

DEVELOPING AN INTEGRATED DATA MINING ENVIRONMENT IN ERP-CRM MODEL – A CASE STUDY OF MADAR

A. Abdullah S. Al-Mudimigh, B. Farrukh Saleem, C. Zahid Ullah

Department of Information System

College of Computer and Information Sciences

King Saud University, Riyadh

Kingdom of Saudi Arabia

mudimigh@ksu.edu.sa, farrukh800@ksu.edu.sa, zahid@ksu.edu.sa

Abstract— As Enterprise Resource Planning (ERP) implementation has become more popular and suitable for every business organization, it has become an essential factor for the success of a business. This paper shows the best integration of ERP with Customer Relationship Management (CRM). Data Mining is overwhelming the integration in this model by giving support for applying the best algorithm to make the successful result. This model has three major parts, outer view-CRM, inner view-ERP and knowledge discovery view. The CRM collects the customer's queries, ERP analyzes and integrates the data and the knowledge discovery gives predictions and advises for the betterment of an organization. For the practical implementation of the presented model, we use MADAR data and implemented the Apriori Algorithm on it. Then the new rules and patterns suggested for the organization which help the organization solve the problem of customers in future correspondence.

Keywords— Apriori Algorithm, CRM, ERP.

I. INTRODUCTION

As an electronic business environment changes more rapidly under globalization, even small and medium size companies also change their business. With enterprises becoming bigger and bigger, the legacy business systems may not be flexible enough to adapt this change and the discordance between business and information systems in their organization may occur [4]. Therefore, recently most companies use an Enterprise Resource Planning (ERP) system for improving core competency.

Enterprise Resource Planning (ERP) integrates the functionality of all the business departments in an organization in a single system to carry out the particular needs of these different departments and share their information very easily. Interaction channels between enterprises and customers have

The revised version submitted on 30th March 2009. This work was supported by the Research Center of "College of Computer and Information Sciences", King Saud University, Riyadh, Kingdom of Saudi Arabia.

F. A. Author is an Associate Professor in the department of Information Systems, King Saud University, Riyadh, Kingdom of Saudi Arabia. Mob: 00966-504171443, mudimigh@ksu.edu.sa.

S. B. Author is a Researcher in the Department of Information Systems, King Saud University, Riyadh, Kingdom of Saudi Arabia. Mob: 00966-530706625, farrukh800@ksu.edu.sa.

T. C. Author is a Researcher in the Department of Information Systems, King Saud University, Riyadh, Kingdom of Saudi Arabia. Mob: 00966-543807381, zahid@ksu.edu.sa.

been gradually changed owing to the development of information technology. In the highly specialized business environment, the interaction model should be re-engineered to enhance the quality of customer service [9].

ERP's best hope for demonstrating value is as a sort of battering ram for improving the way your company takes a customer order and processes it into an invoice and revenue otherwise known as the order fulfillment process [14]. That is why ERP is often referred to as back-office software. It doesn't handle the up-front selling process (although most ERP vendors have developed CRM software or acquired pure-play CRM providers that can do this); rather, ERP takes a customer order and provides a software road map for automating the different steps along the path to fulfilling it [14]. It is now widely accepted that ERP systems provide a viable alternative to custom application development for the standard information management needs and that it is often superior in terms of quality of the implemented business process [2]. Although current common ERP systems provide enough parameters and can be adjusted according to industry characteristics, they are still too complicated to use only effectively under certain conditions [6]. ERP solutions are designed to solve the fragmentation of information in businesses, and integrate all the information flowing within a company are designed to solve the fragmentation of information in businesses, and integrate all the information flowing within a company [12].

II. RELATED WORK / BACKGROUND

According to *Virgil Chichernea and Romanian* [8] the basic architecture for an ERP system consists of 12 business functions utilizing a common manufacturing database, as shown in the following Fig.1. Beyond that CRM often describes a strategic or philosophic approach for managing customers [1]. Hence CRM could be seen from a process oriented, technological, capability-oriented, philosophical, and/or strategic perspective [1]. According to Forrester Research, 57% of business firms cannot justify CRM investments because they cannot measure customer profitability [1]. The core of the ERP system circulates within the company as well as the management information and control needs of the entire production process, including reducing inventory, labor, and operation costs, improving business processes to enhance operation efficiency and

improving customer response [6]. However, Markus and Robey (1988) pointed out that although industry specific ERP has already focused on industry characteristics and includes the optimal business operation management model, the promotion of ERP is still significantly related to interaction with the organization [6]. The necessary broad level of security is determined by the CRM security objectives which an organization needs to meet[13]. A CRM security strategy outlines in general terms how an organization will achieve its CRM security objectives [13].

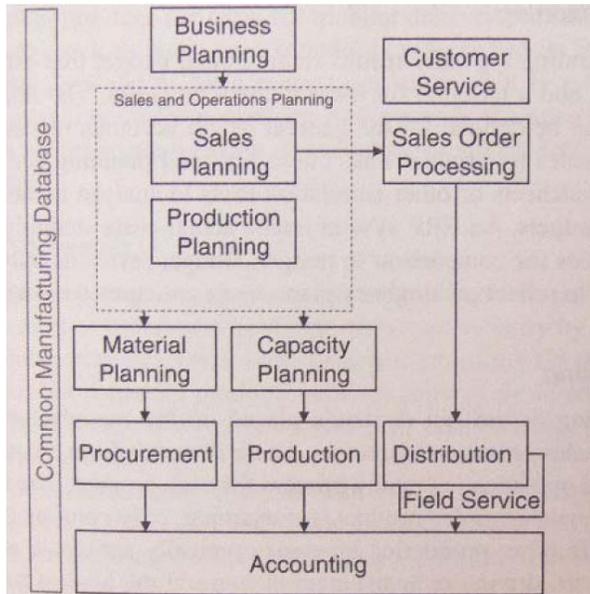


Fig. 1- Architecture of an ERP System

In order to increase the use of ERP systems it is recommended to begin with the financial section, the applications invoicing, cost control, accounting and financial then it should be added many functions from Financial, Relation Management Production, Distribution, e- Business and Analyses [8]. CRM (Customer Relationship Management) systems, which provide the framework for analyzing customer profitability and improving marketing effectiveness, have become an indispensable component in enterprise information systems. Typically, CRM activities include data analysis, campaign design, response analysis of customer data[3]. The order of the customer is routing automatically to the next department when one department finishes their work of the customer order and each department have access to the single database that holds the customer's new order [10].

III. METHODOLOGY

The ERP-CRM model shown in the Fig.2 , clearly described the ERP model to solve the business problems. Whenever customer request engender directly forward to the concern department for the assessment and positive response. After statistical analysis and evaluation of the request the answer back to the corresponding customer and this feedback will be saved in the database for the future requirements. This

scenario is most common in each and every organization for creating more sophisticated and steadfast environment we presented this whole scenario in our model in three different views. In effect after, there is a construction of an easy to use and implement surroundings for the upper management and their employees for put their stress and expertise within the company's limitation and taking their company on top and behaving with their customer on priority.

The three views are as follows:

- i. Outer View
- ii. Inner View
- iii. Knowledge Discovery View

Description of Three Views

A. Outer View

Whenever a customer contact with the company the customer support officer receive customer's request. In the company's prospectus this department has much importance because of correspondence directly with the customer. In our model we presented customer relationship management as an outer view. CRM is responsible for receiving requests and replying to the customer directly. These requests includes queries, complaints, suggestions and orders then forward these requests to the inner view enterprise resource planning (ERP) through the query generator. After taking action on the perspective request the answer will forward through the CRM –The Outer View. And result will also be save in the database for knowledge discovery view.

B. Inner View

The important part of the model is inner view or ERP view. In this view each department have equal access to a single database that holds the customer's data or complaints. In ERP view the customer queries rotating and evaluating by the concern department. For example a customer want to purchase any product will apply for a product through the customer support department (outer view) and the request will be forward to the sales department (inner view) and sales department will check the payment status in the database and will forward the same request to the operations department (inner view) for the delivery of the product and the record will be stored in the database to generate new rules and patterns (knowledge discovery view) from the experienced data.

C. Knowledge Discovery View

This view is concern with the central database having all kind of data saved from outer and inner views. This data can be customer's history, manufacturing status and sales. In this environment we can use several kinds of data mining techniques for discovering the knowledge. The best implementation is presented in this paper by using Apriori Algorithm.

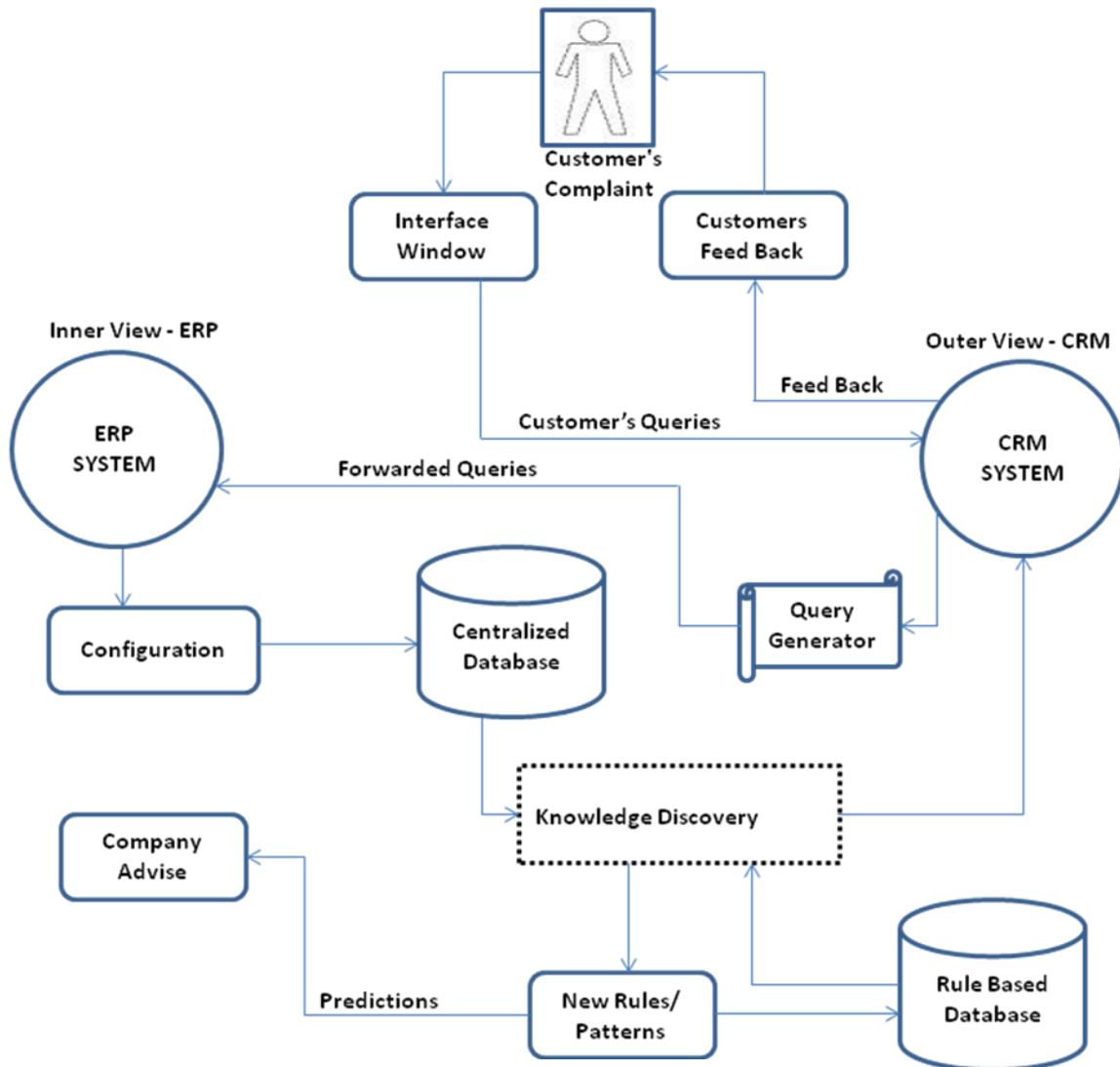


Fig. 2- ERP – CRM Model

IV . CASE STUDY

For the practical implementation of presented model we applied data mining technique on MADAR data. MADAR is an ERP based organization physically working in King Saud University dealing with all administrative software of the university and also do work for outer projects. The efficient implementation of presented ERP-CRM model using data mining techniques is applied on MADAR data. For this we used Association mining- Apriori Algorithm for finding new rules and patterns from the experienced data. The description of all phases on our case study are as follows:

A. Apriori Algorithm

Apriori is a classic algorithm for learning association rules. Apriori is designed to operate on databases containing

transactions (for example, collections of items bought by customers, or details of a website frequentation) [7,11]. As is common in association rule mining, given a set of itemsets (for instance, sets of retail transactions, each listing individual items purchased), the algorithm attempts to find subsets which are common to at least a minimum number C of the itemsets. Apriori uses a "bottom up" approach, where frequent subsets are extended one item at a time (a step known as candidate generation), and groups of candidates are tested against the data. The algorithm terminates when no further successful extensions are found [7, 11, 15]. One way to construct a

simpler model computed from data, easier to understand and with more predictive power is to create a set of simplified rules [5]. Apriori Algorithm is suitable to compute the rules and patterns and predict for any organization to improve the customer satisfaction. We implement Apriori algorithm on MADAR data and generated some rules and patterns for MADAR. The descriptions of these rules are in the following steps.

$$C_t \leftarrow \text{Subset}(C_{k,t})$$

for candidates $c \in C_t$
 $\text{count}[c] \leftarrow \text{count}[c] + 1$
 $L_k \leftarrow \{c \in C_k \mid \text{count}[c] \geq \varepsilon\}$
 $k \leftarrow k + 1$
 $\bigcup L_k$
 return k [7, 11, 15].

A.1. Apriori Pseudo Code

$\text{Apriori}(T, \varepsilon)$

$$L_1 \leftarrow \{ \text{large 1-itemsets that appear in more than } \varepsilon \text{ transactions} \}$$

$$k \leftarrow 2$$

while $L_{k-1} \neq \emptyset$
 $C_k \leftarrow \text{Generate}(L_{k-1})$
 for transactions $t \in T$

B. Programming Tool Used

For the implementation of Apriori Algorithm to get new rules on the MADAR data we used VB technology. Input and output data files can be in any format e.g databases, Notepad, Excel worksheets, etc. But in this case we used Notepad and Excel worksheet as input and output files.

B.1. VB Interface

The VB interface is shown in Fig. 3

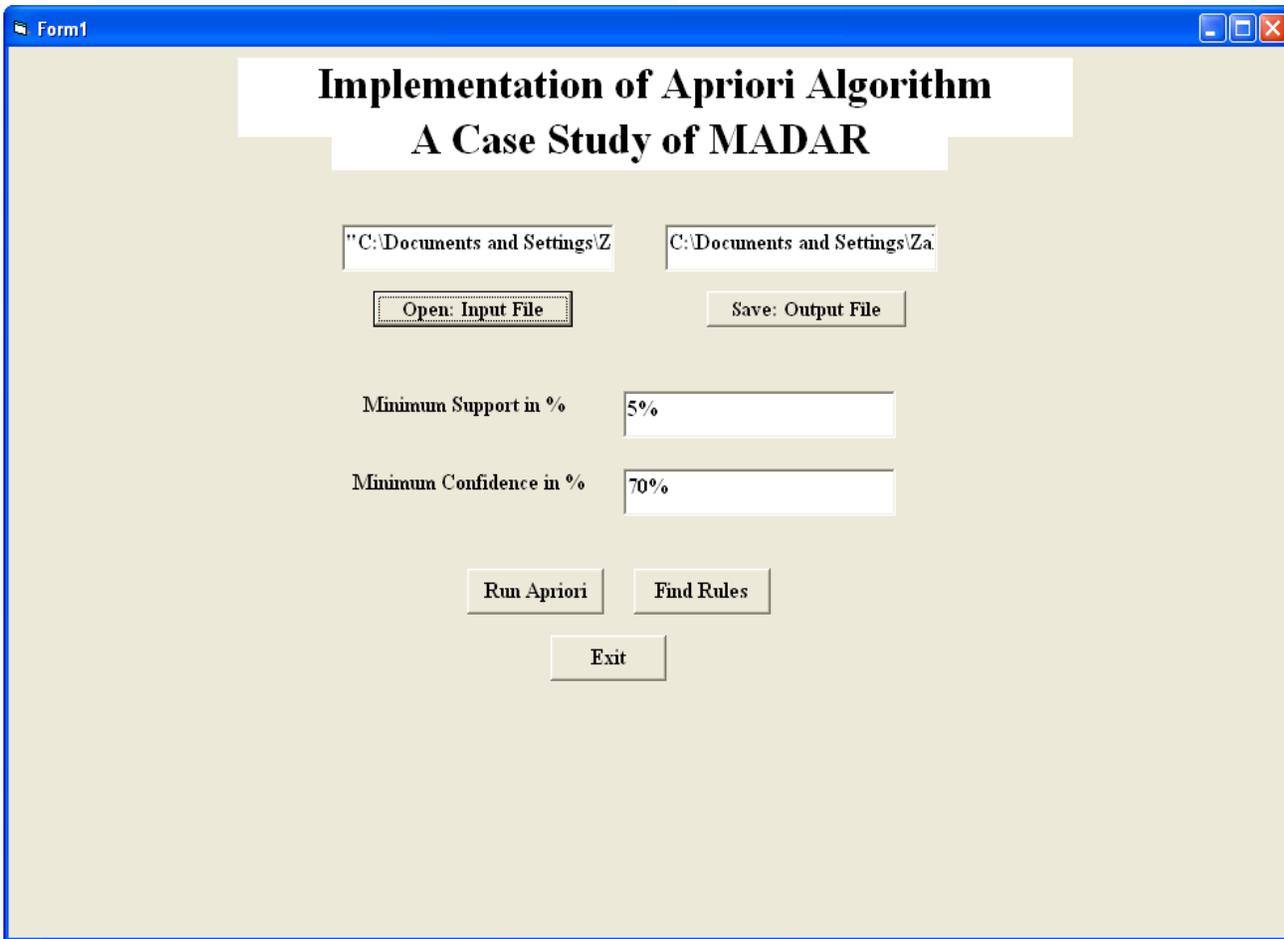
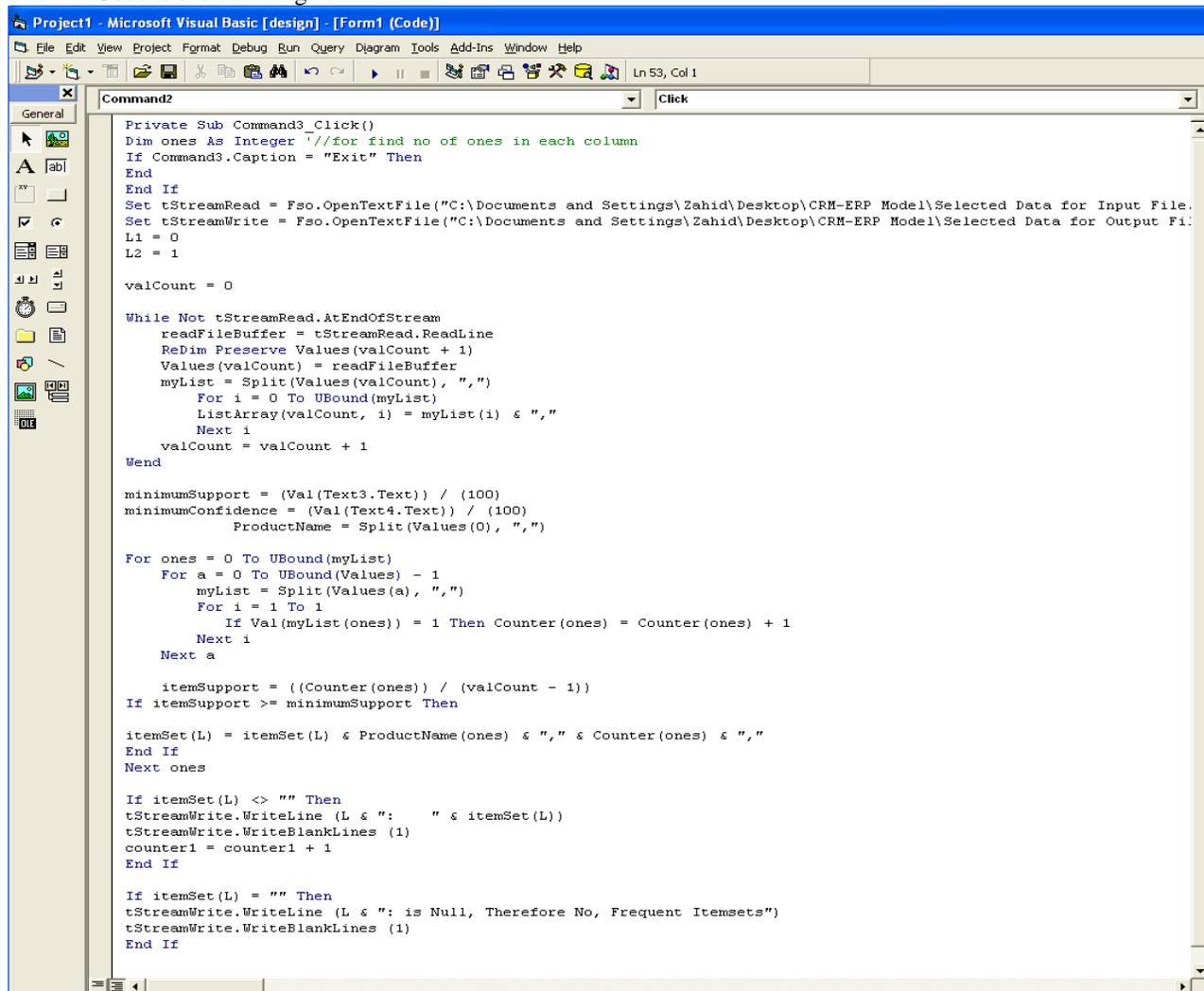


Fig. 3- VB Interface for Apriori

B.2. VB Code

The VB Code is shown in Fig.4.



```
Project1 - Microsoft Visual Basic [design] - [Form1 (Code)]
File Edit View Project Format Debug Run Query Diagram Tools Add-Ins Window Help
Ln 53, Col 1
Command2 Click
Private Sub Command3_Click()
Dim ones As Integer '//for find no of ones in each column
If Command3.Caption = "Exit" Then
End
End If
Set tStreamRead = Fso.OpenTextFile("C:\Documents and Settings\Zahid\Desktop\CRM-ERP Model\Selected Data for Input File.
Set tStreamWrite = Fso.OpenTextFile("C:\Documents and Settings\Zahid\Desktop\CRM-ERP Model\Selected Data for Output Fi.
L1 = 0
L2 = 1
valCount = 0
While Not tStreamRead.AtEndOfStream
readFileBuffer = tStreamRead.ReadLine
ReDim Preserve Values(valCount + 1)
Values(valCount) = readFileBuffer
myList = Split(Values(valCount), ",")
For i = 0 To UBound(myList)
ListArray(valCount, i) = myList(i) & ","
Next i
valCount = valCount + 1
Wend
minimumSupport = (Val(Text3.Text)) / (100)
minimumConfidence = (Val(Text4.Text)) / (100)
ProductName = Split(Values(0), ",")
For ones = 0 To UBound(myList)
For a = 0 To UBound(Values) - 1
myList = Split(Values(a), ",")
For i = 1 To 1
If Val(myList(ones)) = 1 Then Counter(ones) = Counter(ones) + 1
Next i
Next a
itemSupport = ((Counter(ones)) / (valCount - 1))
If itemSupport >= minimumSupport Then
itemSet(L) = itemSet(L) & ProductName(ones) & "," & Counter(ones) & ","
End If
Next ones
If itemSet(L) <> "" Then
tStreamWrite.WriteLine (L & " " & itemSet(L))
tStreamWrite.WriteLine (1)
counter1 = counter1 + 1
End If
If itemSet(L) = "" Then
tStreamWrite.WriteLine (L & " : is Null, Therefore No, Frequent Itemsets")
tStreamWrite.WriteLine (1)
End If
```

Fig. 4- VB Code for Apriori

C. DATA GATHERING/ SURVEY

We gathered the data by survey. For this we make a survey for MADAR and collect the two months data through a questionnaire from each and every department. The data is then organized in a small database.

C.1. Data Transformation

In the Fig.5. we transferred the useful data from the database into the excel format for describing the data more sufficiently and for applying some rules and formulae on surveyed data. Furthermore we columned the data in customer query, queried department, corresponding department and action by the department.

S.No.	Customer's Query	Queried Department	Forwarded to: Concerned Department	Actions of the Department
1	Bugs in Software	Software Maintenance	Debuggers	Declined
2	Salary Calculation mistakes	Salary Department	Programmer-Salary Dept.	Need some time
3	Changes in contracts for new employee	Employees Department	Programmer-Employee Dept.	Call a Meeting
4	Salary structure for each designation	Salary Department	Programmer-Salary Dept.	Replied on the spot
5	Budget approval for coming year	Finance Department	Programmer-Finance Dept.	Declined
6	Changes in budget in current year	Finance Department	Programmer-Finance Dept.	Need some time
7	Last 6 months purchased items	Purchased Department	Programmer-Purchased Dept.	Call a Meeting
8	Project expenses	Research Department	Programmer-Research Dept.	Call a Meeting
9	Webmail problem	Website Controller	Web Developers	Replied on the spot
10	User id problem	Website Controller	Web Developers	Declined
11	Salaries payroll problem	Salary Department	Programmer-Salary Dept.	Call a Meeting
12	Keeping record of residential permit - (Aqama)	Passport Department	Programmer-Passport Dept.	Need some time
13	Passport keeping record	Passport Department	Programmer-Passport Dept.	Replied on the spot
14	Login problem in the KSU website	Website Controller	Web Developers	Call a Meeting
15	Online course registration form	Admission Department	Programmer-Admission Dept.	Replied on the spot
16	File uploading and download problem	University Database Controller	Database Administrator	Need some time
17	Mail server problem	Website Controller	Web Developers	Replied on the spot
18	Faculty members Website maintenance problem	Website Controller	Web Developers	Replied on the spot
19	University magazine	Publishing Department	Programmer-Publishing Dept.	Need some time
20	University calendar	Publishing Department	Programmer-Publishing Dept.	Call a Meeting
21	Colleges portals	College's Web Developer	Web Developers	Replied on the spot
22	Information for international students	Research Department	Programmer-Research Dept.	Replied on the spot
23	Information sharing problems	Database Administrator	Database Administrator	Call a Meeting
24	Online transferring of salaries to bank accounts	Salary Department	Programmer-Salary Dept.	Declined
25	Percentage increment control in salaries	Salary Department	Programmer-Salary Dept.	Need some time
26	New employee entry problem	Employees Department	Programmer-Employee Dept.	Call a Meeting
27	Employee's ID exceed from previous limit	Employees Department	Programmer-Employee Dept.	Need some time

Fig. 5- Transformation of Data

C.2. Data Enhancement

In the Fig.6. we enhanced the data by categorizing the data according to the appropriate action of the department. In which we categorized all three actions of the department in three (03) categories. Further we add one more column to assign binary

value (0 or 1) according to the action from the MADAR correspondent. This extra column is the key for the implementation of apriori algorithm which is shown in the next steps.

S.No.	Customer's Query	Queried Department	Forwarded to: Concerned Department	Actions of the Department	Binary Value of Particular Action
1	Bugs in Software	Software Maintenance	Debuggers	Call a Meeting	0,0,1
2	Salary Calculation mistakes	Salary Department	Programmer-Salary Dept.	Need some time	0,1,0
3	Changes in contracts for new employee	Employees Department	Programmer-Employee Dept.	Call a Meeting	0,0,1
4	Salary structure for each designation	Salary Department	Programmer-Salary Dept.	Replied on the spot	1,0,0
5	Budget approval for coming year	Finance Department	Programmer-Finance Dept.	Replied on the spot	1,0,0
6	Changes in budget in current year	Finance Department	Programmer-Finance Dept.	Need some time	0,1,0
7	Last 6 months purchased items	Purchased Department	Programmer-Purchased Dept.	Call a Meeting	0,0,1
8	Project expenses	Research Department	Programmer-Research Dept.	Call a Meeting	0,0,1
9	Webmail problem	Website Controller	Web Developers	Replied on the spot	1,0,0
10	User id problem	Website Controller	Web Developers	Replied on the spot	1,0,0
11	Salaries payroll problem	Salary Department	Programmer-Salary Dept.	Call a Meeting	0,0,1
12	Keeping record of residential permit - (Aqama)	Passport Department	Programmer-Passport Dept.	Need some time	0,1,0
13	Passport keeping record	Passport Department	Programmer-Passport Dept.	Replied on the spot	1,0,0
14	Login problem in the KSU website	Website Controller	Web Developers	Call a Meeting	0,0,1
15	Online course registration form	Admission Department	Programmer-Admission Dept.	Replied on the spot	1,0,0
16	File uploading and download problem	University Database Controller	Database Administrator	Need some time	0,1,0
17	Mail server problem	Website Controller	Web Developers	Replied on the spot	1,0,0
18	Faculty members Website maintenance problem	Website Controller	Web Developers	Replied on the spot	1,0,0
19	University magazine	Publishing Department	Programmer-Publishing Dept.	Need some time	0,1,0
20	University calendar	Publishing Department	Programmer-Publishing Dept.	Call a Meeting	0,0,1
21	Colleges portals	College's Web Developer	Web Developers	Replied on the spot	1,0,0
22	Information for international students	Research Department	Programmer-Research Dept.	Replied on the spot	1,0,0
23	Information sharing problems	Database Administrator	Database Administrator	Call a Meeting	0,0,1
24	Online transferring of salaries to bank accounts	Salary Department	Programmer-Salary Dept.	Replied on the spot	1,0,0
25	Percentage increment control in salaries	Salary Department	Programmer-Salary Dept.	Need some time	0,1,0
26	New employee entry problem	Employees Department	Programmer-Employee Dept.	Call a Meeting	0,0,1
27	Employee's ID exceed from previous limit	Employees Department	Programmer-Employee Dept.	Need some time	0,1,0
31	Note:				
32	Replied on the spot	1			IF Value is 1 then Assigned Binary Value will be: 1,0,0
33	Need some time	2			IF Value is 2 then Assigned Binary Value will be: 0,1,0
34	Call Meeting	3			IF Value is 3 then Assigned Binary Value will be: 0,0,1

Fig. 6- Data Enhancement

C.3. Selected Data for Apriori Implementation

In the Fig. 7. Shows the selection of concerned data after some enhanced features we used as an input file. We select notepad format as an input file for the Apriori program developed by

using VB Technology. The selected data for input file includes the Customer Query and Binary Value of action on the query did by department. Moreover we put 5% minimum support as an input also for the generation of frequent itemsets from the input file.

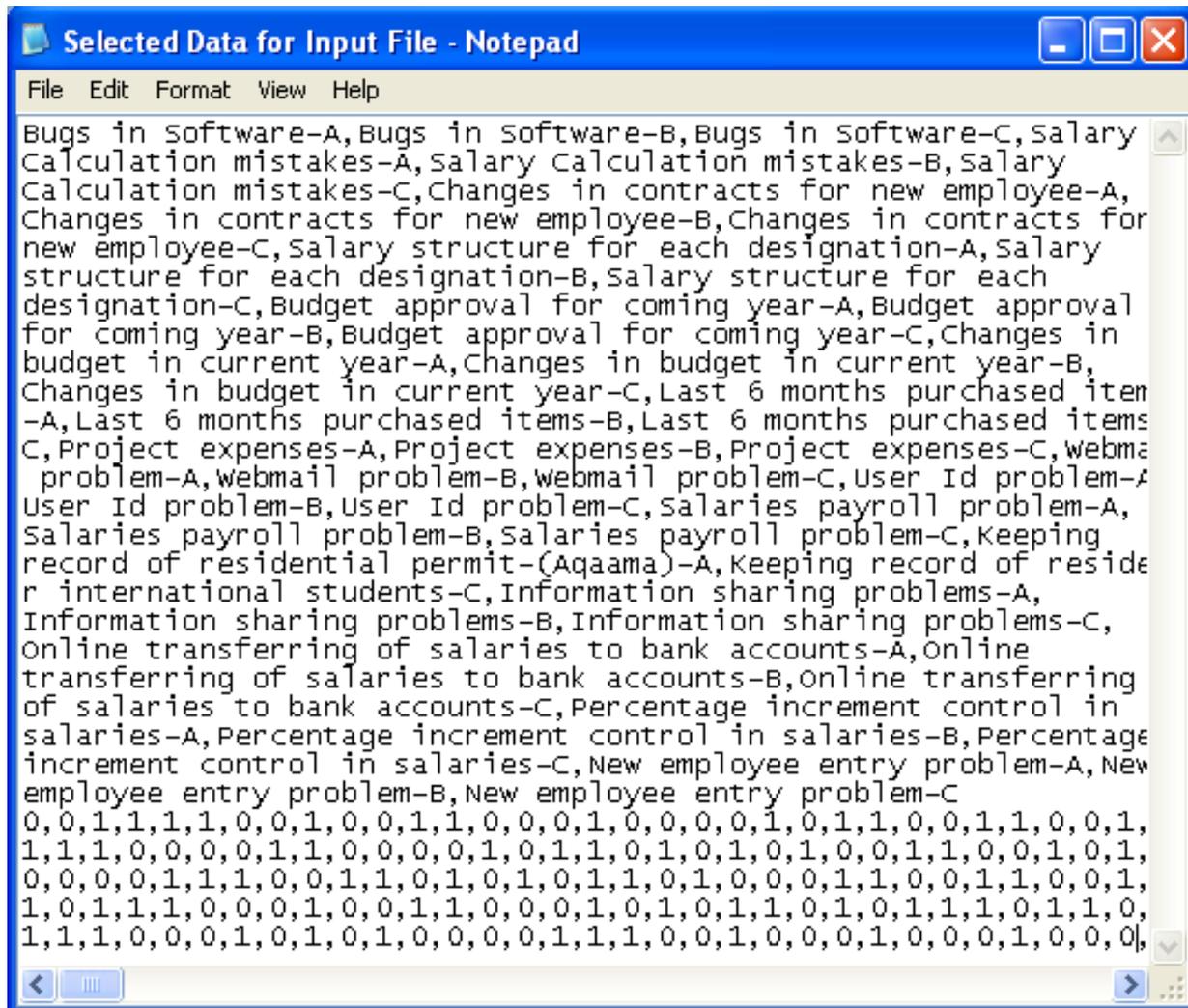


Fig. 7- Selected Data for Apriori

C.4. Output Data

The Fig.8. Shown the output file with 5% minimum support. We applied apriori algorithm for the generation of frequent itemsets. These Itemset generation is based on the customer query, corresponding binary value and minimum support(5%). In consequence we find out that how much queries has been dealt on time, and how much queries were delayed in the last

two month. In the next step we generated and suggested some rules from the frequent itemset generations (output file) to the MADAR organization for handling with the customer in more efficient way and for the betterment of the organization in future. This was a sample implementation of apriori algorithm on the CRM-ERP based model. We can find different kind of frequent itemsets generation in the same manner by increasing or decreasing the minimum support.

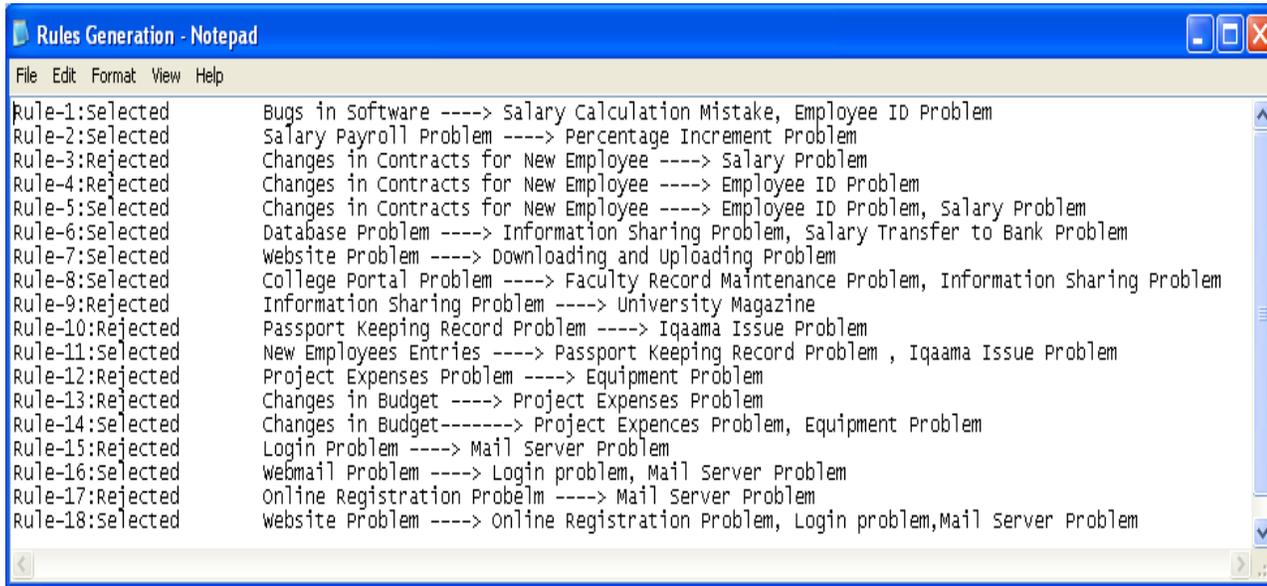


Fig. 9- Rules Generation

V. FUTURE WORK

The model will be enhancing with more information and more data mining technique will be applying and new rules will be generated in future for the enhancement of an organization. New ERP tools will be used to modify the existing work and make ease for the customers to access the organization's facilities with out any hesitation.

VI. CONCLUSION

In today's technologies the customer have a lot of difficulties to access the organization's facilities. The customer have problem in contacting the organization. The model presented in this paper will solve these problems all the customers complaints will be recording in the central database and will be process according to the customer need. The customer can easily contact the organization and can purchase the organization products very easily. The CRM (outer view) will collect the information about the products and the queries will be forwarded to the inner view (ERP) to act upon these queries. The knowledge discovery view generates new rules and patterns for the betterment of an organization for future correspondence to improve the growth of the customers for an organization.

VII. ACKNOWLEDGEMENT

Our cordially thanks goes to Rector and Vice Rector (KETT) of King Saud University for their financial support. Our special thanks goes to the Dean and Vice Dean College of Computer and Information Sciences King Saud University who encouraged us in the field of research. Also thanks to our chairman Abdullah S. Alghamdi for each and every thing provided us for this work. Thanks to Maqsood Mahmood for their guidance.

REFERENCES

- [1]. Sonja Grabner-Kraeuter, Gernot Moedritscher, Martin Waigunyc, Werner Mussnigh, "Performance Monitoring of CRM Initiatives", in Proceedings: IEEE conference on System Sciences, 2007.
- [2]. Philippe Dugerdil, Gil Gaillard, "Model-Driven ERP Implementation" In Proceedings: ICEIS, 8th International Conference on Enterprise Information Systems, May, 2006, Paphos, Cyprus.
- [3] Han-joon, Kim TaeHee, Lee Sang-goo, Lee Jonghun Chun, "Automated Data Warehousing for Rule-based CRM Systems", 14th Australasian Database Conference (ADC-2003), Adelaide, Australia, 2003.
- [4]. Jae-won Park, Nam-Yong Lee, "A Conceptual Model of ERP for Small and Medium-Size Companies Based on UML", IJCSNS International Journal of Computer Science and Network Security, VOL.6 No.5A, May 2006.
- [5]. Mar_a C. FERN_ANDEZ_, Ernestina MENASALVAS_, Óscar MARB_AN_ Jos_e M. PE-NA_, Socorro MILL_AN, "MINIMAL DECISION RULES BASED ON THE APRIORI ALGORITHM y", Int. J. Appl. Math. Comput. Sc.i, Vol.11, No.3, 691704, 2001.
- [6]. Wen-Hsiung Wu, Chin-Fu Ho, Hsin-Pin Fu, Tien-Hsiang Chang, "SMES IMPLEMENTING AN INDUSTRY SPECIFIC ERP MODEL USING A CASE STUDY APPROACH", Journal of the Chinese Institute of Industrial Engineers, Vol. 23, No. 5, 2006, pp. 423-434.
- [7]. Apriori Algorithm, http://en.wikipedia.org/wiki/Apriori_algorithm #Algorithm, Accessed Date: 12th April, 2009.
- [8]. Virgil Chichernea, Romanian, "THE USE OF THE ERP-CRM-CIM SYSTEMS WITHIN THE MASTER'S DEGREE PROGRAMMES" In Proceedings: Annales Universitatis Apulensis Series Oeconomica, Nr. 9 / 2007, Volume 2.
- [9]. Chang-Shing lee, Yi-Chuan Wang, Wei-Ming liu, Yi-Chen lin, "Crm Ontology Based On CMMI Project Planning For Business applications", in Proceedings: IEEE conference on machine learning and cybernetics, Hong Kong, August, 2007.

- [10]. Darwin Publications, "Executive Guides, Enterprise Resource Planning - ERP", "<http://www.netessence.com.cy/downloads/erp.pdf>", Accessed date: March 21, 2009.
- [11]. Agrawal R, Imielinski T, Swami AN. "Mining Association Rules between Sets of Items in Large Databases." SIGMOD. June 1993, 22(2):207-16.
- [12]. Gail Corbitt, Marinos Themistocleous, Zahir Irani, "ERP/EAI System Issues and Answers: A Research Journey", in proceeding: IEEE conference on system sciences, 2005.
- [13]. Mahdi Seify, "New Method for Risk Management in CRM Security Management", in proceedings: IEEE conference on Information Technology, 2006.
- [14]. Thomas Wailgum, "Enterprise Resource Planning: Definition and Solutions", CIO
http://www.cio.com/article/40323/ERP_definition_and_solutions, Accessed date: March 11, 2009.
- [15] S. Kotsiantis, D. Kanellopoulos, Association Rules Mining: A Recent Overview, GESTS International Transactions on Computer Science and Engineering, Vol.32 (1), 2006, pp. 71-82