified as non-performing.

![China Bank Loan Market Share](image)

Figure 4.2 China Bank Loan Market Share in 2009
And in ICBC, we have two respondents from different departments.

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<th>Data Resource</th>
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<td><strong>Respondent</strong></td>
<td>Li Yalin</td>
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<tr>
<td><strong>Position in bank</strong></td>
<td>ICBC IT Support Centre Shandong Branch employee</td>
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After we write Email to interview IT engineer Li Yalin in ICBC's Shandong Branch. And he replied us and provided his opinion about DSS used in ICBC and suggested that we can carry out our research with the help of their bank journal and some websites. And the following is the results we got from interview with Li.

Regarding the first interview question, Li answered that the systems he knows which can provide decision support function is Loan DSS, CRM and Transaction Control and Monitor, and he also suggested some materials that we can get further information about DSS used in ICBC. After a series of search and check work, we got the result.

The following are DSS used in ICBC:

(1) Loan Decision Support System, which is a hierarchical structured IDSS.

(2) Integrated Bank Card information Analysis System
Integrated bank card information analysis system is developed with the support of data warehouse technology, and it has the functions of management, statistical analysis, monitoring. This system uses data mining and on-line analytical to collect and integrate related information and builds multidimensional data management repository. The system use statistical analysis tools to generate figures, tables and data, and the system can check the latest information on credit card, monitor business conditions and predict its development trends. Also provide automatic analysis of information, and real-time, accurate, scientific, clear data support.

(3) ERP (Enterprise Resource Planning) System, Ufida ERP
EPR had promoted the development of ICBC. With the brought in of DSS and many other new BI Systems, ICBC strengthened and upgraded their EPR to ensure those systems co-operate well.

(4) CRM (Customer relationship management) System,

(5) Investment Analysis System
Investment and Trading Analysis System provide decision support mainly in stock and bonds trade to optimize the profit.
(6) Transaction Control and Monitor

Transaction Control and Monitor provide risk analysis and transaction control in the process of transaction.

He explained in his email DSS in ICBC is mainly used to reduce the risk and earn more profit for the bank (Loan Decision Support System), and to improve customer service and reduce the risk (CRM), and ensure the safety of transaction (Transaction Control and Monitor). He said the main job that DSS does in his bank is that control the risk, no matter it is for loan or transaction or other business. He emphasized that for loan business, a wrong decision could cause financial lost to the bank. Especially that they are a commercial bank focus on commerce and loan in industry area, how to escape from non-performing loans is always a hard task for them.

Then we decided to read more materials about the Loan Decision Support System. The following is the results we got from further research. Loan Decision Support System of ICBC is an intelligent decision support system with hierarchical structure, it is also a three bases DSS that is widely used in China's bank. And the following figure show the decision making process of how this DSS makes a loan decision.

![Diagram of Loan Decision Process](image)

Figure 4.3 Model of Review and issuance of loans from ICBC's Loan DSS
This is the figure of Model of Review and issuance of loans from ICBC's Loan DSS, they use IDEFO method to make an economic model for loan decision-making process. After a loan application is sent into this system, the data will be under first round of censor and check, and staff and system will be responsible for the censor work in the first round. And if the application is legal the data will send for the second round of analysis. The second around of analysis is individual credit analysis. If the application is individual loan application, relevant data will be analyzed and after analysis data will be sent to loan decision part to generate a result. If needed, data will be under a series of project credit analysis depended on the type of loan. If it is not individual loan application, data will be sent to company credit analysis part, and relevant data will be analyzed here. If needed, the data will be analyzed again by project credit analysis depended on the type of loan the company applied for. After two or three rounds of analysis, data will be sent to loan decision part to generate results. Credit analysis work is operated by staff, manager and system together. The result generated by the system contains two types: refuse and approval. If the loan application is refused, the report of refuse will be generated. If the loan has been approval, the type of loan, maturity and amount of the loan will be reported and a result report will be generated, this process is operated by staff and system. Reduce the risk of the loans is the primary goal to achieve for the bank. Loan price is also a very important goal, but secondary goal to be achieve. The system will notice the staff to consider the price only when the primary goal has reached a conclusion. Another point to be mentioned here, the original price of ICBC's loans has been divided into several grades. When the decision result is "agree to lend", the bank will consider raise lending rates again in order to obtain more profits, and the interest rate will be calculated in another expert system to make sure it would be acceptable by the customer. This expert system is based on several strong database and knowledge base and this system will weight precisely between loan risk and loan interest rate for different lenders.

In the fourth question he mentioned that the application of those systems benefit their works since they have already became the biggest share in loan business market in China, it is a persuasive argument on this problem. And the system brings a faster speed in processing loan business. Under the traditional way, there were a lot of processes in censoring and checking data and getting report from different sub-systems to generate a final decision. After brought in this system, all the business data collected from front-end is put into data warehouse for data analysis, which could bring a faster speed in processing data and lower risk. In addition, the system could reduce illegal loan and non-performing loan. The fact is that after the bring in the system, ICBC's non-performing loans has been reduced to under 5%. Compare with the number in 2004 that 19.1% loan is non-performing. It is a great improvement in reducing business risk. It makes ICBC more competitive in the market. Then he mentioned DSS is also used to monitor the transaction, reduce the chance of loss or hacked during the transaction and maintain the safety of the bank's business.

Regarding the drawbacks he mentioned that many systems in their bank are outsourced or developed by IT company. Although they sent some IT employee from the bank to develop the system with the IT company together, but there could be design flaw existed in the system, because the developer does not know financial knowledge so well, also there could
have bad communication between the developer and bank staff. Also he mentioned that the restriction can be from outside rather than DSS or bank itself. For example the market and the command chain within the bank and policy trend could influence the development of DSS in banks. And he said that the bring in of intelligence system like DSS make executives less authoritative since the results generate by intelligence system is well computed and more persuasive. And for decision makers, too much information sometimes hinders them in make a choice since there is too much data to evaluate.

And finally he said he agrees that DSS plays a very important in ICBC, especially in risk management and optimizing profit.

<table>
<thead>
<tr>
<th>Data Resource</th>
<th>Journal</th>
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<tbody>
<tr>
<td>Respondent</td>
<td>Ding Tingting</td>
</tr>
<tr>
<td>Position in bank</td>
<td>Manager in Beijing Erlizhuang Branch</td>
</tr>
</tbody>
</table>

Another resource is from the journal of bank, *ICBC Report*. The editor interviewed several staff in the bank, and ask how their work is improved after the bring in of business intelligence systems. One manager in Beijing Erlizhuang Branch Ding Tingting explained how Integrated Bank Card information Analysis System facilitates her work. She said

"Bank card business is different from other business in bank, compare to other credit business in commercial bank, it has higher risk of overdraft and there is no mortgage, which makes the evaluation of customer credit very important. But you have to provide a better service to attract more customers. This make a contradiction, it is hard for us to decide whether to board our market and issue the card or to be controversial. However, act controversially could make us lost our share in the market. After the application of the system in our branch, we could perform risk evaluation and customer segmentation through the system to define the type of customer and decide whether we should issue the card or refuse the application. And also the system provides us attrition analysis function to monitor customer attrition and maintain our best customers and keep our share in the bank card market and make us competitive. And it is easier for us to carry out the profit ability analysis on a new business product after bring in the system." 

### 4.3 Interview results of Agriculture Bank of China (AB CHINA)

Agricultural Bank of China Limited (AB China), also known as AgBank, is one of four biggest banks in China. Found in 1951, has 320 million retail customers, 2.7 million corporate clients, and nearly 24,000 branches. AB China is China's third largest lender by assets, total assets amount RMB 9,695,967 million by 30 June 2010 (about SEK 9,695,967 million), its
product cover personal banking, corporate banking, Agri-related business, e-banking, financial markets, credit card, wealth management.

The Head Office of Agricultural Bank of China divided their 40 sub-systems into nine categories:

1. Channel applications system which is based on accounting
2. Exchange clearing system which is used within AB China
3. Exchange clearing systems used to do the settlement with other banks
4. Business application systems used by operating department
5. OA system
6. Head Office and financial analysis support systems
7. Information system which submits business report to superior and regulatory department
8. Reporting system which communicates with shareholders and customers
9. Desktop monitoring and management systems

Among all the systems AB China used, we focus on the type of system could provide decision support. And the following systems are DSS used by AB China:

1. Financial Analysis Decision Support System
2. Bank Card Management System
3. CRM (Customer Relationship Management)
4. Risk control and report System

The interviews we carried out in AB China contain three respondents.

<table>
<thead>
<tr>
<th>Data Resource</th>
<th>AB China Journal</th>
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</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Xiu Lei</td>
</tr>
<tr>
<td>Position in Bank</td>
<td>CIO of AB China's IT Support Center</td>
</tr>
</tbody>
</table>

Xiu Lei gave a speech on the Conference of Financial Information Technology. He said:

"DSS has been applied in many different business areas in Agriculture Bank of China. For instance loan, investment and funds. It can help in managing risk, detecting fraud and evaluating the profitability. Previously it was a barrier for banks to make an advisable decision because of lack of access to detailed high volume data. But Decision support system provides the data in a direct and easy-understanding way. The system provides trend curves with various indicators, column chart and pie chart (helps to compare directly), get a deeper insight into inherent relationship between data. The system provides a strong support for staff in operation department and helps them make the right decision."
He briefly introduced the Financial Analysis Decision Support System in AB China:

"Financial Analysis Decision Support System contains two main parts: front-end software systems and project implementation. The system involves a wide range of technology and products. This system's business intelligence software platform is Microsoft's products, including common database platform MS SQL Server, Online Analytical Engine (Analysis Service), and integrated ETL's tool platform (Data Transform Service). Front-end software system is developed by the R & D center in Guangzhou which is an independent product named BI Office. It is a powerful set of BI tools. It provides users with the functions of tables and graphically display. Also it manages on-line analysis result, irregular reports, alerts, data mining, presentation, and its own data management and many kinds of advanced BI services based on OLTP and OLAP engine"

<table>
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<tr>
<th>Data Resource</th>
<th>Email Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Cui Zonghe</td>
</tr>
<tr>
<td>Position in Bank</td>
<td>Business Manager in Beijing Branch</td>
</tr>
</tbody>
</table>

Cui is one business manager of AB China. He said that agriculture is the primary industry in China, AB China is special in providing financial support to agri-related business. The feature of their business is that the amount of business cases is large, but the amount of capital in each case is small. That makes AB China spend a lot of energy on their database and data warehouse since they have huge number of customers with lower risks and most of the loan is rather small in amount. Financial Analysis Decision Support System is the most important decision support system in AB China since it deals with the most important business in AB China.

With the statistical analysis of the data in the database, they can flexibly obtain the daily business data and generate results to support decision-making for different business. It helps normal staff to generate reports of the relative business. For managers, they can spend less time on shifting through data and read the reports directly. Combine the results from report with their own knowledge and experience, managers can make a decision on whether it works faster.

Future more, the bank could design a new investment project or financing product to make profit according to the results from DSS.
Wang is a teller in AB China's Beijing Branch. When we asked him how DSS effects his daily work, he answered that : " First of all, I am not clearly about the definition of DSS, but I have to say that Information System in our bank brings a lot of benefits for my daily works. We can check the clients information and accounts easily through the bank's system and the details of each transaction. It is convenient for us to do the daily settlement and monthly report, like Balance Sheet, profit and loss sheet.

### 4.4 Interview results of China Construction Bank (CCB)

China Construction Bank is one of the four biggest banks in China. To date, it is ranked as the nation's second largest and the second largest bank in the world by market capitalization. It owns 13,629 domestic branches and total assets reached 8.7 trillion RMB (about 8.7 trillion SEK). Its product cover Finance and insurance, Consumer Banking, Corporate Banking, investment Banking, Investment Management, Global Wealth Management, Private Equity, Mortgages, Credit Cards.

The interview we carried out in CCB contains 3 respondents.

<table>
<thead>
<tr>
<th>Data Resource</th>
<th>CCB journal</th>
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<tbody>
<tr>
<td>Respondent</td>
<td>Liang Jianwen</td>
</tr>
<tr>
<td>Position in Bank</td>
<td>Technique Manager of CCB IT Center</td>
</tr>
</tbody>
</table>

We found the description of the whole systems on the CCB journal wrote by a technique manager in CCB's IT Center named Liang Jianwen.

As Liang mentioned that the main IT systems has been divided into four models: Business Model, Management Information System Model, Channel Model and Other Models. It covers all businesses of the bank, such as Internet Bank, personal and business loan, investment and so on.

The four IT models support the daily work of CCB. And among all the systems, there are several DSS included. Those DSS co-operate with other systems to provide IT support to
CCB's business. The following are DSS used in CCB:

- CRM
- Personal Loan System
- Risk Management System
- Financial Management System
- Accounting Management system

Among all the banks in China, CCB is the first bank use CRM(Customer Relationship Management ). CCB puts 56% of its assets in bonds which is the highest, and most of it's loan are toward company not individuals, which makes the management of customer relationship very important to CCB.

He pointed out that the variety of banking services springs from different kinds of clients. Bank needs to satisfy different types of customer from individuals, small businesses, industries to large diversified organizations. Each of them has different requirements for bank service. Bank should do best to satisfy them, but it is also needed to consider their financial status to avoid fraud and bad debts expense. So the CRM is particular important for the bank not only for attracting more customers, but also reduce unnecessary loss.

<table>
<thead>
<tr>
<th>Data Resource</th>
<th>IBM</th>
</tr>
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<tbody>
<tr>
<td>Respondent</td>
<td>Zheng Xiaojun</td>
</tr>
<tr>
<td>Position in Bank</td>
<td>Technique Support of IBM China</td>
</tr>
</tbody>
</table>

As we learned from the white paper of CCB, their CRM was designed by IBM. So we sent e-mail to IBM software engineer Zheng Xiaojun to do the further research. Zheng showed us the structure of CRM in CCB.
This is the structure of the CRM used in CCB, data is collected from many business systems, or terminal like POS, ATM. Then data from these business systems and terminals will be sent to CRM Data Integration System for integration, after integration data will be sent to data warehouse for deeper processing and store. When the process of data in data warehouse is finished, data will be going through a series of analysis including customer data analysis, customer activity analysis and product data analysis, the results will be provided to customer terminal like Call center, Customer Service, Internet Banking through interfere.

Zheng said the processing of data in the system is transparent to the users who working in the bank. They do not need to understand the details of how the data warehouse deal with the data. They want the system to be friendly to the users. So the IBM provides user-friendly customer information maintenance and log in window. IBM also provides dynamic attributes and management systems, customer number generation and distribution systems. Customer information management authorized system (different level of users, groups can enjoy different level of resources and access rights). Control the quality of customer information (Based on the "unknown" percentage of an attribute). Customer information data loading and export (get from customer data and customer business data)

As last, he said that what IBM provided to the customers is the best solution. Since they are professional and responsible to support and maintain their customers' systems. And their system improves the performance of bank.
Gu is Customer Manager in Shanghai Branch of CCB. He admitted that CRM brings advantages to the bank business. He said

"In our customer evaluation system, we define customers into different level: high loyalty and value customers, high loyalty but low value, low loyalty but high value, low loyalty and value, and potential customers. And we have different strategy toward different customers. And then the CRM can help us do the customer business behaviour analysis, customer component analysis and define the type of customer. Then we can know more about the customers' specific needs and adjust the level of service to reflect the customer's importance or status, this would help in building customer loyalty and decreases customer agitation.

Through analyzing different groups of customer, we can improve the customer satisfaction according to their requirements. CRM also helps us in identifying potential customers. The system keeps tracing the profiles of our customers, so that we can make a strategy to target potential customers for our business and make a proper service plan for them. Furthermore, through analyzing the customers' information and their consuming behaviour, we can sniff illegal actions of customer, avoid credit fraud and reduce the loan risk."

### 4.5 Summary of empirical findings

In this part, we present the interview results from different interviewees in four banks to get an understanding about DSS from their point of view. Among our interviewees, there are higher level in the bank, normal staff from different sections, and IT support staff in bank who knows most about the systems provide decision support in banks. After we carried out interview, we choose valuable interview materials and present it in this chapter. And in this summary part, we will summary the results we got from the interviews and present the result in the form of brief answers to the research questions. And a detailed explanation of application situation of DSS in China's banks will be presented in the next chapter.

**Sub question 1:** Which type of DSS is applied in China's banks and how it works?

We found out that there are nine kinds of DSS that support the daily work in China's banks:
(1) Executive Information System (EIS)
(2) Asset/Liability Management System (ALM)
(3) Credit Risk Management system
(4) Bank Card Risk Analysis System
(5) Ledger Audit System
(6) Investment and Trading Analysis System
(7) Data analysis and predict system
(8) Transaction control and monitor
(9) Customer Relationship Management (CRM)

Regarding how does DSS work in those banks, according to the results from respondents we interviewed, we concluded the application of DSS into three types Application in investment and trading, Application in insurance and risk control, Application in fixing operation problems. Application in investment and trading is the type of DSS works in optimizing the profit and predicting risks in investment and trade, application in insurance and risk control is used to calculate the risk in business and prevent unnecessary lost, application in fixing operation problems including DSS which does not belong to the former two types or the kind of DSS works within a special area.

**Sub question 2:** What are the improvements and drawbacks DSS bring to banks?

The improvements DSS bring to banks:

DSS improves efficiency in bank's work, reduce the time needed in dealing with business in a bank. With less time cost and better efficiency, banks could achieve higher satisfaction from their customers and their own staff in different level. And DSS brings better control in risk to banks and helps in reducing operational cost and enhancing organization within the bank. New manager and staff can learn business rules from DSS. Finally, DSS makes a bank more competitive in the market.

The drawbacks DSS bring to banks:

If DSS in a bank is not appropriately used, it could bring cognitive biases and lead the decision maker into a wrong way, also some managers consider the use of DSS as transferring decision authorities from them to a software system and they refuse to take responsibility for the decision. And DSS makes bank staff lost their ability in making judgments in business and make them rely too much on the results of system. Sometimes DSS provide too much information which makes it harder for higher level staff to make a decision. There could be design flaws in the system. One more point is that the bring in of DSS cause conflicts between bank staff and system, for normal staff some of them cannot get use to new techniques and the bring in of DSS makes them concern about losing their job, and the higher level staff are worrying about lose their value and authority while facing an intelligence system.
When we were interviewing people for answer to this question, some interviewees mentioned that many drawbacks are actually from outside not just within the bank. For example technique restriction, immature market and immature credit system and bank industry, policy trend. Those factors did restrict the development of DSS and DSS's work within a bank.

**Sub question 3:** How does DSS facilitate the bank staff on their works?

After the interview, we classify the bank staff who's work could be affected by DSS into 3 types: Higher level staff, Manager or middle level staff and Front line staff.

For higher level staff, DSS provides decision support to higher level staff or senior executives in risk evaluation and profit rate evaluation. DSS provides business suggestions to executives and DSS could help the higher level in making strategy plan for the future development of the bank.

For manager or middle level staff, DSS helps in improving customers satisfaction and loyalty through provide analysis of customers' information. DSS could sort and analyse customer's purchase behaviours and requirements and help banks in targeting their potential customers. With the help of DSS, business managers can design specific financial products according to different customer's requirements and customer manager can attract more customers and create more values.

For front line staff, we found out that most normal level staff did not have a comprehensive concept of decision support system. However, the fact is DSS improves the front line work, makes their daily business operations more effective and reduces the heavy work of normal staff.

**Sub question 4:** Future trends of DSS in banks and new techniques

Our interviewees mentioned the future trends of developing DSS in banks are Customer Relationship Management and Risk Management. The traditional product-centric developing model has been out of date and customer-centric has becoming the new trend. As the competition between banks is becoming intensive every day, how to meet customers' demands timely and accurately and target potential customers is extremely important. This is the motivation of the IT development department to build their business intelligence systems toward a customer-centric direction. So does risk management, risk management is important to banks and it is also a tough process. If the risk in business could not be correctly evaluated and predicted, it would bring lost to the bank and in some cases the lost could be fatal to a bank. The new techniques have been introduced in last chapter and we will not repeat it in this part.
5 Analysis

The purpose of analysis part is to find out how DSS is used in China's banking area. We will emerge and rearrange the data we collected, and generate the results and present it here.

And in this chapter, the results will not be present in the form of answer to the research questions in order to provide the readers with a comprehensive understanding on the application situation of DSS in China's banking industry. The presentation of results in this chapter is in accordance with the real application situation. However, the corresponding relationship between research questions and the contents can be illustrate in the following figure.

Figure 5.1 Corresponding relationship between research questions and the contents

5.1 Types of DSS in China's banking area

According to the results from interview, DSS used in China's banking area can be concluded into the following types:
(1) Executive Information System (EIS)
(2) Asset/Liability Management system (ALM)
(3) Credit Risk Management system
(4) Bank Card Risk Analysis System
(5) Ledger Audit System
(6) Investment and Trading Analysis System
(7) Data analysis and predict system
(8) Transaction control and monitor
(9) Customer Relationship Management (CRM)

We conclude the application of different types of DSS in different banks in the following table. "√" means that this type of DSS is used in the bank, "×" means that this type of DSS is not used in the bank, if the function that this type of DSS provide is contained in other system, it is labeled with "Contain in other systems".

<table>
<thead>
<tr>
<th>Type of DSS</th>
<th>BOC</th>
<th>ICBC</th>
<th>AB China</th>
<th>CCB</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIS</td>
<td>√</td>
<td>×</td>
<td>Contain in other systems</td>
<td>×</td>
</tr>
<tr>
<td>ALM</td>
<td>Contain in other systems</td>
<td>Contain in other systems</td>
<td>Contain in other systems</td>
<td>Contain in other systems</td>
</tr>
<tr>
<td>Credit Risk Management system</td>
<td>√</td>
<td>Contain in other systems</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Bank Card Risk Analysis System</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Ledger Audit System</td>
<td>√</td>
<td>×</td>
<td>Contain in other systems</td>
<td>×</td>
</tr>
<tr>
<td>Investment and Trading Analysis System</td>
<td>Contain in other systems</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Data analysis and predict system</td>
<td>Contain in other systems</td>
<td>Contain in other systems</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Transaction control and monitor</td>
<td>Contain in other systems</td>
<td>√</td>
<td>Contain in other systems</td>
<td>Contain in other systems</td>
</tr>
<tr>
<td>CRM</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Table 5.1 Types of DSS used by China's banks
Here is results conclude from the table:

(1) CRM, Bank Card Risk Analysis System, Credit Risk Management System, Investment and Trading Analysis System, Data analysis and predict system are the most commonly used systems in China's bank. Almost every bank we interviewed has applied these types of DSS. Which also shows that risk control, investment analysis and credit evaluation is the area that DSS is applied most commonly, no matter those functions are implemented in the form of independent system or contain in other systems as a function model.

(2) Normally, ALM and Transaction control and monitor is contained in other systems as an function models not a independent system in China's banks.

(3) EIS and Ledger Audit System are not widely used by China's banks. We did some literature study on why these two types of DSS are not widely used. We found out that the general ledger auditing work in China's banks is mainly done by staff and computing system, normally they do not need to provide decision making support, the results of auditing is sent directly to bank higher level and the decisions of auditing mainly depends on the personal experience of bank higher level. EIS meets a similar situation, the structure of bank restricts the development of system like EIS, detailed discussion will be given on the following restriction part.

(4) Another point can be concluded from the table is that risk management (especially in bank card, credit and loan) and customer management and customer analysis and profit earning are the main purpose of using DSS in China's banks.

After discussed the types of DSS, we move the viewpoint to support techniques, the support technique used by DSS contain Data Market, Data Mining, Expert System, Artificial Neural Networks (ANN), Knowledge Management, Cloud Computing, Real-time monitor, OLAP and some Modelling Techniques, and we conclude those key support techniques used by different types of DSS in a table to show the relationship between key support techniques and different types of DSS. And the following table is a summary of key support techniques for different types of DSS in China's banking area.
### Type of DSS | Key Support Techniques
--- | ---
(1) Executive Information System | Data Market / Data Mining
(2) Asset/Liability Management system (ALM) | Data Mining / Expert System / Data market / Artificial Neural Networks (ANN)
(3) Credit Risk Management system | Knowledge Management / Data Mining / Modelling Techniques
(4) Bank Card Risk Analysis System | Data Mining / OLAP
(5) Ledger Audit System | Data Market / OLAP
(6) Investment and Trading Analysis System | Modelling Techniques / Knowledge Management / Cloud Computing
(7) Data analysis and predict system | Data Market / Modelling Techniques / Knowledge Management
(8) Transaction control and monitor | Data Market / Real-time monitor
(9) Customer Relationship Management | Data Market / Modelling Techniques / Cloud Computing

Table 5.2 Key techniques use by DSS in banking area

### 5.2 Application of DSS in China's banks

According to the theoretical study, DSS have been applied in six different ways in banks: Accounting Analysis, Credit Management, Plan and Overall Management, Bank Card Management, System Management and Costumer Management. In this part we would discuss the application of DSS in China's banking area. And we conclude the application of DSS in China's banks into three categories.

#### 5.2.1 Application in investment and trading

As we can get from the former interviews, DSS used in investment and trading is normally embedded as BI models to make investment and trading decisions. For investment DSS is used to optimize the profit and meet the banks’ needs in predicting risk and return on investment. For trading DSS provide decision suggestions for automatic trading and finding market opportunities to make trading fast and profitable. DSS applied in this area requires strong data warehouse which could provide proper advise in investment and trading. Also a mature algorithm is needed to analyze the collected data. Normally this type of DSS provides services to the higher level staff in a bank. According to the data collected from the four banks, this is a very important application of DSS in China's banks.
5.2.2 Application in insurance and risk control

In insurance and risk control, DSS is widely used and many of our interviewees agree that risk control is the most important application of DSS in banks. DSS has been used to calculate risks effectively and it is already been bounded tightly with the matter of risk management. This type of system can help the work of both higher level staff and normal staff in a bank. For example, they can be designed to help the higher level staff with evaluating the risk of investment. They can be set for normal staff to prevent abnormal transaction and payment or help customer manager to attract customer and enlarge bank’s savings. The aware and alert of risk is the top demand for this type of system. For example, some DSS would send transactions data or alarm information by end terminals like text message or email to the card holders, so that card holders could monitor their transaction. The involvement of consumer could help in raising the safety of business. Nowadays some systems are intelligent enough to detect abnormal transactions. And as we can see from the data we gathered, insurance and risk control is an important application of DSS in banks.

5.2.3 Application in fixing operation problems

DSS is also used in fixing operation problems. This includes DSS which does not exactly belong to the former two categories. For example, bank card evaluation system, customer relationship management and many other kinds of DSS works within a special area.

The following table in the conclusion of different types of DSS and its range of application.

<table>
<thead>
<tr>
<th>Type of DSS</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)Executive Information System</td>
<td>Investment and trading/ Fixing operation problems</td>
</tr>
<tr>
<td>(2)Asset/Liability Management system (ALM)</td>
<td>Insurance and risk control</td>
</tr>
<tr>
<td>(3)Credit Risk Management system</td>
<td>Insurance and risk control</td>
</tr>
<tr>
<td>(4)Bank Card Risk Analysis System</td>
<td>Fixing operation problems/Insurance and risk control</td>
</tr>
<tr>
<td>(5)Ledger Audit System</td>
<td>Fixing operation problems</td>
</tr>
<tr>
<td>(6)Investment and Trading Analysis System</td>
<td>Investment and trading</td>
</tr>
<tr>
<td>(7)Data analysis and predict system</td>
<td>Insurance and risk control</td>
</tr>
<tr>
<td>(8)Transaction control and monitor</td>
<td>Fixing operation problems</td>
</tr>
<tr>
<td>(9)Customer management system</td>
<td>Fixing operation problems</td>
</tr>
</tbody>
</table>

Table 5.3  DSS's range of application
5.3 How DSS facilitate different layers in banks

We got from the interview that DSS can facilitate the work of staff in different layers in a bank. However, when DSS was brought into banking industry, it was designed to provide decision support for higher level staff and senior executives. With the developing of DSS, it is serving a wider range of people in banking industry. In this part, we will discuss how DSS facilitate bank staff in different layers.

5.3.1 Higher level staff

When DSS was brought into banking industry, it was mainly designed to provide decision support for higher level staff or senior executives in a bank. For example DSS used to support investment and trading. Investment process needs a lot of analysis, a financial analysis system can be used to analyze the financial situation and provide risk or profit rate evaluation and give business suggestions to the executives. Also in the selection of funds, risk analysis system is used to calculate risk and make sure that the higher level makes the right choices. Another example is that EIS can help the higher level in making strategy for the future development of the bank. The answer to how does DSS facilitate the bank higher level can be conclude into the following point: make better choice in investment, reduce risk, making policy or business rules.

5.3.2 Manager or middle level staff

As business and customers manager they have consider about customers satisfaction and loyalty instead of just selling their financial products. Some types of DSS for example CRM could provide them with detailed analysis of their customers' information, and help customer manager to target the potential customers as well as increasing the profit of their business. DSS also provide support in sorting and analyzing customers' purchase behaviour and requirements and releasing the potential relationship.

So the IT department should improve the website of the bank, also Internet bank functions. The manipulation of customer could be more convenient.

However, managers also realized that many younger customers would like to enjoy the convenient and fast speed from the Internet bank and mobile bank. So the call center and counter service are targeted for the customer who does not familiar with the Internet bank.

Supporting by the assistant of DSS, business manager can design specific financial products according to different customers' requirements. And customers manager can attract more customers to their bank and extent the customer cycle, therefore create more values.
5.3.3 Front line staff

As the front end staff, DSS is a highly computerized system for them. Most normal level staff do not have a global concept of DSS, although DSS have reduced their heavy work. DSS improve the work of front line, and make their daily business operations effective, including reduce fraud, decrease loan processing time and optimize financial products. For instance, a DSS prevents abnormal transaction or payment or just attracts customer in order to enlarge bank’s money savings and the old one we mentioned before which sent messages and Emails to customer while there is large amount transaction. Those are all operated by normal staff within the bank and the reports generate by those kinds of DSS do not need to report and decide by the high level. It is designed to help the daily work of normal staff.

5.4 The Improvements DSS bring

According to the results from the interviews and theoretical study, most of data we collected shows positive attitude in the bring in of DSS to banks. After checked the opinion from different people, we conclude the improvements that DSS brings in China's banks into the following points:

5.4.1 Improves efficiency in bank's work

The first advantage is DSS improves efficiency in bank's work. With the support of data warehouse and knowledge base, DSS could provide a quick transfer in financial information, and better data analysis, which is more efficiency than the traditional way. Before the bring in of DSS, the collection, transfer and data analysis work in a business is done manually, or support several separate systems which could not generate a comprehensive report. That means decision maker need to wait a long time for the reports and then spend a lot of time on reading the separate results generate by different systems. After bring in DSS into banks, this has been greatly improved. Not only the higher level staff of bank benefits from the DSS, also the normal staff is helped by DSS, which saves their time in generating reports and graphs.

5.4.2 Time-saving

Decision support system helps reduce the time needed in dealing with businesses in a bank. DSS provides staff with timely information which could be used for decision making and helps in enhancing employee's productivity. For modern society business, time is becoming more important. Some company says: Speed is life. If a bank is faster in making a decision, the chance of getting a high-profit project is higher and the chance of earning profit is higher too. Also DSS could satisfy banks’ customers better with a fast and accurate response and bring more profit. And the data analysis, report and graph generate function DSS provide has
saved many bank employee from the boring work of processing data and generating graphs.

### 5.4.3 Better control in risk

Risk control is also a very important application of DSS in bank area. Evaluation of risk is a very important to financial activities. DSS provide a strong support in data collection, processing and analysis, which could generate results with better accuracy. We mentioned in the beginning of this chapter, Credit Risk Management system and Bank Card Risk Analysis System are two widely used systems in China's banks to evaluate the risk in bank card and credit to reduce the risk in business. Transaction control and monitor system is also a type of system provides risk control in banks, it prevents risk during the process of transaction and reduce unnecessary lost. DSS is widely used in China's banks to help to analyze and predict risks.

### 5.5.4 Higher satisfaction from customers and bank staff

With the help of DSS, banks can achieve higher satisfaction from their customers and their staff in different level. After bringing DSS in banks, the efficiency of work in banks have been greatly improved and less time is cost in processing business, which brings higher satisfaction from the customer. Also banks could provide their customers with fast and accurate response, allocate customer’s needs in a more accurate way, those all help in satisfying the customers of a bank. Regarding staff in banks, for higher level staff DSS provides them with the function of processing and analyzing data also generating report, which could save their time and provide a strong support in their decision making process. For normal staff, DSS saves them from the boring work of drawing graph and making reports, which improves the satisfaction from normal staff.

### 5.4.5 Better interpersonal communication

Use of DSS in bank helps improve the interpersonal communication between same level of employees and between managers and employees. DSS could coordinate employee in the same level and improve the communication in their work which could improve the quality of their work, also the interpersonal communication between managers and their employees. With the improving of interpersonal communication, the efficiency of working has been improved greatly, which brings better profit to the bank.

### 5.4.6 Reducing cost

Cost control is also a very important task to banks. If the bank is not quick enough in processing, analyzing data and generating report, it could delay the decision process, which
would result in a higher cost during in financial activities. The application of DSS in bank helps bank staff in making quicker decisions and reducing cost. However, it is not all about speed, as we mentioned in the beginning of this chapter, Ledger Audit System, Asset/Liability Management system and Investment and Trading Analysis System are used by China's banks, those systems are designed to reduce the operational costs for banks and make the cost of operations as small as possible.

5.4.7 Enhancing organization within the bank

The bring in of DSS in banks make the division of labour within a bank clear, and it is easier for staff to obtain business data and improve the efficiency. It is easier for managers to monitor the performance of employees and improves the bank's human management work. The human management work is more efficient and simpler than before. Also DSS enhances understanding of business operations for new managers.

5.4.8 More competitive in market

Banks agree that the application of decision support systems in their bank provides a competitive advantage over those banks do not use DSS or working in the traditional way. DSS makes the effectiveness and efficient of work better, reduce extra cost on time and labour, and provide accurate decision support report. Through CRM system, banks can attract more customers. Using risk management, banks can reduce the non-performing loan rate and improve the security of investment and trading. The application of DSS makes a bank more competitive in financial market.

5.4.9 Learning business rules through DSS

The application of DSS in banks can help bank staff in learning business rules. There are two types of learning bring by DSS. The first type is managers they could learn new concepts from DSS. The second type is that it can bring a better understanding of business fact as well as the process of decision making. This process also enhances the professional quality of staff in bank.

In summary, DSS brings benefits and improvements to the daily work of banks in China. DSS improves their working efficiency and reduce the burden of heavy work, provide fast and accurate decision advice to high level of bank and release normal bank staff from boring work.
5.5 The drawbacks DSS bring

After introduced the improvements brought by DSS, there are also drawbacks of DSS, especially in the biggest developing countries with a labour-intensive industry structure. After research, we found out that we cannot say that DSS is perfect. Nothing is perfect in this world, there are advantages and there are disadvantages. The interesting point here is that there are drawbacks from DSS itself and it is shared by the world. However, some of drawbacks are special since they are not from DSS itself but from the conflicts between labour intensive industry structure and technology which intend to release human labour.

5.5.1 Cognitive biases

First drawback we want to discuss here is cognitive biases, according to Winograd and Flores (1986), "Once a computer system has been installed it is difficult to avoid the assumption that the things it can deal with are the most relevant things for the manager's concern.". Cognitive biases are generated when managers or high level staff could not understand the system appropriately. They may become not as objective as before in decision making. They are led and influenced by the results from system. Normally IT technology is used to encourage rational action, so does decision support technologies. It is designed to encourage decision makers rationalize their actions and support their decision making, not provide cognitive biases and lead the decision maker's decision in the wrong way.

5.5.2 Power transfer and responsibility

Another point needed to be mentioned is power transfer and responsibility. With the building of DSS in those banks, it is perceived as transferring decision authority from staff to a software system. If there is a bad decision, system or the designer of the system would suffer the blame. People may deflect personal responsibility to a system, but what should be notice is that decision support system is an intermediary between the people who built the system and the people who use the system, they are designed to support people making in making decision. People make a bad decision, not system make one. It cannot be ignored that the failure of support may cause by design flaws, but human is the main part of decision. System should not become the excuse for people to escape from their responsibility. It is important to consider how much should human decision maker be involved in the "decision loop".

5.5.3 Lost of ability in making judgment

The journal of ICBC reported that" There is a tendency to accept solutions because 'the computer says so' "after the bring in of DSS and other business intelligence systems. This is an unanticipated consequence. It is trustful that DSS reduces the skill needed to perform a
decision task and make staff gets into the habit of relying on the support systems.

5.5.4 Information overload

Some problems are brought by information overload. Great quantity of information troubles decision makers and many DSS in banks. DSS is designed to manage information for users, conversely some DSS in bank provides too much information makes it harder for higher level staff to make a decision. This actually reduces the efficiency of work. DSS developers need to measure the quantity of information generated by the system.

5.5.5 Design flaws

As we know, most of the DSS used by banks are outsourced and developed by IT companies. It is possible that there are design flaws in the system. The design flaws are caused by many reasons, for example inadequate understanding of the task or user of the system, inadequate modelling of “reality” and inadequate understanding of human information processing constraints.

5.5.6 Conflicts between DSS and Staff

It has been found out that not everybody works in bank welcome DSS, especially senior staff. Many employees showed their concern on the bring in of DSS. We classify them into two groups: normal staff and higher level staff.

(1) Normal staff

We start with normal staff. The normal staff's concern contain two points: the first one is that in traditional way which they get used to, they should examine and verify business data, contact the company manually to get more data they need and generate reports by themselves, then report the data to high level staff for decision. After brought in DSS into banks, the decision support work does not depend on them as it used to be. Some of the employees are not evaluated as important since they are not good at working with IT system or their work can be replaced by systems. They suffer the feeling of frustration and lost. This brings down their working efficiency and could bring a negative impact on the bank.

The other concern is even worse. They are anxious about losing their job. The fact is that China still keeps a labour intensive industry structure because of the huge population. The bring in of new technology is intended to release human labour. However, it brings job losing at the same time. And the conflict between labour intensive industry structure and technology which has a target of release human labour has become even more serious. After bring in new systems into these banks, many employees start to worry about losing their jobs. If their work can be done by IT system, the bank can save a lot of cost on salary. With the concerns and job
losing, management work becomes harder and this brings a huge negative impact on banks.

(2) Higher level staff

What higher level staff concern is that DSS would diminish their status and force them to do clerical work. They are afraid that they may lose their value and authority while facing an intelligence system. Another point of their concern is that DSS may lead to power struggles. People fight over the authority of accessing data, thus spoiling the organizational environment. Sometimes higher level staff may have some personal motives and advocate the development of a particular DSS. But this might harm other people in the bank as a whole since they may lose their job after the bring in of the system.

In summary, although DSS brings a lot of benefit to working of China's banks, the negative aspects still exist. There could be cognitive biases, design flaws in a system, power transfer and responsibility, and conflict with bank staff. Anyhow, it is agreed by most respondents that DSS benefit their bank greatly even if it has some shortcomings.

5.6 Restrictions on the development of DSS

What we want to discuss in this part is the drawback from outside environment. As we had been discussed, DSS makes great effort to the daily work of China's banks. More and more employees start to realize that DSS benefit them in their daily work. However, in our study we realized that there are restrictions to the development of DSS, and in this part we would explain the major restrictions on the development of DSS in China's banks.

5.6.1 Technique restrictions

Technique is the most important restriction we should mention here. DSS was brought into China's banking area in around 2004, later than it was widely served in American's banking industry. Research and development of new techniques still has along way to go.

5.6.2 Immature market

After a long time under planned economy system, market economy system is not mature in China, the market system is still under developing. The trend of financial activities is somehow not stable and hard to predict, this brings difficulty to the developing of knowledge base and model base that DSS need, it is also hard to modelling the activities. Copy the system directly from other developed countries does not work, because of the immature market system and different business rules. It is very important to build DSS which suit this special market well. More spending will be put on since we cannot just build a system according to the experiences from other countries.
5.6.3 Immature Credit system and Bank Industry

Under planned economy system, there is no need of an individual or company credit evaluation system. How to evaluate the credit of individual or company was never a problem for China until the beginning of 1980s. A database to record individual or company's credit information within banks in China is brought in 1990s. And it is quite new. More data and analysis models are still needed to optimize the system. And many functions of DSS is based on the data from the national credit system, the immature of credit evaluation system restrict the development of DSS. Banking industry suffers the same restriction. There is a strong opinion of administration rankings in banks. It should be removed, so that staff can have more freedom within the bank.

5.6.4 Policy trend

Another point to be mentioned here is the trend of policy. As we can see that the government plays an important role in China's economic activities. When the economic is in a bright situation, the policy toward investment and trading will not be so good compared with the worse time, to prevent the economic from getting"over hot". We cannot simply say that the decision making of financial activities has nothing to do with politics. However, every bank is following the policy trend to obtain the highest profit. It makes many DSS serves in this area does not sound as important as it should be. It is also a restriction to the development of DSS in China.

5.7 New techniques of DSS and its application

5.7.1 New techniques and developing trends

(1) Cloud Computing in Bank's DSS

Information and data security has been paid more attention. Security is crucial for banks. Banks face the challenge that they should provide convenient services to the customers as well as improve their own status and credit. For example, credit card fraud: criminals steal customer's credit card account number and password and spend or transfer a large amount of money. Phishing of bank website, e-mail spoofing, Internet trading traps, attack bank website, steal or sniffer customer's account and password. They all make huge losses for customers. Moreover, if the bank server is attacked by the cracker, it does not only interrupt the normal transaction or loss confidential information, but leading systems failure which could cause irreparable damage to the bank. In addition, it is the prerequisite for the normal running of the banking system that data storage is under good reliability and stability. The whole system should consist of high technology, scientific management, convenient maintain, efficient
running, in time backup and reliability.

Cloud Computing is a recommended solution to solve the problems we mentioned in the last paragraph. Cloud Computing has evolved from Distributed Computing, Parallel Computing and Grid Computing. It is also a commercial product. Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources( for example networks, servers, storage, applications, and services)which can be rapidly provisioned and released with minimal management effort or service provider interaction. And the key characteristics of Cloud Computing are agility, cost reasonable, powerful computing and storage capability, security, reliability and scalability.

A. Combine Cloud Computing and Data Mining.

It enhances the bank's data processing capabilities and makes business decisions quickly. Nowadays, the scope of bank business has been enlarged from signal service to integrated. Business model is gradually changed, from distributed processing to centralized management. So the range of data involve is also enlarged. The biggest advantage to combine Cloud Computing with Data Mining is that rapidly extracting valuable data from mass of information can be achieved to support the decision making in banks.

In addition, the application of Data Mining need good calculation ability and storage capacity of IT support platform. Computing in Cloud Computing normally runs in distributed computers and the order of magnitude is TB or even PB. Processing of business data including storage mass data, analysis, processing, mining can be completed in a short time, which could provide scientific, predictable decision-making and technical support.

B. Provide strong support for the bank's growing business data storage.

Because of geometric growth of information and data, it is more difficult to manage business information. The management of business information requires higher reliability and space for data storage. Traditional storage technology cannot satisfy the demands since they increase the network congestion and is limited by the network transmission capacity.

However, Cloud Computing can handle this problem. There are millions servers in the whole systems. Even if one station fails, other servers can rapidly solve the problem within a very short time by cloning technology. Entire data will be copied to the other one and continue the process. For the international banks, if an inevitable disaster happened in one country, the data can be transferred to other country server of the same group. So the data are safely kept.

C. Enhance the security of bank data to prevent variety of virus threats and malicious intrusions.

If the bank uses cloud computing technology, once found an application into the computer, the computer will send this information to the remote server. Meanwhile the server will broadcast this message to other nodes within the group and request the information about this
program. The aim of request is to check whether this program is acknowledged by others computer. If no one knows it, then the main server will send it to the malicious software lab to check and wait for the results. Cloud computing adds more protection mechanisms to ensure the data are foolproof.

In addition, cloud computing vendor has expert who can provide a variety of intrusion detection and intrusion prevention services according to spyware, Trojans, viruses and worms. Furthermore, the use of encryption technology effectively protects the data and the bank network security.

D. Reduce the total cost of banks
The cost includes equipment costs, operation cost, power consumption, room space and the cost of future expansion. With the development of banks, business expands from one region to another one and the number of branch is growing, which will cause the total cost rising. By using cloud computing, it is unnecessary to purchase expensive equipments and cost more. It completely transferred to the cloud computing vendor to improve the efficient of resource utilization.

(2) Intelligence Decision Supporting System

Intelligence Decision Supporting System the type of decision support system combined with Artificial Intelligence, Neuron Network and Expert System. IDSS deal with complex decision problems through logical reasoning. It solves the problems by qualitative analysis, it also contains decision support model to solve the problem of quantitative analysis. The capacity and range of dealing with the problem have been improved greatly.

IDSS has been applied in many businesses of banks such as in Customers Relationship Management and Risk Management. IDSS focus on analysis, knowledge reasoning and learning. It is similar with the way human think and make decisions, which makes system friendly to user. DSS combine with Expert system is the highlight of the IDSS. It enhances its knowledge base by tracing the behaviour of human. Ultimately, IDSS can make simple decision without the help of human.

However, IDSS is still not mature enough to be widely used in every business of banks. In China the period of using DSS in banks is relatively short, the knowledge base and model base could not meeting the demands of covering every business. Especially in risk management, which has many variables needed to be modeled. For example, the American financial crisis cannot be predicted by IDSS, but after the crisis through the machine learning and analysis the phenomenon, data and human behaviour of the crisis, the system could generate a new relational model, which will help predict the similar situation. Neural network and model algorithm are the important direction of IDSS development.
5.7.2 The application of new techniques

(1) Customer Relationship Management

The traditional product-centric models have been gradually diluted and are shifted to customer-centric. Top customers are the target of banks. The competition among banks is quite intense. Thus how to timely and accurately meet the requirement of customer extremely important. For that purpose, the banks should have a comprehensive understanding of customers' information, grasp accurately and response quickly to their needs. CRM is based on the customer information and transaction data. Using information technology, the vast amounts of data in the database can be deeply analyzed to find out the different characteristics and analyze their behaviour. Mining information with commercial value will help banks planning and making better decision. The application of data mining aims to find out implicit, unclear information and it can be used for predicting behaviour and results, which is the basis for decision making.

Nowadays most customers information and transaction data can be obtained from the networks. But the data is distributed and massive. Customers Relationship Management based on Data Warehouse is a good solution. Although some banks systems employ the simulated function software, they are far from a complete system architecture. Data source, Data Warehouse System and CRM Analysis System are the essentials. Especially, CRM analysis system is the kernel of the whole systems. In order to improve the CRM, more information is needed. Information can be collected from customers shopping behaviour, e-mail, even to the telephone service. Traditional data (only focused on the number) is not enough, unstructured information should also be abstracted and analyzed. So there is a high demand on the Database and Data Mining to deal with unstructured information such as query text, picture or voice information. The development of new financial product would be customer-made, which could make the customers feel that the product or service is designed for himself or herself. That is also called one to one personal service. It helps maintain customers and attract new customers.

(2) Risk Management

Risk management is always a tough process for banks. US financial crisis still affects the global financial because Wall Street "abused" the financial derivatives and underestimated the sub prime crisis, it can be concluded as the failure of the risk management. So banks need rules and tools to help them implement the risk management and avoid financial losses. Basel II is a global capital regulatory accord developed by the Basel Committee on Banking Supervision in Basel, Switzerland. On 26th JUN ,2004, central bank governors and the heads of bank supervisory authorities from G10 countries endorsed the publication of a revised framework for bank capital measurement and capital standards. The overriding goal of Basel II is to insure the stability of the global banking system. The primary focus is on managing the risk associated with bank lending activities. DSS will assist the bankers and managers to make
sophisticate reports and make a better decision.

In China, most bank systems are designed by professional IT consultant companies, such as IBM, SAS and so on. IBM is offering a solution to help banks address the information management challenges of Basel II. They build a data warehouse for Credit and Risk systems to improve decision support and internal auditing. "China's business intelligence software market report in the second half of 2009 " shows that many customers trust and choose SAS analysis technology. And the market share of SAS in the advanced analytic software market is 51.7%, increased by 20.8% compared with the time of last year. It can be deduced that most of banks are using DSS to support them. Risk Management includes credit business such as loan, personal credit card, and treasury business.

Risk Management System will be designed in a three layers architecture. Data collection: economic data during the financial operations, and some external data is also needed for operational risk measurement. Abstract and integration of data: system improves data quality by fitting data into suitable models. The last is the analysis of application layer. It provides evaluation and solution to senior managers.
5.8 Summary

After introduced the application of DSS in China's banking area and its improvements, drawbacks, it is better to understand DSS from a whole point of view. As we get from the research, decision support system is not directly known by all people who work in the bank although it does exist and has been widely used in different sections. Sometimes even the users are not aware of these DSS if they are not IT professional. However, DSS still provides a lot of help to the daily work of bank. And decision support system does not replace decision maker, instead the system support decision makers to improve the ability of making decision. The interactions between the decision-makers and computer make it work more effectively than only by a decision-makers or computer, and generate a human-computer co-decision-making environment.
6 Conclusion and Final discussion

In this chapter, we would summarize the results and draw conclusions for this thesis. And evaluate the methods and research process.

6.1 Conclusion

Decision support system does not intend to replace the manual operation, it improves the business process to optimize the management and decision. Through the study and analysis in the former chapters, it is fully demonstrated that DSS is a significant component of bank information systems.

DSS could help banks achieve the goal of scientific management and intelligent decision support. Huge variety amount of information that is meaningless for human becomes the basis resources extracted and analyzed by DSS.

According to the interview that there are nine kinds of system which support the daily work in China's banks: Executive Information System, Asset/Liability Management system (ALM), Credit Risk Management system, Bank Card Risk Analysis System, Ledger Audit System, Investment and Trading Analysis System, Data analysis and predict system, Transaction control and monitor, Customer Relationship Management (CRM). And the nine kinds of system can be concluded the adoption of DSS into three types of applications: Application in investment and trading, Application in insurance and risk control, Application in fixing operation problems. And DSS benefits the work of bank staff from senior executive, managers to front line staff.

According to the research, widespread use of DSS in more businesses within banks is an unavoidable trend. Moreover, with the development and improvement of new technology, the advantages of application DSS in banks become even obvious, which is timeliness, accessibility, quality, and better control of organizational information. Particularly, we have to mention again, DSS does play a powerful role in the risk management of bank, reducing unnecessary loss.

However, there also exists some limitation whatever from the system itself or from the outside element affection. There is still a gap between the human and machine or between theory and reality which is also a challenge for the system designers. Especially when it is not appropriately used, it could lead the decision maker into a wrong way and create conflict between human and machine. Also the limitations from outside create negative influence, for instance techniques and bank industry and economy environment even policy trend.

Regarding the future study and learning, DSS will become much stronger and powerful due to improving the model base and knowledge base. More types of reference will affect the
solutions provided by the decision support system. As the users of system, they should feedback the experiences of using the DSS to the IT sectors to help them update the system and reduce the gap between the human and machine.

6.2 Implications for Informatics

The research questions of the thesis are about Decision Support System and how it is applied in China's banking area. As we discussed in the thesis, the informatics techniques well support the application of the DSS and impact the effectiveness and efficiency of making decisions by the decision makers, reduce the risk of investment and attract more clients, finally maximize the profit.

Information Systems have changed the daily work of people and the process of decision making. It has learned the knowledge and experiences of human, impacts and improves human activities.

With the development of information technology, DSS could become more intelligent while reduce the limitations of the DSS.

6.3 Method Evaluation

In this research, literature study has been carried out before interviews to provide scientific background and theoretical support for empirical research. After the theoretical study, empirical study and data analysis, we agree that the research methods we chose has related the existing theory about DSS with the research questions and generate useful results.

During the research process, the main problem is that most existing literature about Decision Support System is focused on the framework of the system and the hybrid of DSS with other techniques like on-line techniques or artificial intelligence. In the field of application, it is hard to get literature support before we carry out the interviews. This makes the use of hermeneutic important to this research. Another problem is the definition of the decision support system, DSS is a quite broad field which involves different types of system and it is difficult to tell whether a system is DSS or not, we have to define a boundary for the research, finally we decided to follow the concept defined by George M. Marakas in his book Decision Support System in the 21st century: In this research, DSS means the type of system could provide decision support not the type of system only provide decision support. The broaden of concept also widen our research area.

After the reviewed the existed literature in relevant area, we use inductive method to generate our interview questions, and this process help to make sure that the interview questions are strongly related with our research questions and have sufficient theoretical support from the
literature study.

As mentioned in the second chapter, in our research the purpose of theoretical study is to provide a strong scientific background in decision support system. About how DSS is applied in China's banks, we have to get relevant information from interviewing different types of bank staff and system developers, they are the people who have rich experiences with DSS, and the sampling of interviewees have been divided into two procedures as discussed in the second chapter. We carried out semi-structured interviews, we encouraged our interviewees to provide more information under the condition that they would like to. After the interviews, we agree that it is correct to carry out semi-structured interviews since it would keep the interview close to the research questions as well as get more information from interviewees also avoid digress from the subject.

Finally, interview is good way of collect data and it is suitable for our research, we got the data we need to present in our report.

6.4 Result Evaluation

In this part, the evaluation of research results will follow these criterias: Qualities of result presentation, Quality of result and Validity of result and research according to the theory of Larsson(1994).

6.4.1 Qualities of result presentation

In this part, the qualities of result presentation will be evaluate from three aspects: perspective consciousness, internal logic and ethical value

The researcher's own perspective is hard to escape while interprets reality. Perspective consciousness notices the researcher to interpret the result from a scientific perspective. By describing the researcher’s own experience and methods used in the research, researcher's own perspective can be adjusted. And in our research, we describe the authors' own experiences within the research area in chapter 1 and chapter 2.

And the next evaluation content is internal logic which means consistence between the research questions, data collection and analysis. In the literature study part we start with a brief introduce of previous research in this area. Then we introduced decision, process of decision making, DSS and DSS in banks. The introduction of concepts goes forward one by one and we designed the theoretical framework according to the character of knowledge itself and combine the interpret of theory with our research question. And in the empirical result part, we present the interview result from different respondents and the interview was designed according to the research questions. The relationship between theoretical study and
empirical study has been explained in the 2nd chapter, and in our research the theoretical study is mainly the scientific background and theory support to empirical study. Analysis is the part that results from theoretical study and empirical study are concluded, analyzed and presented. Ethical value is the other important aspect to evaluate the results and guide the research with good ethic is very important. In the evaluation of this aspect, the researcher has to notice that the existence of same concepts under different labels. In our research, different concepts have been carefully distinguished to avoid same concepts under different labels. And it is important that all the results are generated from data collected, and we ensure all the results are from the data collected and all the results presented in analysis part have evidences from theory or empirical part. The last point here is that the respondent should be treated in an ethical corrected way, and we have explained about how we deal with ethical issue and make sure our research is carried out in an ethical corrected way in the 2nd chapter and we will not provide detailed information again in this part.

6.4.2 Quality of result

The quality of result will be evaluated from the following criteria: richness of meaning, structure and theory contribution.

Richness of meaning means that integrate different parts of a text to a whole to achieve a comprehensive understanding. And the richness of meaning is a very important aspect to evaluate the quality of research result. In our research, we combine the theory from literature with the results we got from interview and present in the way which could provide readers with a comprehensive understanding of DSS's application situation in China's banks.

Structure is also an aspect to evaluate the quality of results, a good structure is clean and easy for the reader to catch the point they need. And in our thesis, we try to present our work in a clean and simple structure, the main part thesis has been divided into theoretical study part and empirical study part and analysis part, that is easy for readers to catch the point they need. And the structure within each part has been introduced in 6.4.1, we try to keep a clean structure and good logical relationship within each part. It is also important to keep a good balance between the richness of meaning and structure. Although there is a lot of content to present, we try to arrange a suitable structure for each part to achieve a good balance between the richness of meaning and structure.

Theory contribution is the last aspect to evaluate the quality of result, it means that the research able to create value to the existing theory. During the research process, we found out that most of theory within our research area is focus on the introduction of new techniques about DSS and few relevant literature can be found in the area of DSS's application situation especially in a special industry. And we believe our research area is new and special.
6.4.3 Validity of result and research

Validity of result and research is also important in evaluating a research. The validity of result is normally considered from three aspects: the discourse criterion, empirical verification and consistency.

The discourse criterion is the first aspect to evaluate, and it describe is the opinion that the authors hold can be tested by other opinions and has the ability to defend for itself. In our research since our primary results are from interviews, before presenting the results we had compared the results we get from one respondent with the answers from other respondents and also we checked the results with the theories from literature to make a strong argument for our results.

The second aspect to evaluate the validity of result is the empirical verification. Which is the problem of how to make sure the validity of empirical study and does the result we get from interview present the reality. As we claimed in the second and last paragraph, the results we got have been compared with other interview results also we check the results with theories from the literature study and we present it in an original way to show the current situation. And this is how we make sure the validity of results in the empirical part.

And last point to evaluate the validity of result is the consistency. And the evaluation of consistency focus on is that relationship between the whole and each part should be clear and logical. We have already described the inner logical relationship and structure of our paper, and the relationship between each part and the whole has been proved in the former part.

About the validity of research, the theoretical part of this research can achieve a high degree of research validity. However, the research validity is more uncertain when it comes to the empirical part consider about the information is mainly from interviews. As we explained in the second chapter, consider about the validity problem, we have carefully designed our interview to make the validity of the data we collected and the whole research process.

6.5 Possibilities to generalize

This research is based on the literature study and interviews. Since our research topic is the application of DSS in China's banks, interview is our main resource for the research. The interviewees are different levels of staff in the banks and the interview questions cover various aspects, which will make our research comprehensive and professional. This paper provides the basic information for the researchers and students within informatics area and gives suggestion to the relative financial institutions. And it also predicts the future trends of DSS development in banks.
6.6 Suggestions for further research

For future research, we agree DSS will become more useful due to the improvement of model base and knowledge base. More factors will affect the solutions provided by the decision support system. As the users of system, they should feedback the experiences of using the DSS to the IT sectors to help them update the system and reduce the gap between the human and machine. Even the user is not the professional computer expert.
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# Appendix 1

## Interview Question Form

<table>
<thead>
<tr>
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<th>Question</th>
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<tbody>
<tr>
<td>A</td>
<td>Is there has any web based/software system to which could help make decisions in your bank?</td>
</tr>
<tr>
<td>B</td>
<td>Which kind of Decision Support System is that?</td>
</tr>
</tbody>
</table>
| C | What kind of job does the Decision Support System do in your bank? 
   (And please send us all the relevant data you can get)                  |
| D | Does it benefit the bank and it's customer and do you think the work in your bank has been improved by the system? Is there any drawback bring by the system? |
| E | Does the system work well in your bank and how do you evaluate it?       |
University of Borås is a modern university in the city center. We give courses in business administration and informatics, library and information science, fashion and textiles, behavioral sciences and teacher education, engineering and health sciences.

In the School of Business and Informatics (IDA), we have focused on the students' future needs. Therefore we have created programs in which employability is a key word. Subject integration and contextualization are other important concepts. The department has a closeness, both between students and teachers as well as between industry and education.

Our courses in business administration give students the opportunity to learn more about different businesses and governments and how governance and organization of these activities take place. They may also learn about society development and organizations' adaptation to the outside world. They have the opportunity to improve their ability to analyze, develop and control activities, whether they want to engage in auditing, management or marketing.

Among our IT courses, there's always something for those who want to design the future of IT-based communications, analyze the needs and demands on organizations' information to design their content structures, integrating IT and business development, developing their ability to analyze and design business processes or focus on programming and development of good use of IT in enterprises and organizations.

The research in the school is well recognized and oriented towards professionalism as well as design and development. The overall research profile is Business-IT-Services which combine knowledge and skills in informatics as well as in business administration. The research is profession-oriented, which is reflected in the research, in many cases conducted on action research-based grounds, with businesses and government organizations at local, national and international arenas. The research design and professional orientation is manifested also in InnovationLab, which is the department's and university's unit for research-supporting system development.