A DECISION MODEL FOR SUPPLIER RECOMMENDATION IN A SUPPLY CHAIN MANAGEMENT SYSTEM

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ABSTRACT

This paper proposed a decision model for supplier recommendation in a supply chain management system. The proposed model exploited the use of suppliers' information and past purchasing history to create a list of potential suppliers of a raw material. The Satake Corporation (Thailand) was selected to be a case study of this research project. To evaluate the proposed model, all purchasing information has been gathered from the corporation's database. The dataset consisted of 12,340 different items and more than 2,500 different suppliers. A procurement staff with more than ten years of experience was invited as an expert for supplier selection. The procurement staff was given a task to evaluate and select suppliers for each item based on suppliers' information and the past experience with the suppliers. A staff's judgment for each item is considered perfect. The top two results were compared with the staff's judgment. The result showed an accuracy of 93.33%.

Index Terms—*Decision Model; Supply Chain Management System; Supplier Selection*

1. INTRODUCTION

Due the economical crisis spreading all over the world, gaining competitive advantages seem to be an only option to make a company survive. Cost reduction is one of the initiatives for achieving a competitive advantage. The value of raw material purchasing is up to 80% of production cost. Developing an effective way to manage suppliers and procurements process could help one company reduce the production cost significantly. A supply chain management system (SCM) [1] [2] is one of efforts that bring together manufacturing, purchasing and technical department to create more efficient working environment, which result in a lower cost of business operation.

The paper is organized as follows. Section 2 provides some details related to Satake Corporation (Thailand) and then describes some related works. Section 3 introduces a proposed decision model. Section 4 then describes the experimental setting and shows the result of the experiment. Finally, Section 5 presents acknowledgement of this research project.

2. RELATED WORKS

2.1. Satake Coporation (Thailand)

Satake Corporation (Thailand), a joint venture company between Chareon Porkaphan Engineering Company Limited and Satake Corporation (Japan), was established in 1986, The main business of the company is to produce a comprehensive range of individual machines, integrated systems and totally engineered solutions for the processing of rice, wheat and other grains. With the inherited technology from Stake Corporation (Japan), the company distributes its products across Thailand and exports them to the foreign countries such as India, Brazil, and United States of America.

In each year, staffs in the procurement department puts a lot of effort and spend time inefficiently to select suppliers for raw material orders. They consider many factors such as raw material unit cost, a quality of raw material from the past purchasing, lead time for evaluating each supplier. Figure 1 shows an influence diagram of the supplier selection decision of Satake management and procurement staffs.

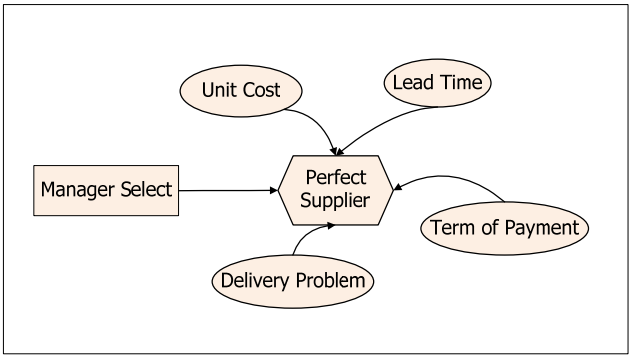

Figure 1 An influence diagram of the supplier selection decision.

2.2. Decision Model and Supply Chain Management Systems

During the past two decades, a decision support system (DSS) has been widely applied in the decision making process for managers and other knowledge worker in organizations around the world. This kind of system incorporates a decision model with related data and information to help facilitate judgment by organizing data and evaluate a list of alternatives [3][4][5][6][7][8][9].

However, there was few published research papers focused on integrating a decision model for supplier recommendation into a supply chain management system.

This research paper proposed a decision model for supplier recommendation in a supply chain management system. The underlying assumption of this model is that quality suppliers deliver a quality raw material on time with a reasonable cost.

3. A PROPOSED DECISION MODEL

To develop a decision model for supplier recommendation, a formal interview with Satake's management and procurement staffs was conducted. As shown in Figure 1, there are four main factors that they consider when they made a supplier selection for a part of any product, which are a unit cost, lead time, term of payment, and number of problems occurring when delivery. The model exploits the use of suppliers' data and past purchasing information to compute a satisfaction score for evaluating suppliers.

For each purchased item, let *SS* be a total score of its supplier, $S_{UnitCost}$ be a satisfaction score for a unit cost of the supplier, $S_{LeadTime}$ be a satisfaction score for a lead time of the supplier, $S_{TermOf\ Payment}$ be a satisfaction score for the supplier's term of payment and $S_{DeliveryProblem}$ be a satisfaction score for problems in delivery of the supplier. Equation 1 show how to calculate a supplier's total score for each item based on a satisfaction score of each decision factor.

$$SS = (w_1 \times S_{UnitCost}) + (w_2 \times S_{LeadTime}) + (w_3 \times S_{TermOfPayment}) + (w_4 \times S_{\text{DeliveryProblem}}) \quad (1)$$

where Wi is a weighting for each decision variable and $\sum w_i = 1$

Let $UP_k=\{up_{1k},up_{2k},up_{3k},\ldots,up_{nk}\}$ be a set of unit price of product *k* from all suppliers, $unitprice_{i,k}$ be a current unit price of product *k* for supplier *i*, and $UPAdjust_k$ be an adjustment factor. S_{UnitCost} is calculated according to Equation 2 and 3.

$$UPAdjust_k = \frac{\left|Max(UP_k) - Min(UP_k)\right|}{5} \quad (2)$$

$$S_{UnitCost} = \begin{cases} 100\ if\ \text{unitprice}_{i,k} < \text{Min}(\text{UP}_k) + UPAdjust_k \\ 80\ if\ \text{Min}(\text{UP}_k) + UPAdjust_k \le \text{unitprice}_{i,k} < \text{Min}(\text{UP}_k) + 2UPAdjust_k \\ 60\ if\ \text{Min}(\text{UP}_k) + 2UPAdjust_k \le \text{unitprice}_{i,k} < \text{Min}(\text{UP}_k) + 3UPAdjust_k \\ 40\ if\ \text{Min}(\text{UP}_k) + 3UPAdjust_k \le \text{unitprice}_{i,k} < \text{Min}(\text{UP}_k) + 4UPAdjust_k \\ 20\ if\ \text{unitprice}_{i,k} \ge \text{Min}(\text{UP}_k) + 4UPAdjust_k \end{cases} \quad (3)$$

$$S_{LeadTime} = \begin{cases} 100\ if\ leadtime_{i,k} \le LT_{Threshold} \\ 80\ if\ LT_{Threshold} < leadtime_{i,k} \le 2LT_{Threshold} \\ 60\ if\ 2LT_{Threshold} < leadtime_{i,k} \le 4LT_{Threshold} \\ 40\ if\ 4LT_{Threshold} < leadtime_{i,k} \le 8LT_{Threshold} \\ 20\ if\ leadtime_{i,k} > 8LT_{Threshold} \end{cases} \quad (4)$$

$$S_{LeadTime} = \begin{cases} 100\ if\ payment_{i,k} \ge 8TP_{Threshold} \\ 80\ if\ 4TP_{Threshold} < payment_{i,k} \le 8TP_{Threshold} \\ 60\ if\ 2TP_{Threshold} < payment_{i,k} \le 4TP_{Threshold} \\ 40\ if\ TP_{Threshold} < payment_{i,k} \le 2TP_{Threshold} \\ 20\ if\ payment_{i,k} \le TP_{Threshold} \end{cases} \quad (5)$$

$$DPAdjust_k = \frac{\left|PO_i\right|}{5} \quad (6)$$

$$S_{UnitCost} = \begin{cases} 100\ if\ deliveryproblem_i < DPAdjust_k \\ 80\ if\ DPAdjust_k \le deliveryproblem_i < 2DPAdjust_k \\ 60\ if\ 2DPAdjust_k \le deliveryproblem_i < 3DPAdjust_k \\ 40\ if\ 3DPAdjust_k \le deliveryproblem_i < 4DPAdjust_k \\ 20\ if\ deliveryproblem_i \ge 4DPAdjust_k \end{cases} \quad (7)$$

Let $LT_{Threshold}$ be a threshold value for lead time of all products and $leadtime_{i,k}$ be a lead time of product k for supplier i. $S_{LeadTime}$ is calculated according to Equation 4.
Let $TP_{Threshold}$ be a threshold value for term of payment of all suppliers and $payment_{i,k}$ be a term of payment of product k for supplier i. $S_{TermOfPayment}$ is calculated according to Equation 5.

Let $PO_i=\{dp_1,dp_2,dp_3,\ldots,dp_n\}$ be a set of a purchase order of supplier i, $deliveryproblem_{i,}$ be a number of problems in delivering products of supplier i, and $DPAdjust_k$ be an adjustment factor. $S_{DeliveryProblem}$ is calculated according to Equation 6 and 7.

4. EXPERIMENTAL SETTING AND RESULT OF EVALUATION

This section provides details about how the dataset for an experiment is gathered, how the experiment is set, and the result of decision model evaluation.

4.1. Data Set

In preparation for the experiment, all purchasing information has been gathered from the Satake Corporation's database in its supply chain management system. The information included all purchased items information, all suppliers' information, all unit price information of each item, and past purchasing history. The obtained information has been reorganized and reformatted to allow the decision model to access easier. The final dataset consisted of 12,340 different items and more than 2,500 suppliers.

4.2. Experimental Setting

To evaluate the proposed decision model for supplier recommendation, thirty items were randomly selected from the final dataset. A Satake procurement staff with more than ten years of experience in this department was invited. The staff was given a task to evaluate and select suppliers for each items based on supplier's information and the past experience with the suppliers. The staff's judgment for each item was considered perfect and would be used as the ground truth for measuring an accuracy of the proposed decision model for supplier recommendation.

As illustrated in Equation 1-7, the decision model then took the list of randomly selected items, accessed the necessary information from the dataset, and calculated the total score for each item in the list. The weighting for each decision variables was set equally, which is 0.25 for this particular study. For each item, the first two ranks, ordered by the total score, were compared with the ground truth. The accuracy of the proposed decision model was then measured.

4.3. Evaluation Result

As shown in Table 1 at the end of the paper, the proposed decision model for supplier recommendation works well. Comparing with the manual supplier selection from the procurement staff with more ten years of experience, the proposed decision model for supplier recommendation showed an accuracy of 73.33% and 93.99% when considering only first rank and considering the first two ranks respectively.

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Table 1. Results comparison between manual selection and decision model selection

No.	Product		Manual Selection	Decision Model Selection		Accuracy	
	Code	Description	Supplier Code	Rank	Supplier Code	Rank 1 Only	Rank 1 -2
1	1121064	LOCKNUT (RIGHT) M30 (AN06)	LP049	1	LN002	N	Y
				2	LP049		
2	1121094	LOCKNUT(RIGHT) M45 (AN09)	LP049	1	LN002	N	Y
				2	LP049		
3	FC223810	FLANGE UNIT ZUKFC210+PE	LA017	1	LA017	Y	Y
				2	LN002		
4	T025003	Wooden Case Packing VTA10AB-TA(For SUK)	LC077	1	LC077	Y	Y
				2	LL022		
5	FC3H2309	ADAPTER FOR BEARING H2309	LA017	1	LA017	Y	Y
				2	LN002		
6	FL2030106T	FLOAT 1/2 INCH	LB003	1	LB003	Y	Y
				2	LH023		
7	TFB000530002	PIN 170364-1 (AMP)	LS198	1	LS198	Y	Y
				2	LP123		
8	FR004510011	Pressure Gauge GP1-40	LP123	1	LF001	N	Y
				2	LP123		
9	FD13B058	V-BELT (RED TYPE) B-58 (60Hz)	LM061	1	LM061	Y	Y
				2	OJ003		
10	T063703	Wooden case Packing STBS80C-T,STBS40C-T	LC077	1	LC077	Y	Y
				2	LL022		
11	225133710-M	FC20 for Blade Retainer	LP003	1	LP003	Y	Y
				2	LP131		
12	FC220809	FLANGE UNIT UKFC209	LN002	1	LE012	N	N
				2	LA017		
13	2-6102-0535-HD	Hardening fee of Plate (Vacuum)	LJ011	1	LS029	N	Y
				2	LJ011		
14	FC223807	FLANGE UNIT ZUKFC207+PE	LA017	1	LA017	Y	Y
				2	LN002		
15	FD13B068	V BELT (RED TYPE) B-68	LM061	1	LM061	Y	Y
				2	LS112		
16	FD13A062	V-BELT (RED TYPE) A-62	LM061	1	LM061	Y	Y
				2	LS112		
17	5A0SUSP30*4	SUS304P-2B PVC t3.0 mm 4x8 ft	LL006	1	LL006	Y	Y
				2	LS129		
18	TFN000202001	MANOMETER WO-81FN-3E with KGA81MT-H & L	LI026	1	LI026	Y	Y
				2	LP123		
19	FC110320	BALL BEARING 6320DDU	LN002	1	LA017	N	Y
				2	LN002		
20	T041063-M	FC200 FOR MAIN SHAFT PULLEY	LA053	1	LA053	Y	Y
				2	LP003		
21	TFD000100003	V-BELT 5VX-1180	LM061	1	LM061	Y	Y
				2	LW019		
22	FC220807	FLANGE UNIT UKFC207	LN002	1	LN002	Y	Y
				2	LA017		
23	790112-M	FC200 FOR INTERNAL FRAME	LA053	1	LS184	N	N
				2	LH003		
24	T025600	Packing VTA15AB-TA	LC077	1	LC077	Y	Y
				2	LL022		
25	FD19351060	V-BELT 5V*1060	LM061	1	LM061	Y	Y
				2	LW019		
26	T076020	Wooden Case HA10WA-B(3)-T	LC077	1	LC077	Y	Y
				2	LL022		
27	T083000	Wooden Case for WS600AK	LC077	1	LC077	Y	Y
				2	LL022		
28	FC224108	FLANGE UNIT CM-UKFL208D+CE	LE012	1	LE012	Y	Y
				2	LP123		
29	FC3H2309	ADAPTER FOR BEARING H2309	LN002	1	LA017	N	Y
				2	LN002		
30	FC116319	BALL BEARING 6319	LR003	1	LR003	Y	Y
				2	LS186		
						73.33%	93.33%