Evolution of new WARM using Likert Weight Measures(LWM)

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Summary

The field of data mining draws upon several roots, including statistics, machine learning, databases and high performance computing. Supplier selection is an important process which needs more expertise to select a supplier as the technology complexity has increased. Frequently as there is a change in the market it will be better if flexibility is maintained. Choosing the right method for supplier selection effectively leads to a reduction in purchase risk and increases the number of JIT suppliers and TQM production. AHP is a widely accepted multi criteria decision making model, which is suitable for supplier selection process. But AHP is required high computation power. In order to reduce more computation power, in this paper we introduced a new model called Likert Weight Meaure (LWM), which is considered to be a light weight supplier selection model. Likert model is globally accepted scaling factor for psychometric feedback.

Keywords: *Data Mining, Weighted Association Rule Mining, AHP, LWM*

1. Introduction

Data mining is often defined as finding hidden information in a database. Data mining is also called as exploratory data analysis, data driven discovery and detective learning, is the field of discovering novel and potentially useful information from large amount of data. The field of data mining draws upon several roots, including statistics, machine learning, databases and high performance computing. In recent decades, significant evolutions are developed in data mining techniques. These techniques are applied in various and successful applications in different domains e.g. marketing, investment and banking. Business must be profitable, react quicker and offer higher quality services than even before and do it all using fewer people and at lower cost. With these types of expectations and constraints, data mining becomes a fundamental technology, enabling business to more accurately predict opportunities and risks generated by their customers and suppliers.

Today in industry supplier selection is an important process which needs more expertise to select a supplier as the technology complexity has increased. Frequently as there is a change in the market it will be better if flexibility is maintained. In any industry the cost of the component and the components purchased are the external sources and is important to take decision in the purchase activity. The search of new suppliers is a continuous process for companies' in order to upgrade the variety of product range. There may be more number of suppliers for any product; therefore selecting a supplier is more important. The different aspects to select a supplier may be first, determine the number of suppliers and the mode of relationships with them and select a best supplier among the various existing alternatives. Supplier selection decisions are complicated by the fact that various criteria must be considered in decision making process. Supplier selection and evaluation have become one of the major topics in production and operations management literature, especially in advanced manufacturing technologies and environment (Motwani et al., 1999). The main objective of supplier selection process is to reduce purchase risk, maximize overall value to the purchaser, and develop closeness and long-term relationships between buyers and suppliers, which is effective in helping the company to achieve "Just-In-Time" (JIT) production (Li et al., 1997). Additionally, with the increase in use of Total Quality Management (TQM) and Just-In-Time (JIT) concepts by a wide range of firms, the supplier selection question has become extremely important (Petroni, 2000). Choosing the right method for supplier selection effectively leads to a reduction in purchase risk and increases the number of JIT suppliers and TQM production. Supplier selection is a multiple criteria decision-making (MCDM) problem which is affected by several conflicting factors. Consequently, a purchasing manager must analyze the trade-off between the several criteria. MCDM techniques support the decision-makers (DMs) in evaluating a set of alternatives (Amid et al., 2006). Supplier selection problem has become one of the most important issues for establishing an effective supply chain system.

2. Research Background

There are several supplier selection methods available in the literature. Some authors propose linear weighting

Manuscript received May 5, 2011
Manuscript revised May 20, 2011

models in which suppliers are rated on several criteria and in which these ratings are combined into a single score such as the categorical model. The categorical model is a simple method, but it is also the quickest, easiest, and least costly to implement. However, it may be influenced by recent events and usually implies a high level of subjectivity and therefore it is imprecise (Petroni, 2000). According to Chen-Tung et al. (2006), the Fuzzy logic approach measures for supplier performance evaluation. This approach can help Decision Making (DM) to find out the appropriate ordering from each supplier. Another useful method is the Analytical Hierarchical Process (AHP), a decision-making method developed for prioritizing alternatives when multiple criteria must be considered and allows the decision maker to structure complex problems in the form of a hierarchy, or a set of integrated levels.

The AHP is relatively simple to use and understand. This method incorporates qualitative and quantitative criteria. A review of the supplier selection literature shows that the AHP method to be one of the most commonly applied methods in practice. AHP is an ideal method for ranking alternatives when multiple criteria and sub criteria are present in the decision-making process. The AHP was introduced by (Saaty, 1980). There has been wide discussion about the empirical effectiveness and theoretical validity of this technique. AHP allows the decision-maker to structure complicated problems in the form of a decision hierarchy. The hierarchy usually consists of three different levels, which include goals, criteria, and alternatives.

AHP has some weak points; one of these is the complexity of this method which makes it implementation quite inconvenient. Moreover, if more than one person is working on this method, different opinions about the weight of each criterion can complicate matters. AHP also requires data based on experience, knowledge and judgment which are subjective for each decision-maker. A further disadvantage of this method is that it does not consider risks and uncertainties regarding the supplier's performances (Yusuff et al., 2001). In addition to that it required high computation power to predict the rank order. Recently many organizations are migrating to business intelligence applications, which explore more insight about their business. Most of the applications gather supplier selection insights from the recent business history of the supplier. Yet, this is an efficient system and followed by major vendors such as SAP, Oracle and Microsoft. In order to reduce the more computation power and include psychometric technique, we put forward a novel solution by Likert Weight Measure (LWM) corresponding weight to attribute of different importance called weighted association rule mining.

3. Related works

Liu and Hai (2005) studied supplier selection by integrating a collaborative purchasing program and came up with a new approach, based on the use of Saaty's (1980) AHP method. This method compares the weighted sum of the selection number of rank votes, after determining the weights in a selected rank.

This system, called voting AHP (VAHP), provides a simpler method than AHP, but does not lose the systematic approach of deriving the weights and sorting performance of suppliers. VAHP allows the purchasing manager to generate non inferior purchasing options and systematically analyze the inherent trade–offs among the relevant criteria. It is expected that in near future this method will be applied effectively to various issues such as: policymaking, business strategies, and performance assessment (Liu and Hai, 2005).

Yahya and Kingsman (1999) used Saaty's AHP method to determine priority in selecting suppliers. The authors applied vendor rating in supplier selection and in deciding how to allocate business, as well as in determining where development effort is applied. This study is performed for a government sponsored entrepreneur development program in Malaysia.

Another research based on AHP method unique in one company found out by Tam and Tummala (2001) in empirical study in Telecommunication System. This Telecommunication System Company has a long term investment and is directly affected by the vendor selection decision which is a complex multi-person, multi criteria decision problem. Thus the authors applied AHP to take care of several decision makers to examine the strengths and weaknesses of vendor systems by comparing them with the appropriate criteria and sub-criteria. Time and effort are also reduced in decision making. For easy computation, the results can be transferred to the spread sheet easily.

For Tian Jin Electric Construction Company, Yu and Jing (2004) had developed a new decision model for choosing the optimal supplier combination based on unique company. Yu and Jing (2004) according to previous research by Tam and Tummala (2001), found out through research that trust between suppliers and buyers is the best criterion for selecting optimal supplier which reduces the cost, by using AHP and Linear Programming (LP). The authors established trust for Tian Jin Electric Construction Company. AHP and LP were proposed to consider both tangible and intangible factors leading to the supplier selection under the influence of inter-firm and interpersonal trust. Through research, the authors came up with the fact that quality criteria can be more influential in

supplier selection than quantity. Although other criteria such as: cost, quality and delivery were used and focused trust and its importance for supplier selection methodology.

Wei Wang et al. proposed an efficient mining methodology for Weighted Association Rules (WAR) [13]. The idea is inspired by the fact that a numerical attribute can be assigned for every item which in turn judges the weight of the item in a particular weight domain. For example, soda[4,6] → snack [3,5] is a targeted weighted association rule meaning that if a customer purchases soda in the quantity between 4 and 6 bottles, he is likely to purchase 3 to 5 bags of snacks. WAR uses a two-fold approach where the frequent item sets are generated through standard association rule mining algorithms without considering weight. Post-processing is then applied on the frequent item sets during rule-generation to derive the maximum WARs. WAR doesn't interfere with the process of generating frequent item set. Rather, it focuses on how weighted association rules can be generated by examining the weighting factors of the items included in generated frequent item sets. Therefore, we could classify this type of weighted association rule mining methods as a technique of post processing or maintaining association rules.

Han et al. (2002) proposed a solution where a concept hierarchy was used and association rules were classified into multiple conceptual levels of granularity. This idea inspires the work in (BingLiu, 1999) where the existing association rule model is extended to allow users to specify multiple threshold supports. In the extended model, the threshold support is expressed in terms of minimum item supports (MIS) of the items that appear in the rule. The main feature of this technique is that the user can specify a different threshold item support for each item, similar to the scenario of assigning weights to items. This technique can discover rare item rules without causing frequent items to generate too many unnecessary rules. Liu's model also breaks the "downward closure property". The problem is solved by using a "sorted closure property" where the items in the item space are sorted in ascending order of their MIS values.

4. Likert Weight Measures(LWM)

A Likert scale is a psychometric scale commonly used in questionnaires, and is the most widely used scale in survey research, such that the term is often used interchangeably with rating scale even though the two are not synonymous. When responding to a Likert questionnaire item, respondents specify their level of agreement to a statement. The scale is named after its inventor, psychologist Rensis Likert.

A Likert item is simply a statement which the respondent is asked to evaluate according to any kind of subjective or objective criteria; generally the level of agreement or disagreement is measured. Often five ordered response levels are used, although many psychometricians advocate using seven or nine levels; a recent empirical study found that a 5 or 7 point scale may produce slightly higher mean scores relative to the highest possible attainable score, compared to those produced from a 10-point scale, and this difference was statistically significant. In terms of the other data characteristics, there was very little difference among the scale formats in terms of variation about the mean, skewness or kurtosis. The format of a typical five point Likert measure is 1.Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree.

Association Rule is an important type of knowledge representation revealing implicit relationships among the items present in large number of transactions. Given I $=\{i_1, i_2, ..., i_n\}$ as the items' space, which is a set of items, a transaction may be defined as a subset of I, and a dataset may therefore be defined as a set D of transactions. X and Y are non-empty subsets of I. The support of an itemset X in a dataset D, denoted as *supportD(X)*, is defined *as countD(X)/|D|*, where *countD(X)* is the number of transactions in D containing X. An item set is said to be frequent (large) if its support is larger than a user-specified value (also called minimum support (*min_sup*)). An association is an implication of the form [$X \rightarrow Y$, *sup*, *conf*], where $X \subset I$,$Y \subset I$, and $X \cap Y$ Ø. The support of $X \cup Y$ (*sup*) in the transactions is larger than min_sup, furthermore when X appears in a transaction; Y is likely to appear in the same transaction with a probability *conf*. Given a threshold of minimum support and confidence, methods of discovering association rules have become active research topics since the publication of Agrawal, Imielinski and Swami and Agrawal and Srikant papers [9,10].

In order to make use of the weight in the mining process, several new concepts have been adapted. Support is used in association rule mining. In weighted association rule mining (WARM), item sets are no longer simply counted as they appear in a transaction. This change of counting mechanism makes it necessary to adapt traditional support to weighted support. The goal of using weighted support is to make use of the weight in the mining process and prioritize the selection of target item sets according to their significance in the dataset, rather than their frequency alone. An item set is denoted large if its support is above a predefined minimum support threshold. In the WARM context, we say an item set is significant if its weighted support is above a pre-defined minimum weighted support

threshold. In fact, the threshold values specified by the user are from the margin of significance of cost point of view. This method may be more meaningful than only specifying relatively arbitrary support threshold.

5. Theoretical Framework

In this section, we describes about theoretical framework of the Likert weight measures (LWM), which is specifically designed for supplier selection process using multiple criteria decision making. Analytical Hierarchical Process (AHP) is a structured technique for dealing with complex decisions. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. The following Table-1 represents the sample scenario of suppliers and products relationship depicted in twenty records. It contains nine products and three suppliers.

S.No.	Supplier	Products
1	S1	P1
2	S1	P2
3	S3	P4
4	S1	P3
5	S1	P4
6	S2	P2
7	S3	P2
8	S2	P3
9	S2	P4
10	S1	P5
11	S2	P5
12	S1	P6
13	S3	P6
14	S2	P1
15	S2	P6
16	S2	P8
17	S3	P7
18	S1	P7
19	S2	P7
20	S2	P9

Table-1: Sample Record contains Supplier and Products

The Table-2 represents the original psychometric feedback given by the user using the reference Table-1. The Table-1 represents 20 item sets, for each item set there may be any number of criteria but here for examples 5 criteria has been taken into consideration with a rating scale of 3 – Low, Moderate and High. The order of weight is considered as High as 3, Moderate as 2 and Low as 1. Each cell contains the corresponding feedback to the criteria. ΣCn shows the total response weight for five criteria. The feedback which may contain positive and negative factors; let us considered an example price of product is expected low and quality of the product is expected high. In a general computation of actual feedback is not suitable for all places. Hence, we introduced refactoring technique, which is used to inverse the feedback order with respect to the selected criteria. This process corrects the feedback in uniform pattern.
First row of Table-2 represents the factor to be refactored which is denoted as 1 and others denoted as 0.

0	1	0	0	0	
C1	**C2**	**C3**	**C4**	**C5**	**ΣCn**
1	3	1	2	2	9
3	3	2	1	2	11
3	2	2	2	1	10
3	1	3	2	2	11
3	3	1	2	2	11
2	2	3	2	3	12
2	2	2	2	2	10
2	2	1	2	3	10
2	1	2	1	2	8
2	2	3	1	2	10
2	2	2	2	3	11
2	2	2	2	2	10
2	1	3	1	2	9
1	2	3	2	1	9
1	1	3	2	2	9
3	2	2	3	3	13
2	2	3	2	2	11
2	3	3	1	3	12
3	1	2	2	3	11
1	1	2	1	2	7

Table-2: Original Feedback of User for All Criteria

Table-3 shows the feedback after refactoring, which make it into uniform scale. Refactoring is carried out by converting the negative values into positive values based on the factors 0 and 1. If the value is nearing to zero it is poor and if it is nearing to 3 it is good. After refactoring if there are negative factors it can be ignored. Therefore as in Table-2 the overall rating of each item set is calculated by adding the ratings given for each criterion.

0	1	0	0	0	
C1	**C2**	**C3**	**C4**	**C5**	**ΣCn**
1	1	1	2	2	7
3	1	2	1	2	9
3	2	2	2	1	10
3	3	3	2	2	13
3	1	1	2	2	9
2	2	3	2	3	12
2	2	2	2	2	10
2	2	1	2	3	10
2	3	2	1	2	10
2	2	3	1	2	10
2	2	2	2	3	11
2	2	2	2	2	10
2	3	3	1	2	11
1	2	3	2	1	9
1	3	3	2	2	11
3	2	2	3	3	13
2	2	3	2	2	11
2	1	3	1	3	10
3	3	2	2	3	13
1	3	2	1	2	9

Table – 3 Fedback after refactoring

Table-4 represents the weight measures; F_{W3}, F_{W2}, F_{W1} are frequency of respected weight. Computation of frequency weight is known as LWM, which is computed as follows:

$$LWM = \frac{f_{w3} \times 3 \mid f_{w2} \times 2 \mid f_{w1} \times 1}{\sum C_n}$$

Based on the weight, the supplier of a product whose weight is high when compared to others will be selected. If more than one supplier is having equal score then previous history of record is suggested for assistance. In this method, we pruned the inconsistent and invalid data for computation. Hence, this psychometric feedback is considered to be an additional backbone for supplier selection. Computation time of LWM is significantly lower than that of AHP.

S.no	Supplier	Products	F_{W3}	F_{W2}	F_{W1}	LWM
1	S1	P1	3	2	0	1.86
2	S1	P2	2	2	1	1.22
3	S3	P4	1	3	1	1.00
4	S1	P3	0	2	3	0.54
5	S1	P4	2	2	1	1.22
6	S2	P2	0	3	2	0.67
7	S3	P2	0	5	0	1.00
8	S2	P3	1	3	1	1.00
9	S2	P4	1	3	1	1.00
10	S1	P5	1	3	1	1.00
11	S2	P5	0	4	1	0.82
12	S1	P6	0	5	0	1.00
13	S3	P6	1	2	2	0.82
14	S2	P1	2	2	1	1.22
15	S2	P6	1	2	2	0.82
16	S2	P8	0	2	3	0.54
17	S3	P7	0	4	1	0.82
18	S1	P7	2	1	2	1.00
19	S2	P7	0	2	3	0.54
20	S2	P9	2	2	1	1.22

Table-4: LWM for Supplier & Product

6. CONCLUSION

Supplier selection and evaluation have become one of the major topics in production and operations management literature, especially in advanced manufacturing technologies and environment. Our proposal LWM is a light weight model of supplier selection process and it requires less computation power compared to AHP. In data mining, LWM model is closely associated with weighted association rule mining model. The implementation and integration of this kind is very easy and the LWM is considered to be light weight supplier selection model.

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