Business Intelligence: Financial Decision Support System Research Based on Data Warehouse

S.Kannan, K.Pappathi and M.Karnan

Abstract. Business intelligence is defined as a set of mathematical models and analysis methodologies that exploit the available data to generate information and knowledge useable for complex decision-making process.Business Intelligence(BI) is about getting the right information,to right decition makers,at the right time.To resolve the heterogeneous distribution of data sources of financial business and provide financial decision-making with information support, based on the studies of data warehouse technology and decision support system,the author designed the support system of financial decision-making on the basis of data warehouse applying to Jiangxi Province's finance,which includes the overall planning of system and the key technologies of achieving the system.Practice has proved that the financial decision-making system based on the data warehouse provides powerfull support for varying out analysis of financial forecasts and policy research .In addition, The adoption of compass instrument design philosophy in displaying data shows some reference of realistic sense for financial inctitutions at all levels to build decision system..

Index Terms— Business Intelligence, Data Mining, Data Warehousing, Online Analytical Processing, Knowledge Management and Financial System.

1 INTRODUCTION

With the deepening of the integrated construction of national monetary and financial project, the continuous refinement of financial business applications, such as budget of financial department at all levels, treasury centralized payment, non-tax income, government procurement and so on, the rapid growth of the business processing capacity and data storage capacity, in particular, the propulsion and implementation of bank networking of financial taxation warehouse and data exchange, for the analysis and decision of financial comprehensive information provides large-scale distributed data resources. It is of vital practical significance to study how to extract information from these distributed, mass and rapidly varied financial data resources to provide decision support on some aspects, such as revenue and expenditure analysis, performance evaluation, financial supervision, and economic forecasting and so on, to government decision-maker at all levels. BI as a discipline is made up of several related activities, including data mining, online analytical processing, querying and reporting. BI combines products, technology, and methods to organize key information that management needs to improve profit and performance. More broadly, we think of BI as business information and business analyses within the context of key business processes that lead to decisions and actions and that result in improved business performance.

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Data Warehouse (Data Warehouse, DW) technology, developed from the traditional database, is one of hot spots in information processing technology of modern computer system and injects a new vitality to the development of decision support system. Compared to the traditional database which organizes data towards OLTP, the data of data warehouse is featured being subject-oriented, integrated, constantly changeable and nonvolatile. Its main functions are to separate desired information for decision from the original business operation data, transform scattered and lowly used information into centralized, unified and momentarily usable information, and improve the speed and efficiency of accessing and processing data [2]. The paper studies how to realize financial decision support system on the basis of data warehouse through the analysis of the financial business of Jiangxi Province.

2 LITERATURE REVIEW

2.1 Overall Planning of System

According to the analysis of data characteristic and decision support demand of financial business of Jiangxi province, as showed in Figuare.1, system's overall planning mainly includes leader query, forecasts of economic situation and financial revenue and expenditure, supervision Planning and design of financial decision support system. Among them, the leader query is used to offer the leader important fiscal and financial data to make query and analysis so as to track the situation of budget implementation and financial transactions. It consists of basic data and queries about finance, state-owned assets, wage, funds usage situation, centralized payment, rendering accounts, bill, and financial index, etc.The analysis and forecast of economic situation and financial revenue and ex-

penditure is to establish the analysis and forecast model of financial revenue and expenditure and the macroeconomic forecast model mainly on the basis of financial data and by synthesizing national and provincial macroeconomic data to provide foundation for budgeting, expenditure management and policy-making. It includes data management; data query, report customizing, statistical analysis, model base, economic early warning, and forecast application, etc.Financial supervision system is to make every financial working situation enter into the financial supervision field in time to ensure the stability and security of financial work.

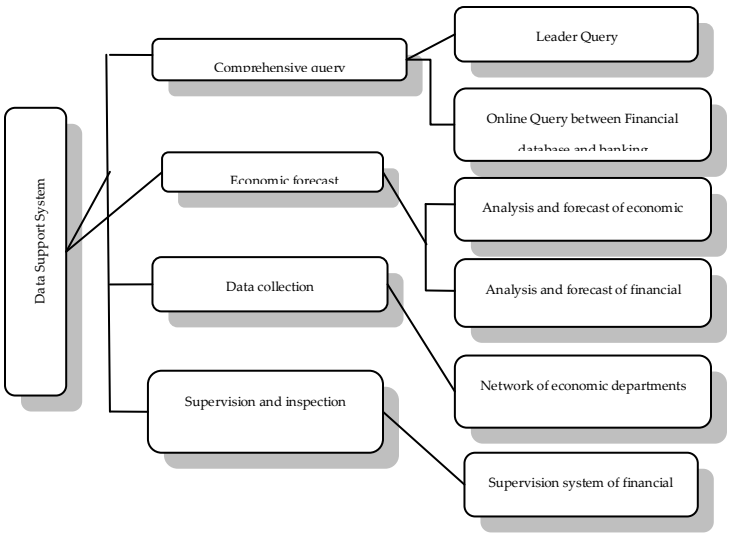

Figure1.Planning and design of financial decision support system.

It is made up of supervisions on budgeting, budget implementation, financial revenue and expenditure management, transfer payment, government procurement, government accounting management, internal financial management and account management etc.Economic departments networking is to set up channels of information acquisition between economic departments and finance through technical means so that financial departments can promptly and fully obtain the situation of the economic development of the whole province. It contains interface configuration, data encryption, data acquisition, data exchange, data synchronization and log and statistics and so on.

3. KEY TECHNOLOGIES

3.1 Data Architecture

At present, the data of monetary and financial project come from all the business data of all budget departments, financial departments at all levels and budget units in the same level and the external data which shared among "the monetary and financial project", finance at all levels, tax base bank and other "monetary and financial projects". Most of business systems use Oracle relational database. However, other related departments may use different data storage methods (e.g. local tax departments use the Sybase database). Furthermore, other semi-structured data sources (e.g. Domino, XML, HTML documents)exist in the actual system, as well as unstructured data sources (e.g. ordinary text files)[1]. Therefore, the data warehouse and decision support system designed should be able to provide support to heterogeneous data sources in order to achieve extraction, transformation, loading and comprehensive analysis of different types of data. To embody the management idea of mass concentration of data and provide prompt, accurate and comprehensive data support to financial decision, data architecture of decision support system adopts the model of regarding "basic data standard of financial business" as a standard and centrally storing the data of budget departments, financial departments at all levels and budget units in the same level as well as the external data.

As is shown in Figure.2, data are divided into provincial data areas and local detailed data areas in accordance with the source and classification of financial business data. Provincial data areas include aggregation data as well as the detailed data of province and budget department, such as local aggregation data, budget departments' aggregation data, budget units' aggregation data, etc. Local detailed data areas mainly refer to the detailed business data of budget units of cities, counties and townships. Moreover, according to financial covered business, these detailed and aggregation data can be classified into budgeting data, budget implementation data, accounting, final account and financial data etc.Storage of these data supports the physical and logical storage in separate rooms and management. Therefore, all kinds of data can be managed through building standard database of basic data of financial business, aggregation database, detailed database and business classification database etc. and the data can be queried and maintained to meet the needs of tracking and analysis of financial information by using some system tools like data mining, data drill-down, data analysis etc.

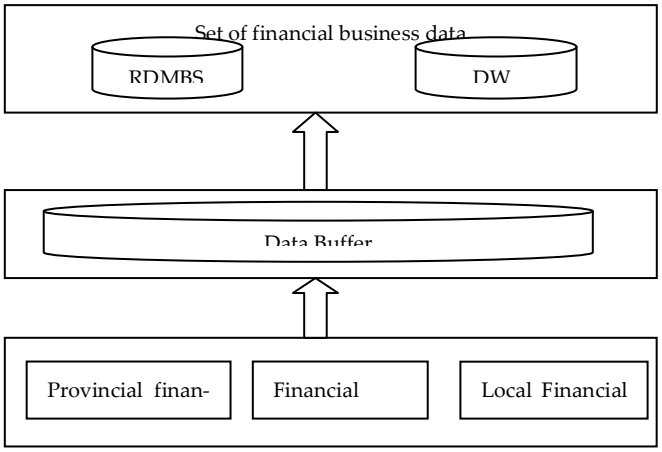

Figure 2. Data extraction model of financial business support system

3.2 ETL Design

Data extraction is the entrance of warehouse. In order to ensure that business data of financial departments at all levels

and budget units safely and stably extract the central data node, it is needed to extract financial and economic data. ETL design process includes data extraction, data conversion and data loading, as shown in Figure.3.Data Extraction is to extract the required data of data warehouse system from the data source system. According to different platforms, source data formats, business systems under performance requirements and source data of different data quantity, different interface ways may be used[3]. To ensure extraction efficiency and reduce impact on normal business processing, the principle "segmenting data and shortening extraction cycle" is applied in the extraction of large data amount, while, for the direct database extraction, the way of negotiation interface tables is adopted to assure the security of production system database. The commonly used methods of data extraction consist of static data extraction, extraction through transaction log, extraction through trigger, extraction based on time marker and extraction through document comparison. In view of the different properties of source data, data extraction should be chosen accordingly. For the distributed Oracle or Sybase relational database etc, we should adopt the method of extracting data through transaction log. While for the other semi-structured or unstructured data, we choose static data, time marker, document comparison or other methods to extract data [4].

Data Conversion is to convert, tidy up, take apart and collect the source data extracted in accordance with the requirements of data warehouse system model in order to ensure the consistency and integrity of data and information model from different systems and formats, and to put these data into data warehouse as required.[5].Conversion can be divided into two steps: first, convert the collected data to financial and economic database; second, convert these data from financial and economic database to data warehouse to achieve analysis and display of financial and economic information.

Data loading is to load the converted data into the data warehouse. Data loading tools or API programming can be used for data loading. The strategies of data loading include loading cycle strategy and additional data strategy. The data loading adopts the way of carrying on functional package for ETL tools, Data Stage, and providing monitoring and scheduler interface to the upper. The requirements of business analysis and the cost of systems loading should be fully considered when dealing with data loading cycle. The data of different business systems should adopt different loading cycle. Furthermore, it is necessary to maintain the integrity and consistency of business data in the same period.

4. ESTABLISHING DATA WAREHOUSE

The core of decision support system is to establish financial and economic data warehouse, which is the important means to analyze and use the centralized financial data. The establishment of data warehouse should start from the reality of financial business. In addition to meet the technical standards, the following factors should be considered for its establishment:

4.1 Subject Determination

In view of the changeable decision and analysis requirement, the data storage of data warehouse must adopt the way of the subject and use the business units as small possible to meet the needs of the flexibility of data warehouse. In addition, every information system should embody the characteristics of integrity, structure, hierarchy, relativity and variability. The design of the objective logicalstructure of data warehouse should reflect the above features.

For example, the municipal financial operations can be divided into eight categories in accordance with the different subjects: region, account, asset, income, expenditure, budget, accounting, settlement. Among them, the income subject contains the basic information related to financial funds, such as funds properties, budget units, and funds sources and so on. The account subject includes the costs information associated with the customers, such as detailed bills, comprehensive bills, account books, accounts, payment records, canceling debts in flow construction and so on. The settlement subject consists of settlement lists, detailed bills and cooperation service suppliers etc. Star structure can be used in establishing the subject model, which is made up of the fact table or a summary table added the related dimension table.

4.2 Definition and Management of Multimedia

. Metadata, as an important resource in data warehouse, describes the data and environment in data warehouse and plays a significant role in designing, management and operation of data warehouse. Metadata meaning is correspondent to the level of knowledge management. Metadata database is used to store data model and define data structures, transformation rules, data warehouse structures, and control information etc.

The definition of metadata generally includes the data source information (e.g. the cost model of query processing), the data information (e.g. the model of source data), the type of data warehouse, the update frequency and the average updated capacity etc. After defining metadata, it is necessary to manage the changes of metadata. System must track the changes of data source under heterogeneous and distributed environment and sent these changes to metadata database. Data warehouse tools can be used to analyze these changes and put them into the data warehouse. For example, if the model definition of a data source changes, source data of data warehouse and the image of table or cube from source data to data warehouse in this model will also change. Likewise, the changes of query frequency and query priority will make the metadata in database warehouse change accordingly.

4.3 Dimensions Design

The original data table is generally unable to organize or browse data dynamically from several angles. However, OLAP method (Online Analytical Processing) or DM method (Data Mining) etc. can meet the needs of multi-dimensional analysis of data. These methods can analyze all dimensions involved in the issues, determine the needed dimensions and variables in view of each subject, then define the relationship model for each subject and finally form a star structure. On this basis, multi-dimensional table is generated and multi-dimensional database is established [6].Dimensions involved in the financial decision and analysis mainly includes time dimensions, account dimensions, region dimensions, work unit dimensions, target dimension, department dimension, economic subject dimensions and data source dimensions etc. For example, if the amount of a subject of a work unit in a day is queried, the dimensions refer to the time, the work unit and the subject. And the amount, which may be displayed in a way of a string after formatting the expenditure and balance, means index or measure value. Of course, it is feasible to design a new "report type" dimension, which will naturally treat "expenditure", "balance" and "money for planning to spend" as dimensions.

5. ANALYSIS AND DISPLAY OF DATA

After building a data warehouse, OLAP analysis tools can be used to establish the analysis and predication model of financial revenue and expenditure, the financial monitoring and early warning models, the policy analysis model, the macroeconomic forecasting model, the macroeconomic prosperity and monitoring model. By means of these means, users can scientifically and comprehensively track the fluctuation factors of macro-economy and financial revenue and expenditure, reasonably control the debt scale and provide auxiliary reference to the government's decision on financial budgeting, expenditure management and policy adjustment. For example, expenditure analysis model can analyze the usage, scale, character and fluctuation of expenditure funds and the distribution of expenditure funds of regions, work units and departments etc. Assets analysis model, which contains assets' acquisition situation, assets' income structure and the analyses of assets' discount situation, risk weight of foreign investment and assets' fluidity, can be conductive to fully monitoring and managing the assets [7].

Data display primarily supplies the needed platform to economic analysis. In the financial decision support system of Jiangxi Province, we have adopted a decision instrument panel, which provide the unified access interface of statistics, analysis and query. As shown in Figure 4: an effect diagram of decision instrument panel shows the statistics of non-tax revenue, the statistics of financial revenue paid and the statistics of accounting at all levels and different types of users can pick the information in view of their needs.

Compared to the data display of traditional decision support system, it has the following advantages:

First, the traditional decision support depends mainly on a series of report forms to convey. These report forms are independent although they have been correlated. Therefore, it is difficult for the decision-maker to find their profound implication [8]. However the decision instrument panel puts indexes which concern the users mostly in an interface and show intuitive figures and enable the users to quickly identify problems, and thus the timeliness and accuracy of the decision can be improved.

Secondly, the different departments are often concerned about different contents. For example, the leaders of provincial finance department are more concerned about the overall situation of financial balance, while business offices are more concerned about their own parts. The traditional system has to make different statements for different people.

However, the pages of decision instrument panel can be customized by the users. Even if different users enter into the same page, they can find out different information which they are concerned about from the same display contents.

Data mining involves discovering various patterns, generalizations, regularities and rules in data resources

(Hauke, Owoc, & Pondel, 2003; Kantardzic, 2002; Poul, Gautman, & Balint, 2003) [12, 23]. Knowledge resulting

from data mining may be utilized in two dimensions, i.e.

- To predict (prediction), and
- To describe (description) reality.

Prediction involves using already known variables to predict future.

6. CONCLUSION

Data warehouse technology supplies an effective and feasible systematic solution to research and development of decision analysis system. This paper introduces the realization process of financial decision support system based on the data warehouse applied to the financial business of Jiangxi Province.Practice has proved: With data warehouse technology, it is possible to provide powerful support to forecast analysis and policy research of financial economy by establishing the centralized data-processing model of "province - city - county and township" and make financial business data a standard, uniform and highly shared data warehouse according to the subject, on this basis, analyzing and mining the scale, composition, distribution, development speed, average level and balance level of things (e.g. financial expenditure, financial revenue) and other characteristics, growing change rules, development trend, relationship and strength between the things (e.g. GDP and non-tax income), scale proportionality of things (e.g. financial expenditure, financial revenue) etc, and establishing reliable and user-friendly data display platform. Therefore, finance management modernization can be achieved.

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REFERENCE

[1] Gao Hongshen. Theory, method and case of decision support system Gao Hongshen. Theory, method and case of decision support system Beijing: Tsinghua University Press, 2001

[2] Chi Taiwei. Design and implementation of data warehouse structure Beijing: Publishing House of Electronics Industry, 2005.

[3] Liu Hongtao & Cheng Lianglun. Research and realization of decision support system based on J2EE power marketing [J], Computer Engineering and Applications; 2008, 44 (15): 218-220.

[4] Chen Jun. Design and realization of decision support system based on data warehouse [J]. Computer Engineering and Design, 2008,10(29):5280-5283.

[5] Liu Hongwei & Xie Weixin. Design and Research of investment decision support system based on data warehouse [J]. Microelectronics and Computer, 2008, 23(2):36-38.

[6] Lu Changhui, Liu Qingbao and Deng Su etc. Problems and countermeasures of dimensions aggregation [J]. Journal of National University of Defense Technology, 2006, 28(4):84-87.

[7] Li Rui. Design and realization of life-insurance decision support system based on data warehouse. Modern Electronics Technique. 2006/19.

[8] Yang Hui & Liang Changyong. A kind of improved data warehouse model [J]. Journal of Hefei University of Technology: Natural Science Edition, 2006,29(8):955-957.

[9] Henderson, J., and Venkatraman, N., "Strategic Alignment: A Model for Organizational Transformation via Information Technology," Center for Information Systems Research, Sloan School of Management, Massachusetts Institute of Technology, CISR WP No. 217, November 1990.

[10] Olszak, C. M., & Ziemba, E. Business intelligence systems as a new generation of decision support systems. Proceedings of PISTA 2004, International Conference on Politics and Information Systems: Technologies and Applications. Orlando: The International Institute of Informatics and Systemics. 2004

[11] Makridakis S., Wheelwright S., McGee V. Forecasting: Methods and Applications. Wiley-Hamilton. 1983

[12] Malone T., Crowston K., Herman A. Organizing Business Knowledge: The MIT Process Handbook. The MIT Press.2003

[13] Snapper J. Responsibility for computer-based decisions in health care. 1998

[14] Winston W., Venkataramanan M. Introduction to Mathematical Programming: Applications and Algorithms.Duxbury Press. 2002

[15] Anscombe F. Graphs in statistical analysis. The American Statistician, 195–199,1973

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