Study and Realization of Supplier Business Intelligence System for Chain Supermarket

Hong Xue, Peiyuan Guo, Huiyan Zhang, Binbin Kang

College of Computer and Information Engineering

Beijing Technology and Business University

Beijing, China

e-mail: hongxue6@yahoo.com.cn

Abstract—With the supplier data of supermarket, the business intelligence system was developed. The paper made use of data guiding into and guiding out service tool of Microsoft SQL Server 2005 as ETL tool. A mass of data needed for analyzing and decision-making were separated from affair database by taking out, transition, cleanout, loading. The data warehouse facing supplier theme was established by Microsoft Analysis Services developing system. On-line analytical processing system was designed. Supplier management Agent managed the data of supplier data warehouse and incepted the information that distribution center Agent sent out. It combined the data mining algorithm of clustering analysis to choose type of suppliers and informed distribution center Agent. The business intelligence system made furthest use of data in the supermarket corporation affair database, transformed them into information and then sublimed the information into knowledge. The system provides effective support for decision-making of governor in supermarket supplier management.

Keywords—supplier; business intelligence; supermarket; data mining; Agent technique

I. INTRODUCTION

Supplier management is an import link in the supply chain of retail trade, which is based on full and effective management to the supplier information of corporation and provides comprehensive management and support for the actuality, providing product or service, information communion, symbiosis, correlation operation decision-making of suppliers. The paper studied the supplier business intelligence system for chain supermarket based on the data warehouse, OLAP, data mining, business intelligence, artificial intelligence and Agent key technique. The system provides effective support for decision-making of governor in supermarket supplier management.

II. DESIGN OF DATA WAREHOUSE

Because data warehouse was the base of supplier business intelligence system for whole chain supermarket, its structure design played an important part in implementing of the system. The paper made use of data guiding into and guiding out service tool of Microsoft SQL Server 2005 as ETL tool. A mass of data needed for analyzing and decision-making were separated from affair database by taking out, transition, cleanout, loading. The data warehouse facing supplier theme

was established by Microsoft Analysis Services developing system [1].

A. Design of the information bag figure for supplier data warehouse

The information bag figure of the data warehouse facing supplier theme was established by the method of packing information, which is showed in Fig. 1. Snowflake model was adopted in the system, because many dimensionalities had complicated arrangement structures.

B. Design of fact table, dimension tables and metadata models

The fact table was situated in center of multidimensional data model and was biggest table in supplier data warehouse. It recorded plentiful particular information of basic operation, which included the main keys and measurement values of correlative dimension tables. The structure of supplier fact table is showed in table I. In the system, supplier dimension table, merchandise dimension table, time dimension table and store dimension table were established by function design [2].

Time	Store	Commodity	Supplier
Year	Name	Name	Name
Season	City	Brand	City
Month	Province	Secondary category	Province
Weak	State	Category	State
Day	Address	Department	Type
	Manager	Division	
	Post code		
	Tel. Num.		
	Opening Time		
Measurement: Speak for quantity, Supply quantity, Supply time, Supplier sale, Supplier cost, Price of having invoice			

Figure 1. The information bag figure of supplier data warehouse

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TABLE I. STRUCTURE OF SUPPLIER FACT TABLE

Word sect name	Data types	Explanation
TimeId	Int(4)	Time code
MerchandiseId	Int(4)	Merchandise code
SupplierId	Int(4)	Supplier code
StoreId	Int(4)	Store code
SpeakQuantity	float(8)	Speaking for quantity
SupplyQuantity	float(8)	Supply quantity
SupplierSales	float(8)	Supplier sale
SupplierCosts	money(8)	Supplier cost
SupplyTime	smallint(2)	Supply time
Store Price	money(8)	Merchandise price of having invoice

Metadata describes object attributes and all information related to the object. The metadata of object was saved in repository when the object was established by Analysis Services developing system. The supermarket supplier data warehouse included mostly theme metadata model, fact metadata model, dimension metadata model and data member metadata model. The theme metadata model is showed in table II.

III. DESIGN OF ON-LINE ANALYTICAL PROCESSING SYSTEM

A. Establishment of multidimensional data volume

Design work for on-line analytical processing system was mostly to establish multidimensional data volume. The data were pretreated by transforming and clearing. Then they were loaded into SQL database. The system used the guide provided by Analysis Manager to establish multidimensional data volume of data warehouse and connect data source.

In the system, MOLAP data storage type was chosen and aggregation was established in Set Aggregation Options faceplate. To intercalate appropriate aggregation options weighed memory space and performances [3]. The data can be observed from arbitrary angle by “browsing data” menu option of system, which is showed in Fig. 2.

TABLE II. METADATA TABLE OF SUPPLIER THEME

Name	Supplier
Description	Supplier data of supplier management department recording
Purpose	Analyzing supplier status
Dimension	Time, merchandise, store, supplier
Fact	Supplier fact table
Measurement values	Speaking for quantity, Supply quantity, Supply time, Supplier sale, Supplier cost, Price of having invoice

维度	层次结构	运算符	筛选表达式				
Warehouse 1	仓库名称	等于	{ Anderson Warehouse }				
<选择维度>							
将筛选字段拖至此处							
将列字段拖至此处							
月份	商品种类	订购量	供应量	供应时间	仓库销售量	仓库成本价	门店零售价
August	Food	39123	34416	1917	32698.2033	15307.4304	17453.1006
	Non-Consumable	6939	6876	261	6314.6574	2906.6794	3419.4033
	汇总	53550	48420	2493	45627.5736	21091.3848	24193.0683
	Drink	3321	3321	144	2938.0059	1536.9683	1781.9757
	Food	37845	35991	1800	36912.2094	16964.7723	19537.812
February	Non-Consumable	4842	4842	218	4469.2002	2169.541	2512.663
	汇总	46008	44154	2180	44319.4155	20672.3016	23832.4707
	Drink	5544	4842	207	3508.5438	1504.7667	1727.5302
	Food	37458	34128	1653	35205.0462	15732.2682	18205.2999
	Non-Consumable	9423	8541	513	7805.9043	3457.7712	3959.9775
January	汇总	52425	47511	2403	46519.4943	20694.8241	23892.8076
	Drink	7047	7047	261	5592.8403	2586.2965	3030.2775
	Food	49265	46008	2448	50296.096	23180.6151	26671.5513
	Non-Consumable	11556	10980	603	11791.2393	5159.0223	5864.0904
	Food	71568	67509	3312	67670.1756	30627.9399	35565.9192
July	Non-Consumable	3447	3447	135	2233.5795	1075.6386	1253.4399
	汇总	36180	33264	1728	34512.4134	16052.6302	18322.9084
	Non-Consumable	10935	10314	531	10628.3259	4578.5655	5324.0715
	Food	50562	47025	2394	47374.3188	21707.0343	24900.3198
	Drink	6669	6553	261	4953.0195	2201.0022	2500.002
June	Food	46692	40221	2151	43033.3749	19721.3022	22662.6181
	Non-Consumable	8775	8667	396	10234.3977	4476.5649	5149.7136
	汇总	62136	54444	2808	58220.7921	26398.5873	30312.5337
	Drink	51183	47178	2259	44008.6176	20062.0899	23109.4278
	Food	55377	50866	2403	47963.3686	21939.3385	25296.7266
March	Non-Consumable	17811	17118	729	15341.3352	7009.0443	8086.3166
	汇总	73456	67919	1566	25700.1381	11579.3973	13297.1491
	September	491076	452043	22527	442765.2294	202102.416	232456.7394
	Food	30456	27619	1566	25700.1381	11579.3973	13297.1491
	Non-Consumable	491076	452043	22527	442765.2294	202102.416	232456.7394

Figure 2. Browse of system multidimensional data

Considering the measurement factors of Speaking for quantity, Supply quantity, Supplier sale, Supplier cost, Price of having invoice, on-line analytical processing can be implemented after supplier multidimensional data volume was established by time dimension, supplier dimension, merchandise dimension, store dimension.

B. Design of on-line analytical processing

Using Cube Browser control part in Visual Basic may realize the OLAP operation to the multidimensional data volume. Level of a dimension was spread or contracted by double-clicking on the sign (+) in the table. It may increase a dimensionality or replace a displaying dimensionality that a dimension or a measurement above window was dragged to grid below it. Different combined forms of dimensionality and measurement were defined as slice of the multidimensional data volume. The data of the multidimensional data volume can be observed from different angles when position of any dimension was changed, which realized circumrotating. Drilling was a process in which analysis server returned some data which have been combined with structure of the multidimensional data volume. System will return the data producing the aggregations by a form of the simple record volume, when we knocked right on any cell and then chose drilling, which is showed in Fig. 3.

日期编号	门店名称	仓库成本价	仓库销售量	订购量	供应量	门店零售价
1998-01-01 00:00:00	2413.2141	5882.8392	6496	5661	2767.2696	
1998-01-03 00:00:00	3464.442	7979.8725	9819	8757	3973.0986	Time By Day
1998-01-04 00:00:00	3067.7229	7229.0034	8154	7065	3560.3352	Warehouse
1998-01-05 00:00:00	7557.7068	17433.9216	18351	17118	8658.6597	Store
1998-01-06 00:00:00	6135.8391	12677.2551	14283	12888	7073.3862	Product
1998-01-07 00:00:00	7104.2841	16487.0082	19746	16956	8147.6127	Customer
1998-01-08 00:00:00	2681.1414	5595.5882	7695	7164	3049.8291	Promotion
1998-01-10 00:00:00	3643.6869	8736.9487	10134	9046		
1998-01-11 00:00:00	3895.5366	7679.9725	10476	10440		
1998-01-12 00:00:00	3793.7188	7730.652	6039	5841		
1998-01-13 00:00:00	2865.9213	6366.9087	7137	6678		
1998-01-14 00:00:00	8168.6376	18082.2636	20826	19323		
1998-01-15 00:00:00	3780.2916	8648.8308	10836	9963		
1998-01-16 00:00:00	8455.2516	17780.3145	19459	17631		
1998-01-17 00:00:00	3787.7607	7999.65	10090	10883		
1998-01-18 00:00:00	1274.9861	2630.8053	3996	2882		
1998-01-19 00:00:00	5088.5216	11192.2948	12566	11691		
1998-01-20 00:00:00	678.7883	1889.739	2610	1944		
1998-01-22 00:00:00	6317.2602	14004.603	18630	18722		
1998-01-23 00:00:00	2449.8108	5728.8546	7542	6639		
1998-01-24 00:00:00	2571.1902	5505.6822	5274	4887		
1998-01-25 00:00:00	5272.5132	11493.1665	12942	12447		
1998-01-26 00:00:00	5152.5243	10269.3393	11556	10269		
1998-01-27 00:00:00	2016.6388	4409.3736	5193	4501		
1998-01-28 00:00:00	1614.9234	15047.5842	18713	18065		
1998-01-29 00:00:00	8655.3339	17015.0922	18038	17334		
1998-01-30 00:00:00	2406.9816	5638.2384	6066	5544		
1998-02-02 00:00:00	2763.0981	6144.0651	5409	5265		

数据示例查看器 (前 30 条记录)

show

Warehouse

Warehouse

Warehouse

Warehouse

Store

Figure 3. Drilling operation of system multidimensional data

IV. CLUSTERING ANALYSIS OF SUPPLIER CLASSIFICATION

Retail enterprises have abroad used ERP and POS systems to support operation of store and headquarters. They added up a mass of data in daily management, from which impersonality knowledge can be mined to class and estimate supplier.

The core idea of K-means algorithm is that n data objects are divided into k clustering, which obtains least square sum of the distances between the data and the clustering center point. K-means algorithm is as follows [4]:

Input: clustering number k , data volume having n data objects.

Output: k clustering.

1) The k objects are chosen from n data objects, which are regarded as primary clustering center points.

2) The distance between every object and each clustering center point is calculated respectively and then this object is come under the clustering that closest clustering center point belongs to.

3) The k clustering center points are recalculated after all objects are allotted.

4) If the calculated clustering center point is fully same with old clustering center point, calculating course converges and classification function goes fixed value. Here, classification is accomplished. Otherwise calculating course of step two is repeated.

5) The results of clustering are exported.

Supplier was regarded as the mining structure key in supplier multidimensional data volume. Merchandise dimension was regarded as nested table. The kind of merchandise was regarded as the key of nested table. Speaking for quantity, Supply quantity, Supplier cost, Supplier sale were regarded as input properties in three kinds of merchandises that are drink, food, rest consumable. The data were identified and classed by clustering method [5]. The clustering results are showed in table III.

Class 1 and class 3 belong to a big class and other classes belong to another big class when speaking for quantity of drink is more than 14492. Class 1 and class 3 belong to a big class and other classes belong to another big class when speaking for quantity of food is more than 107189. Class 1 and class 3 belong to a big class and other classes belong to another big class when speaking for quantity of rest consumable is more than 28178. Here, the suppliers of class 1 and class 3 are mostly chosen. Other classes are chosen when other things appear. The suppliers were evaluated by supplier sale, supplier cost, price of having invoice when a big class was chosen.

V. DESIGN AND REALIZATION OF SUPPLIER MANAGEMENT AGENT

Supplier management Agent managed the data of supplier data warehouse and incepted the information that distribution center Agent sent out. It combined the data mining algorithm of clustering analysis to choose type of suppliers and informed distribution center Agent [6].

TABLE III. CLUSTERING RESULTS OF SUPPLIERS

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
Drink speaking for quantity	26269 ± 2455	2071 ± 1422	17616 ± 942	10475 ± 750	8302 ± 2564	9643 ± 897	6073 ± 2521	7542 ± 0
Drink supply quantity	23506 ± 2343	2071 ± 1422	16488 ± 1442	10143 ± 572	7573 ± 2106	9260 ± 725	7573 ± 2744	6777 ± 0
Drink supplier cost	9023 ± 1047	915 ± 774	6476 ± 1289	3978 ± 225	2798 ± 1021	3617 ± 236	2491 ± 837	2756 ± 0
Drink supplier sale	19840 ± 2443	1991 ± 2281	14041 ± 2433	8960 ± 797	6447 ± 1511	8408 ± 773	5448 ± 2720	5841 ± 0
Food speaking for quantity	190755 ± 2653	15723 ± 2721	151644 ± 9986	69315 ± 3709	50620 ± 1851	69000 ± 4169	6073 ± 4852	76563 ± 0
Food supply quantity	174166 ± 2374	14226 ± 2281	138675 ± 9543	64254 ± 2452	46021 ± 2386	63208 ± 5461	5915 ± 4814	69741 ± 0
Food supplier cost	76323 ± 9000	6529 ± 911	60693 ± 5104	28154 ± 529	20085 ± 74	27445 ± 2508	15065 ± 1591	6577 ± 0
Food supplier sale	167117 ± 6396	14636 ± 2695	134746 ± 9971	61397 ± 1296	44373 ± 348	60925 ± 5281	32879 ± 5026	67275 ± 0
Rest consumable speaking for quantity	49911 ± 8652	2512 ± 984	40734 ± 2655	19221 ± 137	14665 ± 1011	23220 ± 560	7676 ± 3585	15192 $\pm$
Rest consumable supply quantity	45846 ± 8513	2404 ± 856	37420 ± 2691	17637 ± 261	13077 ± 1043	21230 ± 967	6968 ± 2750	13887 ± 0
Rest consumable supplier cost	19742 ± 2934	1097 ± 324	16108 ± 1465	7460 ± 1007	6527 ± 709	9996 ± 654	2180 ± 542	6577 ± 0
Rest consumable supplier sale	44137 ± 6875	2267 ± 698	35655 ± 3340	16147 ± 2640	13996 ± 1914	21107 ± 1761	5446 ± 1780	14519 ± 0

Supplier management Agent chose the type of supplier by clustering analysis algorithm and speaking for quantity of merchandise. In this paper, Agents simulated the action of three suppliers because there were multi-supplier entities in a type of suppliers. Supplier management Agent sent respectively out information to every supplier. Suppliers responded the request of supplier management Agent and provided synchronously the price of merchandise when suppliers received the information that supplier management Agent sent out [7]. Supplier management Agent analyzed the price and chose classic supplier, which is showed in Fig. 4.

Figure 4. Alternation between supplier management Agent and supplier

VI. CONCLUSION

With the supplier data of chain supermarket, the supplier business intelligence system was developed based on data warehouse and Agent technique. The advanced technique of business intelligence was applied to business manage, which has management idea of intelligence and optimizing function. By mining fully existing data resource, supermarket corporation user can capture information, analyze information, communicate information and discover many data relations unrecognized to help supermarket corporation governor to make better business decision-making.

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