Acta Technica *62* (2017), No. 5B, 755–766

Design and development of data warehouse system for vehicle equipment

Cong Ren[1,2], Rui-chang Wu[1,3]

Abstract. With the extensive use of computer management system in equipment inventory management, the efficiency of inventory management had been greatly improved. Due to the analysis of the inventory information and the degree of lack of mining and other reasons, resulting in the current inventory management information system mostly remain in the basic transaction processing stage, which can not provide accurate auxiliary decision-making function, in view of this, for the military vehicle equipment warehouse business needs , Based on SQL Server2008 platform for vehicle equipment data warehouse (QCDW) for the physical realization of the creation of vehicle equipment data warehouse, and on this basis for vehicle equipment inventory multi-dimensional data browsing, analysis results can be used as inventory management to provide decision-making basis.

Key words. Vehicle equipment warehouse, Data warehouse, Data mining, Inventory decision support.

1. Introduction

With the continuous improvement and maturity of the vehicle equipment system, the variety and the number of inventory equipment has a sharp increase, so equipment management data is very large, manual management model has been unable to meet the management information, process standardization, data standardization and transmission network needs.As a result, inventory management information systems are widely used throughout the military. However, at present our vehicle equipment warehouse inventory management information system mostly remain in the basic transaction processing stage, can not provide enough decision support function. At the same time, the face of inventory management in the existence of

[1]Workshop 1 - Institute of Medical Equipment, Academy of Military Medical Science, Tianjin, 300161, China

[2]Workshop 2 - Department of Military Vehicle, Military Transportation College,Tianjin, 300161,China

[3]Corresponding author: Rui-chang Wu; e-mail: majie.19850520@163.com

a large number of past data, can not achieve its effective use [1]. Based on this, this paper attempts to use the data warehouse technology, which integrates data analysis , mining and auxiliary decision function, to develop and design the data warehouse of vehicle equipment, realized the effective mining and utilization of long-term accumulation of inventory data, realized the founction of demand forecasting and decision function, so the management efficiency and level of vehicle equipment warehouse could be enhanced effectively.

2. Data Warehouse Technology Overview

2.1. Data Warehouse

The Data Warehouse (DW) was proposed by WHInmon in 1992, noting that the data warehouse is essentially a set of data at different times that has a stable, integrated, and subject-oriented feature ,it also can be used to assist the manager Decision-making issues in management [2]. Data warehouse for data aggregation technology, by extracting the data from different data sources, through the data processing will be stored in the built-in database, the use of user-oriented data access tools to provide users with coordinated, unified integrated information environment, To help users achieve decision support and in-depth comprehensive analysis. At present, the research on the hotspot in the field of data warehouse is mainly related to the research of real-time data warehouse, including two main research branches based on EAI and ETL.

Data warehouses are generally subject to the theme, integration, time-varying and other different from the application of the database is a significant feature, its composition generally contains data sources, data storage and management, online analytical processing (referred to as OLAP) Server and front-end application analysis tools a total of four parts [3]. (As shown in Figure 1)

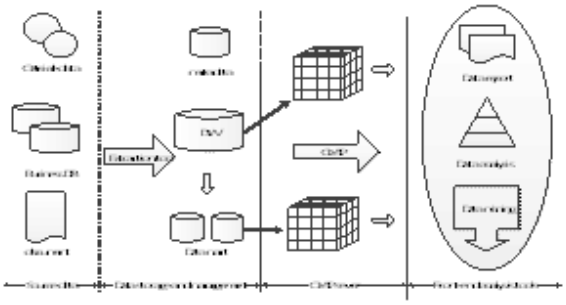

Fig. 1. Structure of data warehouse system

2.2. OLAP Technology

OLAP can conduct online data access, processing and analysis of content on specific topics [5]and provide the results to the user in a visual form. It is generally

multidimensional, comprehensible, interactive, fast and other four characteristics [4].

The basic OLAP architecture is shown in Figure 2, and the data organization in OLAP plays an important role in the efficiency and flexibility of the analysis. [5]Efficiency and flexibility are also important indicators of OLAP technology.

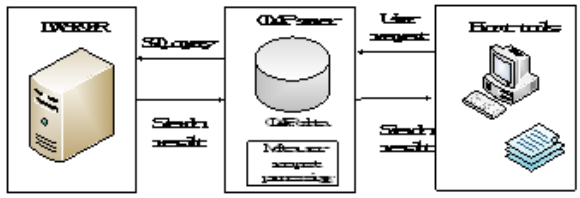

Fig. 2. Architecture of OLAP

2.3. Multidimensional data model

OLAP is based on a multidimensional data model, and the corresponding operation object is called a multidimensional data set, the data cube (CUBE), which is usually defined in the form of data dimensions and fact tables [6].

Multidimensional data sets are generally expressed in the form of multidimensional arrays, and are a data representation of integrated data dimensions and variables [9]. Its structure as shown in Figure 3.

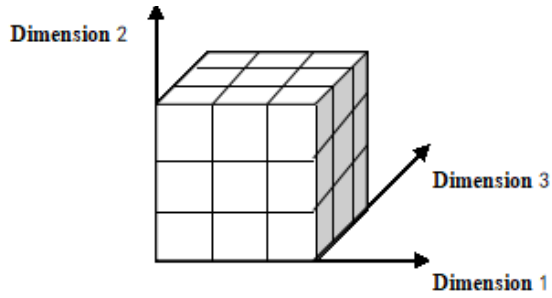

Fig. 3. Multidimensional data cube

3. Design and Establishment of Data Warehouse for Vehicle Equipment

The design and establishment of vehicle equipment data warehouse mainly covers the main parts of vehicle equipment warehouse data source analysis, data warehouse logic model, conceptual model and physical model design, ETL operation of data and realization of data warehouse.

3.1. The Construction Mode of Data Warehouse of Vehicle Equipment and Analysis of Data Source Structure

The central idea of designing the data warehouse is the actual business and demand, and driven by existing data [10]. That is, around the actual business needs, to determine the data warehouse system system and the overall framework, and on the basis of existing data sources, from the existing operational business data to design.

Data warehouse construction model is generally divided into two kinds, respectively, from top to bottom of the construction model and bottom-up construction model[11]. According to the actual situation of vehicle equipment management, the data between each business part is relatively uniform, so it can be used to develop a data warehouse with a high degree of data specification and a relatively fast and effective application in the top-down construction mode of each department.

According to the warehouse to complete a variety of business data, warehouse information data, equipment storage data, equipment out of the library data, equipment demand data system management, and the use of the established data warehouse for the DSS to provide a single, centralized and rich Data sources, This will greatly improve the response speed of the decision-making system and enhance the integrity and security of the data.

3.2. Conceptual Model Design of Vehicle Warehouse Data Warehouse

The design process of the data warehouse includes the design of the conceptual model, the logical model and the physical model.

3.2.1 Create a package diagram

The package diagram contains three target objects:metrics, dimensions, and categories[12]. The various dimensions of vehicle equipment inventory are determined, including the information dimension of the equipment, the storage time dimension, the demand dimension of the equipment, the information dimension of the warehouse and so on. It can be drawn the equipment inventory analysis package chart, in the form of a table to show, as shown in Table 1.

Table 1. Data Warehouse Package Chart

Packet diagram: inventory analysis					
Dimension	Equipment information dimension	Storage time dimension	Equipment order dimension	Equipment demand dimension	Warehouse information dimension
Category	Name of equipment	year	Order amount	Demand unit	Warehouse number
	Equipment category	Quarterly	Ordering method	required quantity	Area number
	Equipment out of the library price	month		Demand type	Cargo number
	Equipment storage price	week			

3.2.2 Conceptual Model Design Based on Subject omain

According to the business scope of the warehouse, according to the warehouse subject domain structure, which includes the theme of the subject, the theme of demand, equipment theme, inventory theme of the four subject domain, each subject domain contains the main key indicators within its theme, the logical structure of the relationship is as shown in Figure 4.

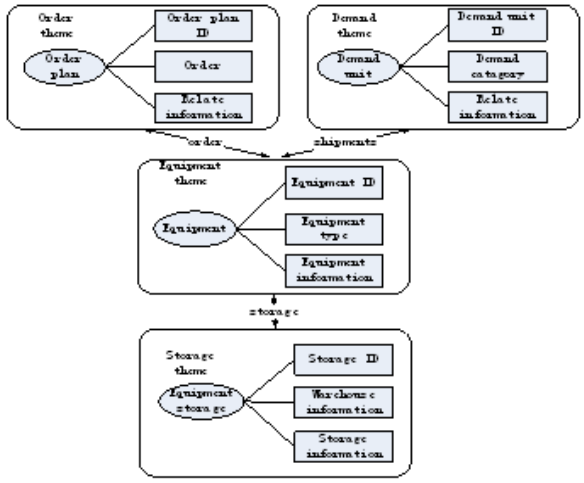

Fig. 4. Topic domain design

From the Figure 4,it can be seen that by applying the method of dividing the subject boundary to the relational model, the division of the subject domain and the data table in the transactional database are combined to obtain the initial conceptual model. In the above topics: vehicle equipment topics may include vehicle equipment table, supply relationship table, demand relationship table, warehouse relationship table and other relations table; equipment warehouse theme may contain warehouse table, warehouse relationship table, warehouse management relationship

table. Connect the keys of these tables to the fields and get the conceptual model shown in Figure 5.

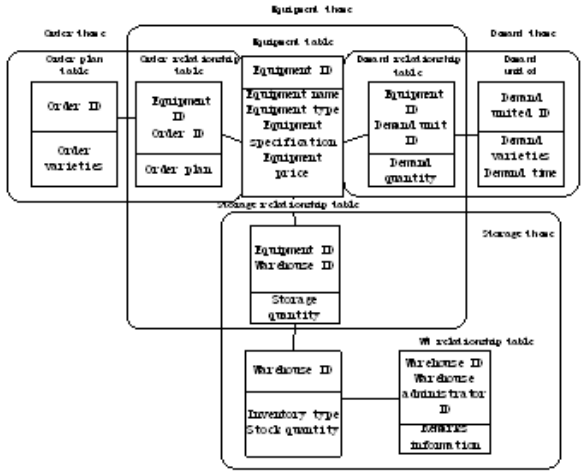

Fig. 5. Data Warehouse Concept Model

3.3. Design of Logical Model for Vehicle Warehouse Data Warehouse

3.3.1 According to the demand analysis and packet diagram design star chart

In order to meet the overall design requirements of the subject-oriented data warehouse, the star chart supports managers to define data entities from their own perspective for conceptual purposes. The star chart is usually made up of three logical entities, that is, indicators, respectively, corresponding to the object in the packet map. The star chart structure shown in Figure 6.

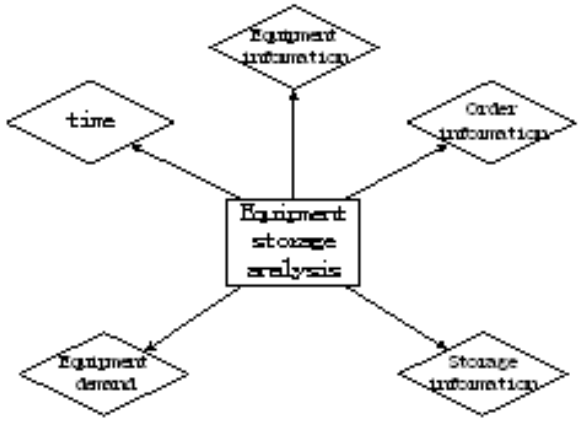

Fig. 6. Star chart design

It can be seen from Figure 6 that the structure of the star schema is actually a

relational data structure, using the fact table and several dimensions to support the data needed for decision making. In the middle of the star chart is the fact table, used to analyze the theme, located in the star is a dimension table, used to describe the relevant attributes. The fact table generally contains specific event data, such as the total amount of equipment demand for the year and the total amount of equipment orders and other data, the new data will be constantly added.

3.3.2 Logical model design

According to the inventory requirement analysis of the vehicle equipment warehouse, the corresponding data granularity is designed, and the final logic model is obtained, as shown in figure 7.

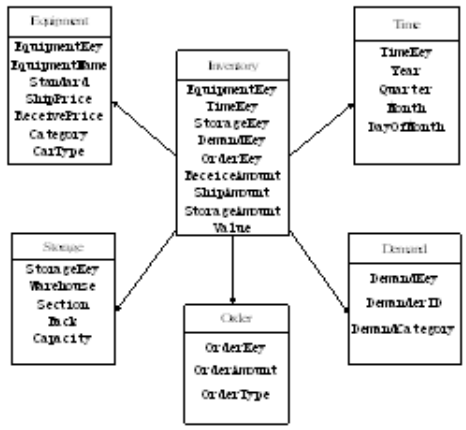

Fig. 7. Data warehouse logical model

3.4. Physical model design of vehicle equipment data warehouse

The design model of data warehouse physical model is similar to that of traditional database design. It is usually considered as the realization process of logical model in computer system. In designing a physical model of a data warehouse, factors that should be measured include access speed, storage space, and maintenance costs.

3.4.1 Physical storage structure design

The vehicle equipment data warehouse design process, the great fact table is divided into different areas of storage; for dimension tables, the relative amount of data record is not too much, so the centralized storage, in table space to accelerate the speed of data access.

In the design of storage structure, some tables that need to be connected frequently should not be placed in the same storage device, but the parallel operation of different storage devices should be used to speed up the data access. As for the details that can be shared by the entire organization, data should be placed on a

centralized server to improve the access efficiency of shared data.

3.4.2 Index design

Data warehouse system has a large amount of data in most cases, so it is necessary to design data index and optimize it to improve the access speed of data. The data warehouse is the theme of "inventory analysis", the huge amount of data storage, but the data update is slow, usually by regular import data form, so in order to improve the data warehouse access and query efficiency, can design more complex indexing strategies. When building a data index, you can add it from the high to the low depending on the frequency of the index. Until you add an index, the data is loaded or the time of the reorganization table is too long, and then the index is added.

3.5. ETL operations and transfers of data

By constructing the three tier model of data warehouse, we can determine the general structure of each dimension table and fact table. Next, the operational data in the vehicle equipment management information system should be summarized, processed and imported into each dimension table and the fact table.

ETL extracts data from the data sources in the appendix, converts the data, and loads the data into the data warehouse to generate fill data as shown in table 2.

Table 2. TIME dimensions

TimeKey	Year	Quarter	Month	DayOfMonth
1	2015	2	5	2
2	2015	2	5	5
3	2015	3	7	1
4	2015	3	8	1
5	2015	3	9	1
6	2015	4	11	1
7	2015	4	11	18
8	2015	4	12	1

3.6. Establishment of data warehouse QCDW for vehicle equipment

This article uses the SQL Server Microsoft Server QCWS Business Intelli- gence Studio to provide the vehicle data warehouse data warehouse creation and access.Firstly, Creating a data warehouse dimension table. The database contains six data tables, tables and other related data.Then Defining a cube.In solution explorer, select new cube commands, use an existing table, set the "Inventory" as a measure of value, also namely fact table.Finally,Select all five dimension tables listed in the interface, and confirm to build the cube.

4. Browse the QCDW cube

For example, you can analyze the inventory data of the A warehouse by multidimensional browsing.

(1) analysis of A warehouse location in each season storage case selection for field Category, select the column field for the Rack (goods) select summary details field for the Storage Amount (inventory), you can get the goods in different season equipment stock number, as shown in table 3.

Table 3. The number of each quarter of different goods inventory browsing

	Rack							
	1001	**1002**	**2001**	**2002**	**2003**	**3001**	**3002**	**Total**
Quarter	**Storage Amount**	**Storage Amount**	**Storage Amount**	**Storage Amount**	**Storage Amount**	**Storage Amount**	**Storage Amount**	**Storage Amount**
2		16	50	10				76
3		275	45	25	200	18	50	613
4	35	15			20			70
Total	35	306	95	35	220	18	50	759

(2) A analysis of different classification categories of equipment in the warehouse storage and the value of each location, select the row field for Category (equipment classification), select the column field for the Rack (goods) select summary details field for the Storage Amount (inventory), can get different types of equipment in the number of different location inventory as shown in table 4:

Table 4. Various types of equipment in different location inventory browsing

	Rack															
	1001		1002		2001		2002		2003		3001		3002		Total	
Category	Storage Amount	Value	Storage Amount	Value	Storage Amount	Value	Storage Amount	Value	Storage Amount	Value	Storage Amount	Value	Storage Amount	Value	Storage Amount	Value
I	22	32	16	250 276.3	45	1665			20	90000					81	3419 41.3
II	10	35120	75	4125			35	2755							120	42000
III	25	500	215	4085	50	2300			200	2200	18	63000	50	4475	558	76560
Total	35	35620	306	2584 86.3	95	3965	35	2755	220	92200	18	63000	50	4475	759	4605 01.3

(3) A analysis of each unit needs warehouse shipments in each month, select the row field to Demander ID (demand unit number), select the column field for the Month (month), select the summary details field is Ship Amount (the number of shipments), can be obtained for each unit in the warehouse for the number of different months of equipment delivery, as shown in table 5:

Table 5. Shipments of units in different units in different units

	Month						
	5	7	8	9	11	12	Total
Demander ID	Ship Amount	Ship Amount	Ship Amount	Ship Amount	Ship Amount	Ship Amount	Ship Amount
001	35	100		50	11		196
002	15	20	160		12		207
003			80		11		91
004				20			20
005				35	10	15	60
Total	50	120	240	105	44	15	574

(4) analysis of various models of the equipment in the storage capacity of different location, select the row field is Car Type (equipment models), select the column field for the Rack (goods) select summary details field for the Receive Amount (in number), each storage warehouse can be obtained for different vehicle type the number of storage equipment, such as shown in table 6.

Table 6. Different types of equipment in the storage capacity of each storage browsing

	Rack							
	1001	1002	2001	2002	2003	3001	3002	Total
Car Type	Receive Amount	Receive Amount	Receive Amount	Receive Amount	Receive Amount	Receive Amount	Receive Amount	Receive Amount
EQ1090E	27	72	35		10	12	35	164
CA1090		162	15	25	100			302
Total	27	234	50	25	110	12	35	493

As can be seen from the examples above, the use of the view tool for QCDW cube set analysis,it can be come true for multi-levei,multi-angle analysis of mineng inventory data,while saving labor costs to greatly improve the prediction accuracy.

5. Conclusion

This paper respectively designs the data warehouse concept model, logical model and physical model, created by this way the vehicle equipment data warehouse, and through the SQL Server2008 provides a platform for the realization of the physical vehicle equipment, create a QCDW of data warehouse, and on the basis of multi-dimensional data browsing vehicle equipment inventory.In view of the fact that the verification data in the model comes from the early database of the army,there are some shortcomings such as lack of data timeliness and deviation,and the next step is to further evaluate and supplement the data source.

References

[1] J. S. Tomar, D. C. Gupta, N. C. Jain: *Whinston: Foundations of Decision Support Systems.* New York: Academic Press *15* (1984), No. 2, 211–220.

[2] J. S. Tomar, A. K. Gupta: *InterMine: a flexible data warehouse system for the integration and analysis of heterogeneous biological data.* Bioinformatics *98* (1985), No. 2, 257–262.

[3] R. H. Gutierrez, P. A. A. Laura: *Data warehouse design approaches from social media: review and comparison.* Social Network Analysis & Mining *18* (1985), No. 3, 171–180.

[4] R. P. Singh, S. K. Jain: *Model Decomposition Speeds Distribution Centre Design.* Operation Research *7* (2004), No. 1, 41–52.

[5] M. N. Gaikwad, K. C. Deshmukh: *Decision support in construction equipment management using anonparametric outlier mining algorithm.* Expert Systems with Applications *29* (2005), No. 9, 797–804.

[6] S. Chakraverty, R. Jindal, V. K. Agarwal: *Analyzing the solutions of DEA through information visualization and data miningtechniques.* SmartDEA framework. Expert Systems withApplieations *12* (2005) 521–528.

Received November 16, 2017