A Supplier Selection Criteria Using Boolean Association Rule Mining

Om Prakash *omprakash026@rediffmail.com*
Assistant Professor/Computer Science and Engineering
PSIT Kanpur,208020, India

Sunil Kumar *sunil.hbti2007@gmail.com*
Assistant Professor/Computer Science and Engineering
PSIT Kanpur-208020, India

Anil Gupta
Assistant Professor/Computer Science and Engineering *anil.g323@gmail.com*
UCER Allahabad-211008 , India

Abstract

Supplier selection is a multi criteria problem; nowadays it is very difficult to select a good supplier among huge number of suppliers. To select a good supplier among numbers of supplier we include both qualitative and quantitative factors. In this project we use Boolean association rule mining to count the support and confidence of suppliers which is based on different qualitative and quantitative criteria of suppliers. These projects generate a rule with some support and confidence and select the supplier who satisfied the criteria condition (Boolean association rule).

Keywords: Association Rule Mining, Support, Confidence, Suppliers selection, BARM (Boolean Association Role Mining) etc**.**

1. INTRODUCTION

Today the cost of raw materials, manufacturing process, and component parts constitutes the main cost of a product. In such circumstances this is very difficult to purchase the goods which assured the quality and cost of goods. In this type of situation buyer decision play a major role to select a good supplier. Basically there are two kinds of supplier selection problem: (1) Supplier selection when there is no constraint. In other words, all suppliers can satisfy the buyer's requirements of demand, quality, delivery, etc. (2) Supplier selection when there are some limitations in suppliers' capacity, quality, etc. In the first kind of supplier selection, one supplier can satisfy all the buyer's needs (Single Criteria) and the management needs to make only one decision, which supplier is the best, whereas in the second type of supplier selection, as no supplier can satisfy all the buyer's requirements, more than one supplier has to be selected (Multiple Criteria). Many techniques have been proposed for supplier's selection using single criteria and multiple criteria supplier selection method. Here we implements a supplier selection method based on multi criteria technique. In this work we implement a Boolean association rule mining on a data set appendix-(1) that count the support and confidence for each criteria based rule and select the suppliers who satisfy the extracted rule (Boolean association rule mining).

2. PROPOSED APROACH

In old method of supplier selection we seen that the variables and the criteria were considered independently which is not practical because some criteria were not independent to others due to the dependencies of criteria supplier selection method not give efficient results. For example when we see the supplier selection method proposed by Dickson we see that Dickson reviewed 23 criteria and claims that Quality, Lead time, and efficiency, On- time Delivery (OD) and Quality

Improvement (QI) are the most important criteria but we see that the criteria: Quality and Quality Improvement (QI), and Lead time and On- time Delivery (OD) are not completely independent so result produce by this method was not more efficient. Similarly Weber proposed another method and concludes that the Price, Lead time, and Quality are the most important criteria. We analyze several rules and found that the following dependencies among several supplier selection criteria:

- Lead time and on- time Delivery (OD).
- Manufacturing processes efficiency and price.
- Quality and Quality Improvement (QI).

In this research we introduce the application of association of rule mining (one of data mining techniques) in supplier selection. Data mining is a process that finds valuable information from a huge amount of data in order to be used in decision making for achieving to business goals. Especially, efficiency of data mining techniques is apparent when the data set is huge. Certainly, there is rich information about suppliers in any company. The purpose is to find the best suppliers that maximize the buyer's profit. So far data mining can enables the managers to making better decisions.

In this approach the supplier selection done in three sections:

1. Select criteria and gather information about that criteria's: In this phase, a few criteria is selected. Then, the available information about the chosen criteria is gathered. In this step we prepare our data set on which we perform Boolean association rule mining for supplier selection.

2. In this step we perform BARM (Boolean association rule Mining). That generates a rule with some support and confidence. "If a rule involves association between presence or absence of criteria and condition associated with that is called Boolean association rule mining." BARM is a single dimension association rule mining. In this rule support and confidence are calculated as: for rule (A→B), Support (A→B) =P (A union B) and confidence (A→B) =P (B / A).

3. In this step we select the supplier who satisfy the extracted the rule. The selected supplier must satisfy the support and confidence extracted by rule.

2.1 Algorithm

Step 1: Select data set (appendix-1) for supplier selection. This data set contains criteria and their corresponding value for each individual supplier.

Step 2: Now select a criteria field as Antecedent variable with condition. On the basis of Antecedent condition we compute the support, means how many suppliers satisfy the Antecedent condition.
The support is calculated as follows:
For rule (A→B), Support (A→B) =P (A union B).
Example: Total numbers of suppliers=27, Antecedent condition = (CL<3.000) Selected random number of instances = 6. (On the basis of Antecedent condition)
So support = 6/27*100 = 22.22 %.

Step 3: Now select a criteria field as Consequent variable corresponding Antecedent variable.(from Appendix – 1)

For example (A → B)
↓ is ↓ is
Consequent Antecedent
Example: select QSO as consequent variable with the condition (QSO>=4) and CL is Antecedent variable with the condition (CL<3.000).

Step 4:-Now we see how many suppliers satisfies the rules.

$$
\begin{array}{ccc}
(A & \rightarrow & B) \\
\downarrow \text{is} & & \downarrow \text{is} \\
(QSO>=4) & \rightarrow & (CL<3.00)
\end{array}
$$

We seen that supplier no.2, 6,7,8,18,19 satisfy Antecedent condition and all of these six suppliers also satisfy the consequent condition.
So confidence of the rule (QSO>=4) → (CL<3.00) is (6/6)*100 = 100 %.

Step-5: In this step we display the selected suppliers who satisfy the extracted rule. For example in above example we see that the suppliers number 2, 6, 7,8,18 and 19 satisfy the extracted support and confidence. So selected suppliers are 2, 6, 7,8,18 and 19.

2.2 Processing Time

This is very important that how much time taken in this approach to select the suppliers among numbers of suppliers. Actually in this approach we focused only on processing time and we not consider interactive time. So when we insert the criteria in antecedent block and in consequent block and submit these details at that point we start the time counting till return the extracted rule. The processing time we also display in new column of extracted rule table.

2.3 Related Works

For supplier selection many methods has been proposed. Thomas, S. [1] proposed an algorithm for incremental updation of association rule mining in large data base. This large data set just work as a data set for vendor's criteria for their selection. Thuraisingham [4] perform another study and conclude that a primer for understanding and applying data mining technique for the supplier selection works. Meo, R., G. Psaila, and S. Ceri [5] did another study about this subject by emphasizing a new SQL-like Operator for Mining Association Rules. E. Timmerman [13], present an approach to vendor performance evaluation. The objectives of the model are selecting the best suppliers and determining order size that maximizes the revenue. We propose an BARM supplier selection methods and we show an example of BARM for supplier selection by using the data set from [9]. Supplier selection criteria are QSO (Quality System Outcome), Claims (CL), Quality Improvement (QI), Response to Claims (RC), On-time Delivery (OD), Internal Audit (IA), and Data Administration (DA). Data set is mentioned in table-1. In each step of BARM, for supplier selection, we should consider one field as consequent variable and other fields as antecedent variables and compute support and confidence. The suppliers who satisfy the extracted rule will selected out of all suppliers list. In algorithm we also compute processing time taken by each extracted rule in this algorithm.

QUANTITIES OF 7 CRITERIA ABOUT 27 SUPPLIERS

Index	QSQ	RC	QI	CL	OD	IA	DA
1	4.5	1	8	5	1	2	22.6
2	5	2	10	1	2	2.5	22.5
3	5	3	10	5	3	1.5	27.5
4	4.5	1	8	5	1	3.5	22
5	5	1	9	5	1	5	28.5
6	4	2	7	1	2	2.5	26
7	5	2	10	1	2	4	24.5

8	5	2	10	1	2	4	24.5
9	4	3	7	5	3	4.5	26.5
10	4.3	3	7.7	5	3	4	25.4
11	5	3	10	5	3	3	28
12	5	3	10	5	3	3.5	27.5
13	5	3	10	5	3	4	28
14	5	3	10	5	3	4	28
15	5	3	10	5	3	4	30
16	5	3	10	5	3	4.5	29
17	4	2	8	5	2	3	22.5
18	4	2	8	1	2	4	24.5
19	4	2	8	1	2	2.5	27.9
20	4.5	3	9.5	5	3	3	27.5
21	3.5	2.5	7.5	5	2.5	3.5	24
22	4	1	8.5	5	1	3.5	26.3
23	4	3	9	5	3	4	29
24	4	3	10	5	3	4.5	27.5
25	4	3	10	5	3	5	29.5
26	3	3	10	5	3	3	22.5
27	2.5	1	8	5	1	3	23.7

TABLE-1 Data Set

2.4 Results Discussion and Snapshots

In this section we show some snapshot of our research and explain our supplier selection results. In this algorithm that's we already explain in proposed approach section, we select one field as consequent field and other anyone field as antecedent variable and we finally get the list of suppliers after submission these entries. The first snapshot shows what type of entries are required in this algorithm.

FIGURE1: Boolean Association Rule Mining snapshot

The second snapshot shows how we select the criteria field, the set of all criteria are shown in snapshot and we can select any of one criteria as consequent or as antecedent variable.

FIGURE2: Boolean Association Rule Mining with Criteria

Once we select the criteria then we select condition for selected criteria in term of the value. These conditions may be either equal to, less than, less than equal to, greater than or greater than equal to.

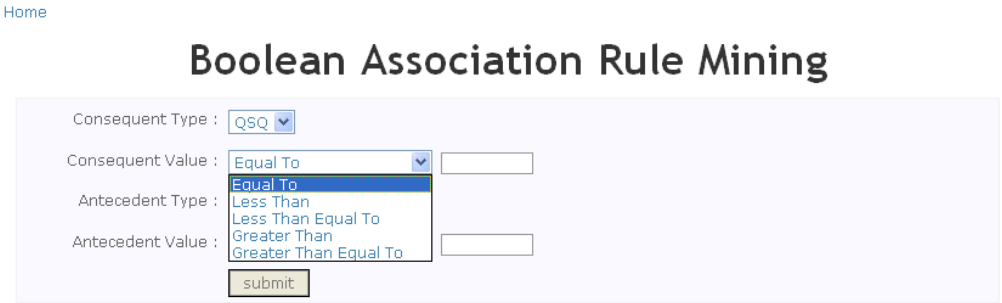
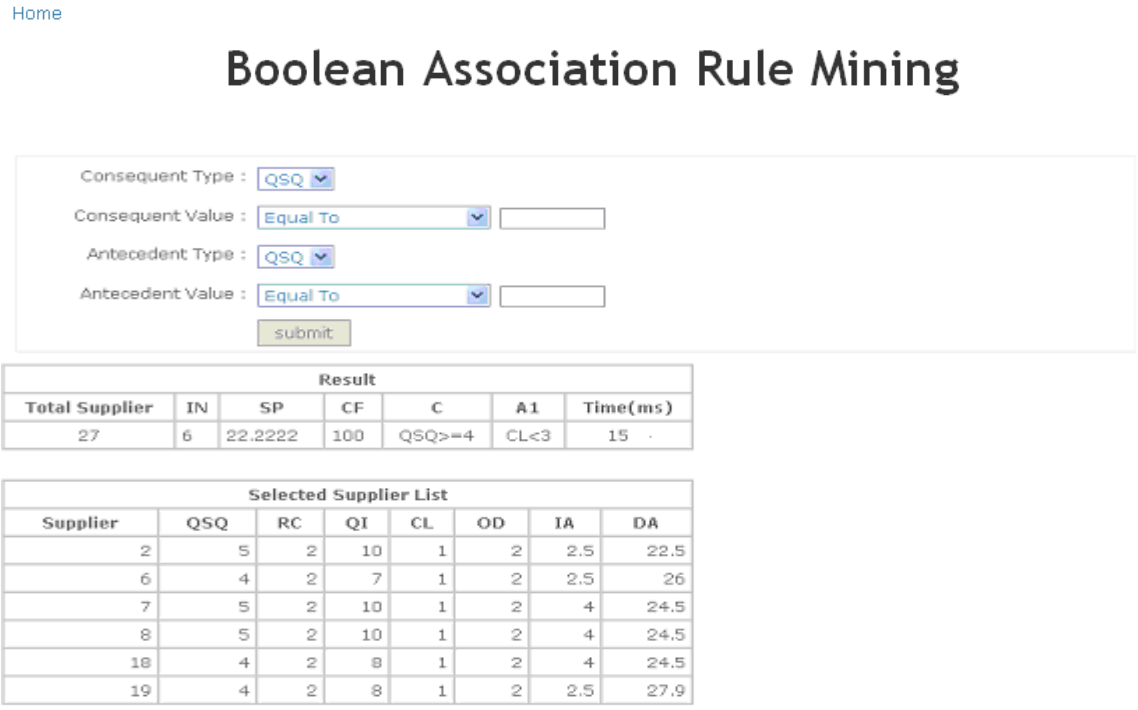


FIGURE3: Boolean Association Rule Mining with Criteria Condition

In this snapshot we select the criteria QSO as consequent type with greater than equal to 4 and criteria claim (CL) as antecedent type with value less than 3 and submit the entered value.

FIGURE4: Boolean Association Rule Mining with Criteria and Values

When we submit these values the detected rule is displayed in this snapshot. We see that the detected rule contain support 22.22 % and confidence 100 % with consequent condition (QSO >= 4) and antecedent condition (CL<3) and processing time of this rule is 15 ml seconds. According to this rule the supplier number 2, 6, 7, 8, 18 and 19 are right suppliers and this list is shown below in the selected supplier list. The selected supplier list contains the all details of selected supplier. For example the details of supplier no.2 are as follows: value of quality service outcome (QSO) is 5, value of response to claim is 2, value of quality improvement (QI) is 10, value of claim (CL) is 1, value of on-time delivery (OD) is 2, value of internal audit (IA) is 2.5 and value of data administration is 22.5.



Result

Total Supplier	IN	SP	CF	C	A1	Time(ms)
27	6	22.2222	100	QSQ>=4	CL<3	15

Selected Supplier List

Supplier	QSQ	RC	QI	CL	OD	IA	DA
2	5	2	10	1	2	2.5	22.5
6	4	2	7	1	2	2.5	26
7	5	2	10	1	2	4	24.5
8	5	2	10	1	2	4	24.5
18	4	2	8	1	2	4	24.5
19	4	2	8	1	2	2.5	27.9

FIGURE5: Boolean Association Rule Mining with List of Suppliers

In next snapshot we show some detected rules for supplier selection using Boolean association rule mining. We also compute the processing time and display in last column.

Detected Boolean Association Rules

Home
Refresh All Results

Boolean ARM Results								
IN	SP	CF	C	A1	A2	A3	A4	Time(ms)
6	22.2222	100	QSQ>=4	CL<=3				32
7	25.9259	57	QSQ>=4	DA<24.250				33
15	55.5556	100	CL=5	RC>2.250				31
3	11.1111	100	CL=5	QSQ<3.750				16
27	100	22	CL=1	RC<3.50				32
12	44.4444	58	QI<8.250	RC<2.250				16
22	81.4815	32	RC<2.250	OD>1.50				15
25	92.5926	24	CL=1	IA>2.250				16
24	88.8889	21	IA<2.750	QSQ>=4				15
22	81.4815	23	DA<24.250	IA>2.750				31
6	22.2222	50	QSQ>4	CL=1				15
6	22.2222	100	QSQ>=4	CL<3				33

FIGURE6: Detected Boolean Association Rules

2.5 Advantage of Proposed Approach

This approach helps to take better decision when the data set is incomplete. In practice it is possible that the information about some variables (variables are a selection of the supplier criteria) is not complete. In that type of case this approach is very useful because in this approach we consider only single criteria condition at a time so if required criteria is not present then we can extract rule by using another similar (alternative of required information.) criteria. This rule also increase the ability for supplier selection in less time because when data set is very huge then this method extract the rule in short amount of time (processing time) because this method only count current selected criteria condition at the time of execution rather than to consider all criteria.

2.6 Future Work and Research Issues

• Use of suggested approach for suppliers in different industries (by enough data) to detect valuable and applied rules and also include some variable criteria in suppliers list to improve the acceptability of rule in large number of industries.

• Development of multi-level supplier selection method using ARM technique that detects more practical results in terms of supplier selection.

2.7 Conclusion

After implementing the BARM in supplier selection, it is clear that the BARM can detect the rules with high support and confidence. The BARM detects valuable patterns about supplier behavior in term of criteria and prevents from making wrong decision repeatedly. The main advantage of this rule is that, it takes less time and in easy way we can update the rule base by changing our preferences (i.e. criteria).

3. REFERENCES

[1]. Thomas, S., et al. “An Efficient Algorithm for the Incremental Updation of Association Rules in Large Databases”. In *Knowledge Discovery and Data Mining. 1997.*

[2] Thomas, S., "Architectures and optimizations for integrating Data Mining algorithms with Database Systems", In *CSE. 1998, University of Florida: Gainesville.*

[3] Thomas, S. and S. Chakravarthy. "Incremental Mining of Constrained Associations". *In Proc. of the 7th Intl. Conf. of High Performance Computing (HiPC). 2000.*

[4] Thuraisingham, B., "A Primer for Understanding and Applying Data Mining". In *IEEE, 2000. Vol. 2, No.1: p. 28-31.*

[5] Meo, R., G. Psaila, and S. Ceri. "A New SQL-like Operator for Mining Association Rules" *In Proceedings of the 22nd VLDB Conference. 1996. Mumbai, India.*

[6] Agrawal, R. and K. Shim, "Developing tightly-coupled Data Mining Applications on a Relational Database System." In *1995, IBM Almaden Research Center: San Jose, California.*

[7] Sarawagi, S., S. Thomas, and R. Agrawal. "Integrating Association Rule Mining with Relational Database System: Alternatives and Implications. In ACM SIGMOD" In *Int'l Conference on Management of Data. 1998. Seattle, Washington.*

[8] Hongen, Z."Mining and Visualization of Association Rules over Relational DBMSs", *In CSE. 2000, UFL: Gainesville.*

[9] Sung Ho Ha and Ramayya Krishnan, "A hybrid approach to supplierSelection for the maintenance of a competitive supply chain, ExpertSystems with Applications", In *Volume 34,Issue 2, February 2008, Pages 1303-1311*

[10] C.A. Weber, J.R. Current and A. Desai, "An optimization approach to determining the number of vendors to employ, Supply Chain Management" In *an International Journal 5 (2) (2000), pp. 90–98.*

[11] G. Wang, S.H. Huang and J.P. Dismukes, "Product-driven supply chain selection using integrated multi-criteria decision-making methodology", In *International Journal of Production Economics 91 (1) (2004), pp. 1–15.*

[12] L. De Boer, E. Labro and P. Morlacchi, "A review of methods supporting supplier selection", In *European Journal of Purchasing & Supply Management 7 (2) (2001), pp. 75–89.*

[13] E. Timmerman, 1986. "An approach to vendor performance evaluation", In *J. Purchasing Mater. Mgmt. Winter, 2-8.*

[14] Om Prakash, Rashid Ali, "A comparative study of supplier selection methods and association rule mining technique for supplier selection process" In *CMEMS, UIT Allahabad,2010.*