# SELECT STUDIES IN ANALYTICAL MODELING OF SUPPLIER EVALUATION AND SELECTION

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# SELECT STUDIES IN ANALYTICAL MODELING OF SUPPLIER EVALUATION AND SELECTION

by

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# CERTIFICATE

This is to certify that the thesis titled "**Select Studies in Analytical Modeling of Supplier Evaluation and Selection"** being submitted by **Mr. Nilesh Rambhau Ware** (Entry No. 2010SMZ8203) to the Department of Management Studies, Indian Institute of Technology, Delhi, for the award of degree of **Doctor of Philosophy (Ph.D.)** is a bonafide record of original research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis, which has attained the requisite standard for Ph.D. degree. The results presented in this thesis have not been submitted to any other university or institute for the award of any Degree or Diploma.

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**Nilesh Rambhau Ware**

# ABSTRACT

"Supplier selection" is the basic building block for any sustainable supply chain network. It is a process of finding the best/alternative set of potential suppliers, at the right time, at the right price, in the right quantity with right quality for a stipulated time horizon. For sustainable and dynamic market scenario, every organization focused on their core competencies while non-core competence activities get outsourced. Supplier gets involved in the product outsourcing process. Cost of materials and services for finished product incurred more than 60% of total sales. Selection of right supplier results in reducing operational cost, lead time; while increasing product quality, profit, competitiveness, customer satisfaction. In the competitive market, all boundaries collapse between firms and collaborative work environment is at first priority. To identify the best supplier(s), various direct and indirect criteria involved which are influencing on supplier evaluation and selection process. Therefore, this problem is considered to be multi-criteria decision making (MCDM) problem. In this process many conflicting criteria gets involved which needs to be ranked or given preference according to organization's policy. Various qualitative as well as quantitative approaches are available in the literature. From a comprehensive literature review, numerous gaps were identified. To bridge these gaps three broad objectives mentioned which is considered as the contribution to the body of knowledge. This research also gives many insightful implications to academicians, researchers and practitioners.

Major contributions made in this research are as follows:

- A comprehensive literature review is done and identifies research issues related to the supplier selection in an automotive industry.
- MICMAC analysis in ISM based methodology here provides the idea on driver-dependence power to all supplier selection factors.

- Comparative study of qualitative methodologies such as AHP, fuzzy-AHP, fuzzy-TOPSIS, IRP, weighted-IRP is done to rank the suppliers.
- Mixed-integer non-linear programming (MINLP) model is developed for multi-time period, multi-source and multi-product scenario supplier selection problem under deterministic scenario. This MINLP mathematical model is illustrated with two different sized problems (2T-4S-2P and 4T-10S-7P problems).
- A new approach of flexible supplier selection integrates the results of qualitative and quantitative methods to get better results considering long term buyer-supplier relationship. Two numerical illustrations 3T-6S-3P and 4T-6S-6P problem are provided to show the working methodology.
- A mathematical model for a stochastic business scenario is proposed. The proposed model handles multi-source, multi-product problem with addition for a multi-time period. The proposed model is developed for three cases where 1) supplier's capacity is stochastic 2) demand is stochastic, and 3) both capacity and demand is stochastic. A chance constraint mathematical approach is used to solve the proposed stochastic model. Two numerical illustrations 2T-4S-3P and 10T-10S-10P are also provided here.
- A case study: Real time data from an automotive company is collected and the proposed model is tested and validated for the real data.

***Keywords:*** Outsourcing, Supplier selection, Supplier evaluation, MCDM

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| | |
|---|---|
| AHP | Analytical Hierarchical Process |
| ANP | Analytical Network Process |
| BJP | Bhartiya Janta Party |
| BSE | Bombay Stock Exchange |
| CI | Consistency Index |
| CR | Consistency Ratio |
| DEA | Data Envelopment Analysis |
| DEMATEL | Decision Making Trial and Evaluation Laboratory |
| DSSP | Dynamic Supplier Selection Problem |
| ELECTRE | ELimination and Choice Expressing REality |
| FDI | Foreign direct investment |
| FNIS | Fuzzy Negative-Ideal Solution |
| FPIS | Fuzzy Positive-Ideal Solution |
| FSS | Flexible Supplier Selection |
| GA | Genetic Algorithm |
| GATT | General Agreement on Tariffs and Trade |
| ILP | Integer Linear Programming |
| IRP | Interpretive Ranking Process |
| ISM | Interpretive Structural Modeling |
| IT | Information Technology |
| KVIC | Khadi and Village Industries Commission |
| LP | Linear Programming |
| MAUT | Multi-Attribute Utility Theory |

| | |
|---|---|
| MCDM | Multi-Criteria Decision Making |
| MINLP | Mixed-Integer Nn-Linear Program |
| QFD | Quality Function Deployment |
| R& D | Research and development |
| RI | Random Index |
| SA | Simulated Annealing |
| SAP-LAP | Situation-actor-process-learning-action-performance |
| SCM | Supply Chain Management |
| SS | Supplier Selection |
| SSIM | Self-Structural Interaction Matrix |
| TCO | Total Cost of Ownership |
| TOPSIS | Technique for Order of Preference by Similarity to Ideal Solution |
| TSSP | Traditional Supplier Selection Problem |
| UPA | United Progressive Alliance |
| VMI | Vendor managed inventory |
| VSS | Vendor Selection Systems |