Rules Generation from ERP Database: A Successful Implementation of Data Mining

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Abstract

An Enterprise Resource Planning (ERP) applications has been remarkably adopting during the current era. It has become an vital factor for the success of business organizations. This paper represents the efficient implementation of data mining techniques on ERP models and databases. ERP specially work on analyze the queries, issues and best use of organizational resources. While using ERP large amount of data having several attributes store in ERP databases. Those data associated with specially customer queries, company responses and other intra-departmental issues. Therefore the data mining can convert those data into extraction of new patterns and information which ultimately is for organizations' benefits and growth. In this context the proposed model showed the best implementation of ERP module with providing extra efficiency using data mining implementation.

Key Words
ERP, Data Mining Techniques, FP Growth Algorithm.

1. Introduction

1.1 Enterprise Resource Planning (ERP)

Enterprise Resource Planning (ERP) incorporates the methods and procedures of all the organizations department into one platform. Which will carry the data in more suitable and reusable format. As Chang described the purpose and importance of ERP as, "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 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]. Nowadays the business changes occur very rapidly, especially the new electronic business inventions always put pressure on the business for the adoption of each and every technology on time. Due to this also small and medium size business changes their business process according to current technology. Jae-won stated in his research that, "An electronic business environment changes more rapidly under the 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].

Thomas Wailgum wrote in his article about ERP in the manner that its improve the business performance as well as the working of all processes. He said that "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]. Furthermore, according the several researches in ERP field, its now broadly accepted that ERP systems provide a feasible alternative to customize application growth for the standard information management requirements and its often better in terms of quality of the implemented business process [1].

Wen-Hsiung said in his research that current common ERP systems provide enough parameters and can be adjusted according to industry characteristics, but they still too complicated to use only effective under certain conditions [6]. Actually ERP solutions are intended to provide the facility to integrate the information in business. Moreover, its provide the facility to flow the data and information inside the company [13 , 21].

1.2 Data Mining Approaches

Data Mining, also popularly known as Knowledge Discovery in Databases (KDD), refers to the nontrivial extraction of implicit, previously unknown and potentially useful information from data in databases. While data mining and knowledge discovery in databases (or KDD) are frequently treated as synonyms, data mining is actually part of the knowledge discovery process [5]. Furthermore, Abdullah et. Al described the data mining in the sense of decision support systems (DSS) that, in decision support management terminology, data mining can be consider as a decision support process in which decision maker is searching to generate rule for the help in decision making [23, 15].

Mainly, data mining tasks has been divided into descriptive and predictive methods. Classification,

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clustering and rule association mining are most common techniques use for predictive and descriptive analysis [10]. Therefore, mainly scholars describe data mining in three major tasks. As Zaine [5] stated in his book chapter about major techniques of data mining as follows:

Classification – Classification analysis is the organization of data in given classes. Also known as supervised classification, the classification uses given class labels to order the objects in the data collection.

Classification consider as an important task of data mining. Using this approach data must be already defined a class label (target) attribute. Firstly we divide the classified data into two sets; training and testing data [11]. Where each datasets contains others atrributes also but one of the attributed must be defined as class lable attribute. Jiawei Han [11] described classification task in two steps process; first is model construction and the second is model usage. The main target of this task is to build the model by using training dataset and then assign unseen records into a class by using the trained model as accurately as possible. While training data set is use to build the model on the other hand testing data set is use to validate the model [10].

Clustering – Similar to classification, clustering is the organization of data in classes. However, unlike classification, in clustering, class labels are unknown and it is up to the clustering algorithm to discover acceptable classes. Clustering is also called unsupervised classification.

Clustering is one of the major task has been applying for data mining, work on unsupervised data (no predefined classes) [12]. Clustering is a collection of data objects, clustered by taking similar object to one another within the same cluster, and dissimilar to the objects related in other clusters. Cluster differentiate by using similarities between data according to the characteristics found in the data and grouping similar data objects into clusters [11].

Association – Association analysis is the discovery of what are commonly called association rules. It studies the frequency of items occurring together in transactional databases, and based on a threshold called support, identifies the frequent item sets.

Data can be use to find association between several attributes, generate rules from data sets, this task is known as association rule mining [12]. Given a set of transactions, find rules that will predict the occurrence of an item based on the occurrences of other items in the transaction. The goal of association rule mining is to find all rules having support $\geq$ minsup (minimum support) threshold and

confidence $\geq$ minconf (minimum confidence) threshold [10].

Moreover, association rule mining can be viewed as a two-step process, first, find all frequent itemsets: items satisfying minimum support. Second, generate strong association rules from the frequent itemsets: these rules must satisfy minimum support and minimum confidence [11].

Continue with the association mining as this technique we use in this research for generating the association rules by using ERP data. [18] discussed the knowledge discovery view by using apriori algorithm [7], the model we can use for extracting rules and pattern form the data. Furthermore, data mining can be apply in ERP data also where association between the several attributes of customer queries provides the result of future prediction of expected solution of the customer queries and department activities.

2. Related Work / Background

An ERP system provide the complete functionalities and specification which by using an organization can get the full of benefits. As Fiono discussed in his article about ERP that, "An ERP system is a packaged business software system that enables a company to manage the efficient and effective use of resources (materials, human resources, finance, etc.) by providing a total, integrated solution for the organization's information-processing needs. It supports a process-oriented view of the business as well as business processes standardized across the enterprise" [16].

Virgil Chichernea and Romanian [8] presented the general architecture for an ERP system which consists of 12 business jobs utilizing a general operational database, shown in the Figure-1. Moreover, [6] has discussed that "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]. Moreover, [6] stated 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".
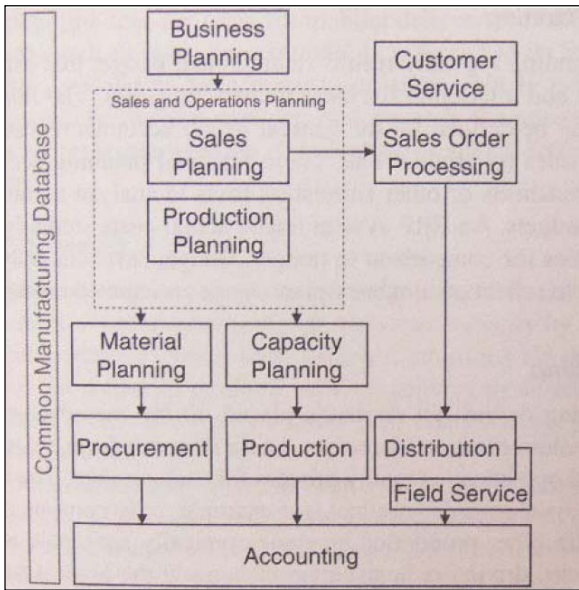
Figure-1 : Architecture of an ERP System [8]

The major concern in this paper is relates with the model presented in figure-2. This model is known as ERP-CRM

model presented by [17], which described the good example of ERP implementation using data mining techniques. This model explained the ERP model to resolve the business issues. According to the authors point of view presented in that paper, whenever customer request to the company it direct to the related department for the evaluation of the query and replied properly. As per the analysis and evaluation of the request the reply back to the asked customer and this whole process will be saved in the database for the future requirements. The scenario described in this model is common in several organizations for creating more proper and steadfast environment. They presented this whole scenario in the model in three different views. After implementation of this model the company can have a complete procedure to predict the customer's query in advance. In fact the major concern with the upper management looks so busy in solving such kind of customer's queries. It can become an automated decision making process [2]. The three views described in the model [17] are as follows:

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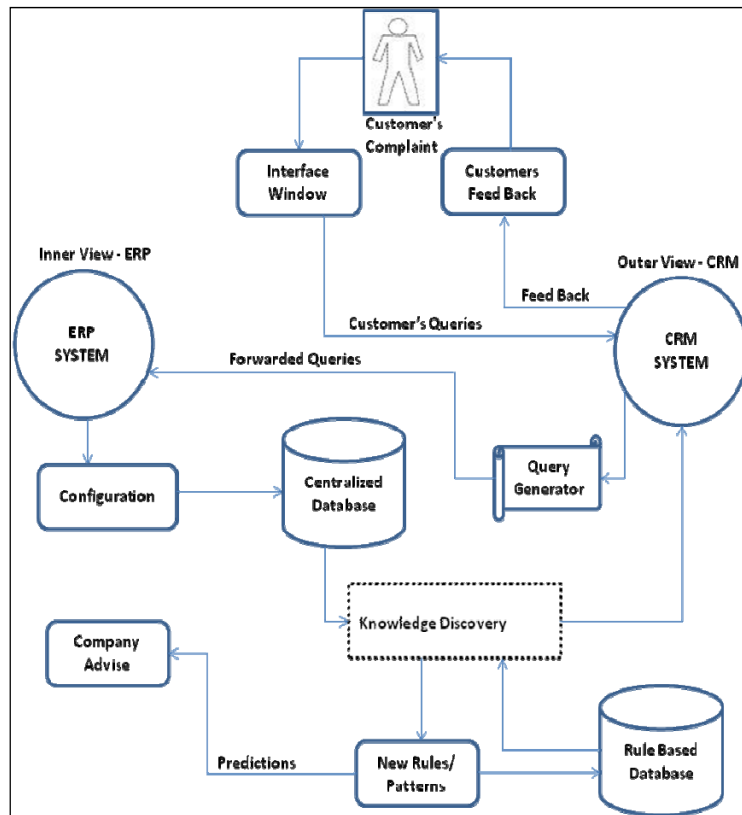   iii.   Knowledge Discovery View

Figure-2 : ERP-CRM Model [17]

The results analyzed using the proposed model in [17] can be applied by using more proper tool. In [17] applied the data mining technique association mining (Apriori Algorithm) by using Visual Basic (VB) interface. While using the VB interface to build your own code is more complicated and less expressive then using an integrated development environment (IDE). There are several IDE tools available for the implementation of data mining tasks such as Rapid Miner [20], and Oracle Data Miner [12].

In this paper a comparative study has been presented by using the same model [17] of ERP. Therefore, another algorithm called Frequent Pattern (FP) applied in this paper by using Rapid Miner tool [20]. The complete description of Rapid Miner and FP Growth algorithm has been presented in the succeeding sections.

3. Case Study

For the practical implementation of presented model we applied data mining technique on the data of ABC organization. Which is an ERP based organization physically working in Kingdom of Saudi Arabia dealing with several small and medium size software projects. Where they are receiving several customer's queries related with software installation and maintenance. We applied the model on the data related with customer queries and responses. Therefore, we implemented the FP growth algorithm to find and generate rules for the future purpose and ease in the responding on customer's queries. We applied the FP growth algorithm using Rapid Miner tool, which is a good professional tool provides the facility of almost every data mining task. The detailed description of all the phases is presented below.

3.1 FP Growth Algorithm

FP Growth is known as one of the standard technique uses for the generation of association rules. FP growth is an algorithm which is working on the basis of divide and conquers method. The major purpose of this technique is to produce frequent item sets by using the combination of data attributes. It basically works on to generate frequent item set without candidate set generation [14]. Another sister method of FP growth is known as apriori algorithm also use in association data mining. Apriori is a classic algorithm for learning association rules [23 , 3]. Apriori is designed to operate on databases containing transactions (for example, collections of items bought by customers, or details of a website frequentation) [24, 22]. 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 [3].

The major steps of FP growth are consist of the following steps:

"Step1- First condenses the database showing frequent item set in to FP-tree.
Step2: It divides the FP-tree in to a set of conditional database and mines each database separately, thus extract frequent item sets from FP-tree directly. It consist of one root labeled as null, a set of item prefix sub trees as the children of the root, and a frequent .item header table. Each node in the item prefix sub tree consists of three fields: item-name, count and node link where---item-name registers which item the node represents; count registers the number of transactions represented by the portion of path reaching this node, node link links to the next node in the FP- tree. Each item in the header table consists of two fields---item name and head of node link, which points to the first node in the FP-tree carrying the item name" [14].

3.2 FP Growth Pseudo Code

Input: constructed FP-tree
Output: complete set of frequent patterns
Method: Call FP-growth (FP-tree, null).
procedure FP-growth (Tree, α)
{
      1) if Tree contains a single path P then
      2) for each combination do generate pattern β
α with support = minimum support of nodes in β.
      3) Else For each header ai in the header of Tree
do {
      4) Generate pattern β = ai α with support = ai.support;
      5) Construct β.s conditional pattern base and then
β.s conditional FP-tree Tree β
      6) If Tree β = null
      7) Then call FP-growth (Tree β, β)}
}   [14]

3.3 Tool used for FP-Growth Implementation

The tool used for the implementation of FP growth in this study is RapidMiner. RapidMiner is an open source package provides good range of major tasks using in data mining; includes, regression, clustering, classification, and association with a good range of sub algorithms too [12]. RapidMiner provides an integrated development environment to build and apply the data mining tasks [20]. It provides the long list of processes, operators and data sets for the help of students, decision makers and researchers showed in figure-3.
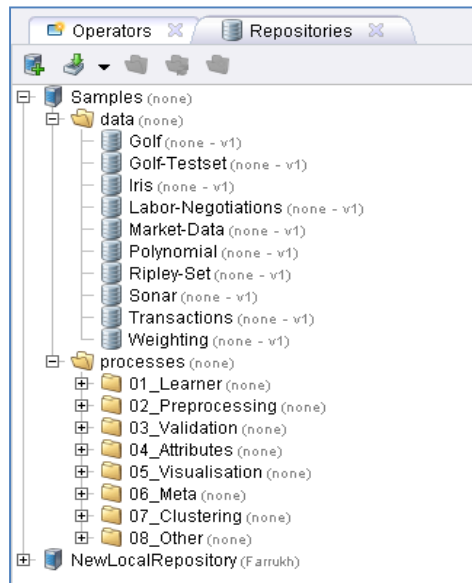
Figure-3 List of Operators [19]

3.4 Selected Attributes for Input File

There was hundreds of queries has been asked and saved in the system while data gathering process. In which we have selected finally fifteen (15) attributes for the final implementation for data mining process. The details of the selected attributes displayed in figure-4.

S.No.	List of Customer Queries	Query Code
1	Figures are not Correct in Generated Bill	FCG
2	Re-order for Pending Request	RoPR
3	Change in Salary Structure	CSS
4	The Password is not Working	PnW
5	The Web Server is not Responding	WSnR
6	The services are more slow in office timing	SsOT
7	The History of the Customer	HoC
8	Manage the Inventory Database	MID
9	Real Time Salary Transformation	RTST
10	Issues of Loan Amount	ILA
11	Dues are not Clear after Payment	DnC
12	Generation of New Employee ID	FNEID
13	Not receiving Company's informative email	NrCIE
14	Registration for Online Account	ROA
15	Call for Meeting	CfM

Figure-4 List of Selected Attributes

3.5 Input File

Now, the list of attributes has been selected for the creation of input file. After implementation of several data preprocessing steps i.e. data discritization, data transformation, the input file has been manipulated according to the requirements of this case study. We

transformed each of the attribute (query) using three values, where each value is defining the action has been taken on the particular query. Out of three columns the value "1" is showing that the action on the particular column has been selected as a response on the query. The details of the distribution of the values and transformation of each attribute into three columns showed in figure-5. The same file has been processed into Rapid Miner as a input file

3.6 The Implementation of FP Growth Process in Rapid Miner

Until now, the input file has been generated and modified according to the requirements of FP Growth and Rapid Miner. Here in this step we will process the FP Growth algorithm by using the above input file. There are several steps related with this process some of the has been discussed below and presented in the figure-6 . There are total four operators used in this process. Operators in the Rapid Miner are kind of function using which we can apply our required tasks. The description of the operators in sequence of the figure has been presented below:

Operator-1- Read CSV: This operator can read CSV files, where all values of an example are written into one line and separated by a constant separator. The separator might be specified in the column separators parameter. The default will split the line on each comma, semicolon and blank. The first line is used for the attribute names as default, controlled by the use first row as attribute names parameter [19].
By using this operator we have processed our input file into rapid miner for further process.

Operator-2- Numerical to Binominal: Converts all numerical attributes to binary ones. If the value of an attribute is between the specified minimal and maximal value, it becomes false, otherwise true. If the value is missing, the new value will be missing. The default boundaries are both set to 0, thus only 0.0 is mapped to false and all other values are mapped to true [19].
In original data input file all values were in binary format, but for the implementation of FP growth all data required to be convert in binominal (True/False) format. Therefore we used this operator to value conversion.

Operator-3- FP Growth: This operator calculates all frequent items sets from a data set by building a FP Tree data structure on the transaction data base. This is a very compressed copy of the data which in many cases fits into main memory even for large data bases. From this FP Tree all frequent item set are derived. A major advantage of FP Growth compared to Apriori is that it uses only 2 data

scans and is therefore often applicable even on large data sets [19].

Now the time for connect the data file with the FP growth algorithm are using in this case study. This operator will scan the data file and extract all useful frequent item sets from the data. The operator requires the Support value for the selection of the data given 95% in this case.

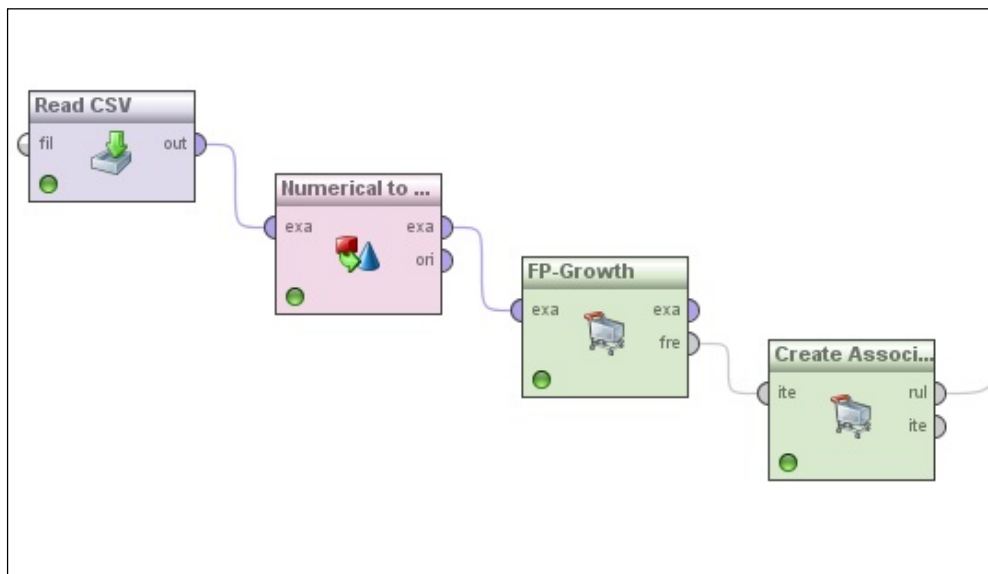| Figures are not Correct in Generated Bill1	Figures are not Correct in Generated Bill2	Re-order for Pending Request1	Re-order for Pending Request2	Change in Salary Structure 1	Change in Salary Structure 2	The Web Server is not Responding1	The Web Server is not Responding2	The History of the Customer1	The History of the Customer2	Manage the Inventory Database 1	Manage the Inventory Database 2	Real Time Salary Transformation 1	Real Time Salary Transformation 2	Dues are not Clear after Payment 1	Dues are not Clear after Payment 2	Not receiving Company's informative email1	Not receiving Company's informative email2
0	0	0	1	1	0	0	1	0	1	0	1	0	1	1	0	0	1
1	0	1	0	1	0	1	0	0	1	1	0	1	0	1	0	1	0
1	0	0	1	0	1	0	1	0	1	0	1	1	0	0	1	0	1
1	0	1	0	1	1	1	0	1	0	0	1	0	1	1	0	1	0
1	0	0	1	0	1	0	1	1	0	1	0	1	0	1	0	0	1
1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0
0	1	1	0	0	1	1	0	1	0	1	0	0	1	0	1	0	1
0	1	0	1	1	0	0	1	1	0	1	0	0	1	0	1	1	0
1	0	0	1	1	0	1	0	0	1	1	0	1	0	1	0	0	1
1	0	0	1	0	1	0	1	1	0	0	1	1	0	1	0	1	0
0	1	0	1	0	1	0	1	0	1	0	1	1	0	0	1	0	1
1	0	1	0	1	0	1	0	0	1	0	1	0	1	1	0	1	0
1	0	0	1	0	1	1	0	1	0	1	0	0	1	0	1	0	1
1	0	0	1	1	0	1	0	1	0	1	0	0	1	0	1	1	0
1	0	0	1	1	0	1	0	1	0	0	1	1	0	1	0	0	1
1	0	0	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0
0	1	0	1	1	0	1	0	1	0	0	1	0	1	0	1	0	1
0	1	1	0	1	0	0	1	0	1	0	1	0	1	0	1	1	0
1	0	0	1	0	1	1	0	0	1	1	0	0	1	0	1	0	1

Figure-5 Input File

Figure-6 The Data Mining Process

Operator-4- Create Association Rules: This operator generates association rules from frequent item sets. In Rapid Miner, the process of frequent item set mining is divided into two parts: first, the generation of frequent item sets and second, the generation of association rules from these sets. For the generation of frequent item sets, you can use for example the operator FP Growth. The result will be a set of frequent item sets which could be used as input for this operator [19].

Finally this operator take the input from the FP growth algorithm, which means that this operator only take the list of frequent item sets generated by the previous algorithm operator. It cannot work on the original data

file. After receiving all frequent item sets it generates the rules from the list given the confidence value 80%.

3.7 List of Generated Rules

The list of rules has been generated using three main process i.e. input file→ frequent item set → rules. There are several rules extracted using 95% support and 80% confidence value. The list presented in figure-7 having right side (premises) and left side (conclusion) with support and confidence value for each rule. Its now very easy to read and understand the rules and apply them for future correspondence. For example in Rule #1 if the "Password is not working OR They called for a meeting" to solve the issue, then in conclusion the problem has been pointed out that the error was in web server was not responding and so on.

After having those list of rules the higher management can guide their customer using knowledge management data bases and can response online by using automated response machine. Furthermore, the knowledge management will be modified after arrival on new queries accordingly. The model presented in figure- 2 showed that, the knowledge management is consider a separate database manage just to help to send the response on customer's queries. The knowledge management only can provide the help to send the response by using the list of rules generated in each iteration. This is complete understanding initiate from customer queries arrival till the customer's satisfaction. Here the customer is not always from the outside of the company but it can be consider any user approaching the system from inside too.

| Premises	Conclusion	Support	Confid...
The Password is not Working2, Call for Me	The Web Server is not Responding1	0.306	0.846
The Password is not Working2, Call for Me	The services are more slow in office timin	0.306	0.846
The Password is not Working2, Call for Me	The Web Server is not Responding1, The	0.306	0.846
Change in Salary Structure2, The Passwo	The Web Server is not Responding1	0.306	0.846
The Password is not Working2, Call for Me	The services are more slow in office timin	0.306	0.846
Change in Salary Structure2, The Passwo	The services are more slow in office timin	0.306	0.846
Change in Salary Structure2, The Passwo	The Web Server is not Responding1, The	0.306	0.846
Change in Salary Structure2, The Passwo	The services are more slow in office timin	0.306	0.846
Change in Salary Structure2, Call for Meeti	The Web Server is not Responding1	0.361	0.867
Change in Salary Structure2, Call for Meeti	The services are more slow in office timin	0.361	0.867
Change in Salary Structure2, Call for Meeti	The Web Server is not Responding1, The	0.361	0.867
Change in Salary Structure2, Call for Meeti	The services are more slow in office timin	0.361	0.867
The Password is not Working2, Figures ar	The Web Server is not Responding1	0.389	0.875
Figures are not Correct in Generated Bill1,	The Web Server is not Responding1	0.389	0.875
The Password is not Working2, Figures ar	The services are more slow in office timin	0.389	0.875
Figures are not Correct in Generated Bill1,	The services are more slow in office timin	0.389	0.875
The Password is not Working2, Figures ar	The Web Server is not Responding1, The	0.389	0.875
Figures are not Correct in Generated Bill1,	The Web Server is not Responding1, The	0.389	0.875
The Password is not Working2, Figures ar	The services are more slow in office timin	0.389	0.875
Figures are not Correct in Generated Bill1,	The services are more slow in office timin	0.389	0.875
Change in Salary Structure2, Figures are r	The Web Server is not Responding1	0.417	0.882

Figure-7 List of Generated Rules
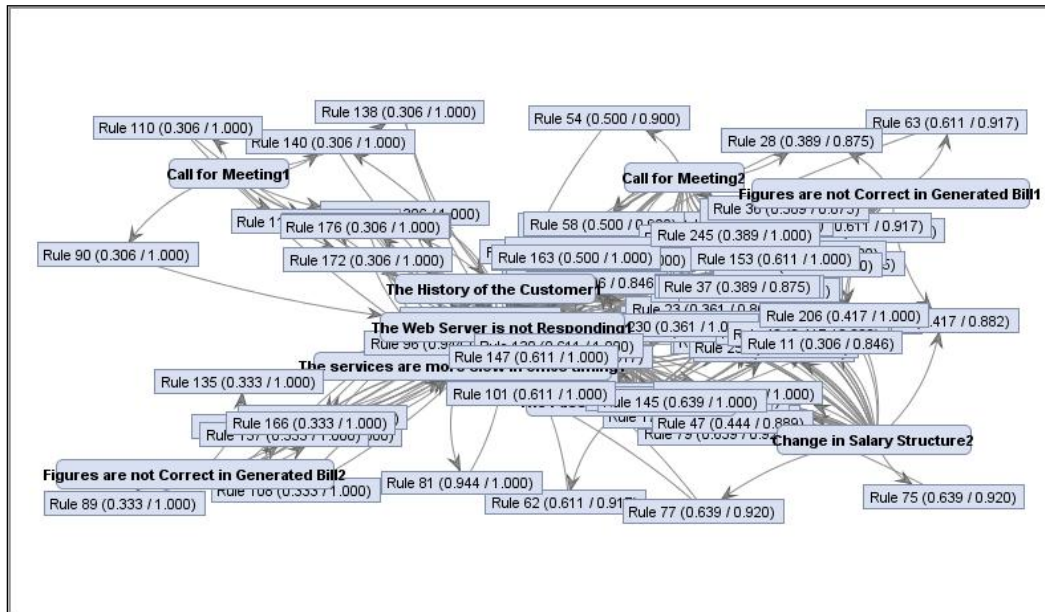
Figure-8 Rules Tree

4. Future Work

The model and case study can be enhanced more in future by implementing some other data mining techniques as well as ERP tools. In this paper we studied the result of using single algorithm. The future perspective can be generation of the new rules using multiple techniques. The concept of ERP building are still in progress the more branches can increase the more phases in the model. Our future task is to apply the same process on different type of data to compare and analyze the results clrearly.

5. Conclusion

Customers play significant role for building the strong architecture for a company. Each query, complain and positive response take company's image one step forward in the open market. Keeping in mind the importance of customers in any organization we tried to work on the customer's complain database using ERP architecture. Moreover the current modern techniques of data mining applied for better understanding of data and generate new rules and patterns for the knowledge management database. ERP based organization has been selected for extracting the data from centralized database having internal and external queries. The knowledge discovery view has to generate new rules for the improvement of organization's performance. Overall the case study in this paper lead us towards building an organization better and satisfy the customer using ERP concept and data mining tasks.

Acknowledgement

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