CHAPTER 3

VENDOR EVALUATION AND SELECTION MODEL

3.1 INTRODUCTION

In increasingly competitive and globalised markets, firms are constantly under pressure to find ways to cut material and production costs. Vendor evaluation and selection is the process of finding the vendors who are able to provide the buyer with the right quality products and/or services at the right price, at the right quantities and at the right time. Traditionally, vendor evaluation and selection is based on invoice cost, vendors’ ability to meet quality requirements and delivery schedule. Numerous methods are available to evaluate and select the vendor, and some of them have been briefly discussed in the previous chapter.

Evaluation and selection of vendor is a typical multiple criteria decision making problem involving multiple criteria that can be both qualitative and quantitative (Mahmut S, 2006). For any organization, profit is one of the most important operational factors. The products handled by the buying organization are prioritized based on the profitability to get operational importance. Initially, a model was developed to evaluate and select vendors based on product prioritization and it is referred to as ‘Vendor Evaluation and selection with respect to Product prioritization’ (VEP) in this work. But, this model considers the benefit of buyer alone while selecting its vendor. To get long term relationship, the buyer must satisfy the expectations of its customers, as customer expectation is one of the important strategic
factors. Therefore, customer expectation is added to VEP model and a new model has been developed. It is named as ‘Vendor Evaluation and selection with respect to Product prioritization and Customer Expectation’- (VEPCE) in this work. The detailed description of VEPCE model is presented in the following section.

3.2 VEPCE MODEL

In the existing literature on vendor evaluation and selection, a model considering the expectations of the customers of the buying organization is not given much importance. A suitable model is needed to select best vendor by integrating both customer expectation and product prioritization. VEPCE model integrates the above strategic (customer expectation) and operational (product prioritization) factors. This model combines product prioritization based on profitability of the buyer and his customers’ expectations to evaluate and select vendors. The different phases of VEPCE model are listed as follows:

- Phase 1 - Product prioritization using Profit Ratio Analysis (PRA)
- Phase 2 - Customer prioritization using AHP
- Phase 3 – Customer-focused product prioritization using Critical Value Analysis (CVA)
- Phase 4 - Vendor evaluation using AHP.
- Phase 5 - Assignment of a set of vendors to a set of products

In the first phase, products are prioritized with respect to profit ratio using PRA. In the second phase, customers are prioritized according to strategic importance of organization using AHP. In the third phase, products
are prioritized again with respect to both Profitability Rank Order (PRO) and customer expectations using CVA. In the fourth phase, a set of vendors are evaluated for each product with respect to set of criteria using AHP. In the fifth phase, each product is allocated to the specified vendor based on the assignment model. The overall framework of VEPCE is shown in Figure 3.1.

**Figure 3.1 Framework of VEPCE**

### 3.2.1 Product prioritization using PRA

In this phase, products are ranked based on their profit ratio. The needed data are price of the product, profit per unit and quantity sold. The procedure to calculate the profit ratio is presented in Figure 3.2. Profit ratios for all the products are calculated. The product which scores the highest profit ratio is given first rank and subsequent ranks are allotted to the remaining products based on the profit ratio. This method of ranking a product based on
its profitability is mentioned as product prioritization and the rank order of the product is mentioned as Profitability Rank Order (PRO) in this thesis.

Figure 3.2 Product prioritization using PRA
3.2.2 Customer prioritization using AHP

In this phase, customers are prioritized according to different criteria favorable to the company and strategic importance of the organization using a multi-criteria decision-making tool AHP. The examples for such criteria are profitability, partnership, volume of purchase, etc. Hierarchy for AHP is built, as shown in Figure 3.3. At the end of this phase, weightages of the customers are obtained by using AHP.

![Hierarchical Structure for Customer Prioritization](image)

**Figure 3.3 Hierarchical Structure for Customer Prioritization**

First, the criteria required for prioritizing the customer is defined. Then the hierarchical structure with respect to criteria and alternatives for prioritizing the customers is formulated. After that, pair-wise comparison of criteria is made using Thomas L Satty scale. Finally, pair-wise comparison of each customer is made with respect to all criteria. Then, the customers are ranked based on the final weightage obtained by AHP. The stepwise description of customer prioritization is shown in Figure 3.4.
3.2.3 Customer-focused product prioritization using CVA

In this phase, products are prioritized based on profit ratio, which are again prioritized by considering the customer expectation. Hence, this phase is named as customer-focused product prioritization. Here, Critical Value Analysis is used as a tool for product prioritization.

According to CVA, customers’ expectations are listed first. Then Customers’ Criticality value (CC) based on the expectations of the customers is defined. Customers’ criticality values are the numerals given for every expectation of the customers. The most important expectation is numbered as one. Subsequent numbers are given to all the other expectations, by analyzing its criticality. Then, CC for all the products is assigned individually by considering the expectations of their customers. After that, CC is multiplied with PRO. The resultant value is then ranked and it is referred as Order of Priority of Service (OPS) in this work. The above procedure is adopted for all the products and all the customers. Finally, the OPS of all the products are normalized with the AHP weightage obtained in Phase-2. The normalized weightages of all the products are multiplied row wise and the average is
found to get CFP (Customer-Focused Product prioritization) weightage. The step wise description of CVA is presented in Figure 3.5.

![Figure 3.5 Customer Focused Product Prioritization using CVA](image)

3.2.4 Vendor evaluation by AHP

Here, a set of vendors are evaluated for each product with respect to a set of criteria using the evaluative model AHP. First, the vendor evaluation criteria are defined. Then, alternative vendors are specified for all the products. A hierarchical structure is formulated, as shown in Figure 3.6. A set of items which are supplied by all the vendors are taken into consideration for pair-wise comparison and a judgment matrix is formulated. AHP procedure is applied, as explained in Appendix 3, to get vendor versus product weightages.
3.2.5 **Allocation of products to vendors**

For allocation of products to vendors, the basis considered is the preference weightage derived in Phase-4. Since a product can be allocated to multiple vendors and a vendor can be assigned with multiple products, there is a scope for maximizing the preference weightage while doing this assignment. This is stated in the objective function of the mathematical model (generative model).

The required number of vendors for each item depends upon the requirement of the buying organization. This is considered as the first
constraint. By considering the past performance of the vendor, the maximum number of products that can be allotted to each vendor is considered as the second constraint. The total number of vendor assignments required for a set of products is considered as the third constraint. This mathematical model is formulated as an Integer Linear Programming model and it is presented below.

Decision variable: \( X_{ij} = \begin{cases} 1, & \text{vendor } i \text{ is allocated to product } j \\ 0, & \text{otherwise} \end{cases} \)

where,

\( i \) - Vendor index, \( i = 1, 2, \ldots, T \), \( T = \) Number of vendors in a set

\( j \) - Product index, \( j = 1, 2, \ldots, M \), \( M = \) Number of products in a set

\( W_{ij} \) - Preference weightage of vendor ‘i’ for product ‘j’

\( N_j \) - Minimum requirement of vendors for product ‘j’

\( O_i \) - Maximum number of products allocated to vendor ‘i’

\( A \) - Total number of vendor assignments needed for ‘M’ number of products

Maximize \( Z = \sum_{i=1}^{T} \sum_{j=1}^{M} W_{ij} X_{ij} \) \hspace{1cm} (3.1)

The objective function represents the maximization of the preference weightage. \( (W_{ij} \) - Preference weightage of vendor ‘i’ for the product ‘j’).

Subject to

\( \sum_{i=1}^{T} X_{ij} \geq N_j \quad j = 1,2,\ldots,M \) \hspace{1cm} (3.2)
This constraint ensures the minimum requirement of the number of vendors for each product.

\[ \sum_{j=1}^{M} X_{ij} \leq O_i \quad i = 1, 2, \ldots, T \] (3.3)

This constraint ensures that the maximum permissible number of products is allocated to each vendor. The number of products allocated to each vendor is estimated based on the ratio of total preference weightage of individual vendor and total preference weightage of all the vendors multiplied by the total number of products in a set.

\[ \sum_{i=1}^{T} \sum_{j=1}^{M} X_{ij} \leq A \] (3.4)

This constraint ensures that the total number of vendor assignments does not exceed the availability.

\[ X_{ij} = \{ 1 \text{ or } 0 \} \] (3.5)

This constraint enforces binary and non-negative restrictions on the decision variables.

### 3.3 CONCLUSION

In this chapter, the different phases of VEPCE model are explained. In the following chapter, application of the VEPCE model in a two stage supply chain is explained.