Evaluation and Ranking of Criteria Affecting the Supplier’s Performance of a Heavy Industry by Fuzzy AHP Method

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Heavy Industry is an industry that involves one or more characteristics such as Large and Heavy Products; Large or Heavy Equipment and facilities; or Complex and Numerous Processes. Outsourcing in heavy industry sector has gained a strategic importance in order to survive in the cost and quality conscious environment. In order to meet the customer demand promptly, any industry must have a healthy and competent supplier base. The purpose of this paper is to evaluate and rank the criteria affecting the performance of the suppliers of a Heavy Industry (BHEL, Tiruchirappalli) by using Multi Criteria Decision Making Tool (MCDM) – Fuzzy Analytical Hierarchy Process (AHP). The Criteria and Sub Criteria affecting the supplier performance have been decided by a team of experts from the industry and through literature study. AHP derives the relative weights of the criteria using pairwise comparison between criteria in a hierarchical system. It also provides a clear picture to the industry about the importance of various factors affecting the performance of the suppliers. This research helps the industry and its suppliers to identify the factors in which they need to strengthen in order to improve their performance.

Keywords: Heavy Industry, Supplier Performance Evaluation, Criteria and Sub Criteria, Fuzzy AHP, Multi Criteria Decision Making Tool

Introduction

Outsourcing decisions are considered to be the most strategic decisions since it enables the company to reduce costs and improve their profit. In today’s highly competitive and global operating environment, due to the high variety of customer demands, advances in technologies and the increasing importance of communication and information systems companies have been forced to engage in outsourcing relationships and hence concentrate on supply chain management in order to have healthy supplier base [Parthiban et al, 2012]. One of the main task in Sourcing is Supplier evaluation & Supplier Selection. Supplier Evaluation refers to the process of evaluating and approving potential suppliers in a supply chain by a series of quantitative assessments [Parthiban et al, 2014]. Since there are several factors which affect the supplier’s performance, it is considered as a multi-criteria problem and it is necessary to make a tradeoff between conflicting tangible and intangible factors to find the best suppliers [Parthiban et al, 2009].

Methodology

This paper proposes the methodology shown in Figure 1 for evaluating the supplier performance using MCDM tools.

Identification of criteria & sub criteria

In order to evaluate the performance of the suppliers of a manufacturing industry, the criteria and sub criteria were chosen by experts from the industry...
based their existing working environment, past experience and present business scenario. The performances of these suppliers are evaluated based on several criteria and sub criteria. They are classified under 3 main Criteria – Quality, Delivery and Performance History, Capacity and Capability, Responsiveness, Service, Safety and Trust. The Sub criteria chosen under the 3 main criteria is elaborated in Table 1.

Case study

**Problem description**

Bharat Heavy Electricals Limited (BHEL) is one of the oldest and largest state-owned engineering and manufacturing enterprise in India in the energy-related and infrastructure sector which includes Power, Railways, Transmission and Distribution, Oil and Gas sectors and many more. It is the 12th largest power equipment manufacturer in the world. BHEL was established more than 50 years ago, ushering in the indigenous Heavy Electrical Equipment industry in India. 74% of the total power generated in India is produced by equipment manufactured by BHEL.

Outsourcing in BHEL has started way back in 1960s as “Ancillary Development” in order to support and develop the people and surroundings near BHEL. Outsourcing department in BHEL, Trichy is responsible for outsourcing various products like Pressure parts fabrication, Attachment fabrication for Shop assemblies, Part processing fabrication for Shop assemblies, Structures, Columns, Ceiling girders, Ducts, Oil Systems, Feeders, Hangers & Suspensions and other miscellaneous fabrication, punching & shearing jobs. The department functions and operates with 250 vendors located in and around Trichy. This paper discusses about evaluating the weightage and ranking of criteria and sub criteria which affects the performance of suppliers of a heavy industry using Fuzzy AHP Method.

**Fuzzy AHP**

Pair wise comparison data was collected from experts in the industry through a standard format. The experts were from various departments in BHEL like Outsourcing Sections which includes Contracts, Material Management, Planning, Expediting and Project Management, Quality – Off Loading Inspection (OLI) section and Finance – Stock Verification section. The experts used the triangular fuzzy values mentioned in Table 2 for rating the criteria and sub criteria in pair wise comparison.

**Results and Discussion**

Data was collected from experts in the industry and the experts used the triangular fuzzy numbers. Fuzzy AHP was used to find the weightage of these criteria and sub criteria. The results are shown in Table 3. A graphical representation of the criteria and sub criteria

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**Table 1 — Criteria and Sub Criteria for Vendor (Performance) Evaluation**

| Criteria                      | Quality, Delivery & Performance History (QDP) | Capacity & Capability (CC) | Responsiveness, Service, Safety & Trust (RSS’)
|-------------------------------|---------------------------------------------|-----------------------------|--------------------------------------------------
| Quality - Product & Manufacturing | Product Range & Capacity                      | Administration Capability   | Discipline & Professionalism                      |
| Quality - Service & Working Environment | Technical Capability                          | Financial Capability        | Accessibility, Availability & Dependability       |
| QC & QA Documentation - Certification & Validity | Infrastructure, Facilities & Layout Design    | Compliance with timeline, punctuality & rules | Accidents                                         |
| Compliance to Delivery Commitments | Man Power - Skill, Qualification & Certification | Compliance with Safety Standards & Rules | Firm & Personnel Trust, Transparency with business partner |

**Table 2 — Crisp Numbers**

<table>
<thead>
<tr>
<th>Very Low importance / Very Poor</th>
<th>Very High Importance / Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0,1,3)</td>
<td>(7,9,9)</td>
</tr>
</tbody>
</table>

**Table 3 — Ranking of Criteria using FAHP**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Quality, Delivery &amp; Performance History (QDP)</th>
<th>Capacity &amp; Capability (CC)</th>
<th>Responsiveness, Service, Safety &amp; Trust (RSS’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weightage Rank</td>
<td>0.756</td>
<td>0.207</td>
<td>0.047</td>
</tr>
<tr>
<td>Sub Criteria Weightage Rank</td>
<td>QDP: 0.404 QDP: 0.127 QDP: 0.133 QDP: 0.066 QDP: 0.044 QDP: 0.24 QDP: 0.037 QDP: 0.05 QDP: 0.022 QDP: 0.017 QDP: 0.011 QDP: 0.006 QDP: 0.019 QDP: 0.014 QDP: 0.012 QDP: 0.010 QDP: 0.005 QDP: 0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Criteria Rank</td>
<td>1 2 3 4 5 6 1 2 3 4 5 6 1 2 3 4 5 6</td>
<td></td>
<td></td>
</tr>
</tbody>
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weightage is shown in Figure 2. It is evident from the result that it is mandatory for the supplier to ensure good quality in the products and services it delivers, to ensure the delivery schedules and commitments made to the firm and to maintain a good performance history and track record.

Conclusion

The objective of this research paper is to evaluate and rank the criteria affecting the performance of the suppliers of a heavy industry using Fuzzy AHP. This research has helped the industry in identification of several important factors affecting their supplier’s performance through the relative weightage and pairwise comparison concept. This study has also equipped the industry with sufficient information about various factors affecting their supplier’s performance which will help them to have a better control over their supplier’s performance and aim towards further improvement.

References