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A Case Study for Supplier Selection in Integra Engineering India Limited's (IEIL) by Using Analytical Hierarchy Process

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Abstract- In the automotive industry, purchasing plays a critical role in the effective functioning of the supply chain. The purchasing department bears the obligation of selecting the appropriate suppliers to get the necessary products for their organization. Therefore, for the procurement manager to select the best supplier from the pool of potential suppliers, the supplier evaluation technique is crucial. The five most often used criteria for evaluating the quality of suppliers are quality, delivery, technology, value, and service, according to the literature. This chapter presents a supplier evaluation and selection process based on ISO 9000/TS16949 standards. taking into account the most crucial factors for assessing the caliber of suppliers based on a study of the literature and practical experience. The supplier to choose from the pool of suppliers is indicated by the computed likelihood. There is less risk associated with choosing that supplier and greater chances of having the supplier chosen if the possibility is higher. With the aid of historical data and market input, this is an easy and affordable method of supplier selection that can be utilized by any size business, but it is particularly useful for small businesses or those with limited resources. The Indian railway system's support structure is maintained by two shells that are joined by a pressing that runs the whole time. The packaging must be removed to change it and swap out the system's damaged components to repair the tracking system. Five suppliers who could readily supply the material in the area where the assembly company is based were discovered after a preliminary assessment to identify potential suppliers of the packaging. Two decision-makers from a group decision (GD) have been integrated. Five suppliers for the supply of components to the railroad industry will be evaluated by the GD.

KEYWORDS: MCDM, AHP Method, Supplier Selection, Supplier Selection and performance evaluations, Supplier Quality Cost, Alternatives.

1. INTRODUCTION

The global business environment of today is characterized by intense competition. With the market so competitive and demanding, every business is attempting to find its place in the worldwide marketplace. If we go back a few years, we can see that businesses have been attempting to come up with ways to reduce costs and stay in a position where they can continue to operate and expand. In the same vein, they are working to enhance their business plans [2], seeing supply chain management as a crucial component of expansion. take on a deliberate assessment model for provider choice while deciding potential and appropriate accomplices. (Karamasa, C et al 2021). The vast majority of the displays in supplier determination depend on the joining of fluffy hypothesis with customary MCDM

techniques. The issue of supplier determination is one of the main issues in-store network the executives, This makes the course of creating and putting to utilize another dynamic strategy for the choice of a supplier a significant angle undertaking of the association. Even though there are quite a large number of fluffy MCDM strategies that have been utilized to settle the supplier (Banaeian et al., 2018).

SUPPLIER DEVELOPMENT ACTIVITY

There are three possible formats for supplier improvement exercises. The primary framework may consist of the compilation of Supplier data, the evaluation of the Supplier's display, and the one-way arrangement of express data regarding the Supplier's evaluation outcomes. The next structure can be the organization of highly specialized, internal processes, or administrative data. The third structure might be the natural exchange of implicit knowledge through the exchange of human resources, which serve as the buyer and supplier companies' representatives. Because they rely on key suppliers, purchasing companies are increasingly involved in their providers' operations due to supplier improvement. Suppliers may be able to improve their capacities through these exercises. (Friedl and Wagner, 2012).

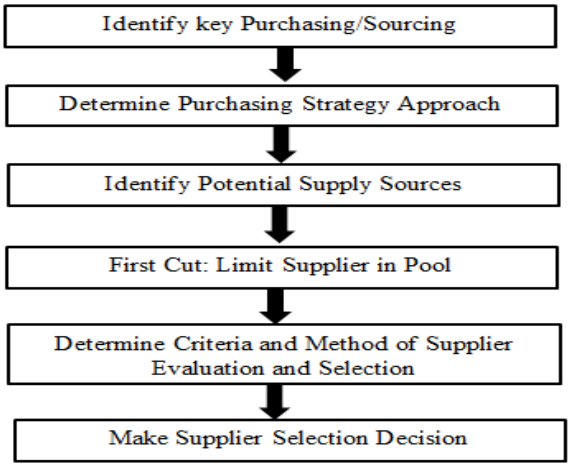

Figure 1 Green Supply Chain Manage

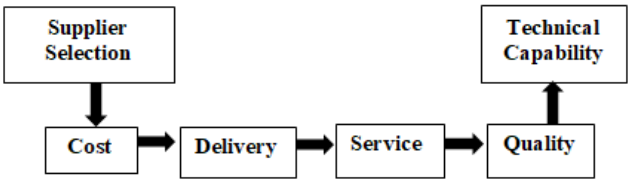

Figure 2. Value Sought by Buyers from Suppliers

1. **COST:** While the unit cost of the material isn't ordinarily the sole rule in supplier choice, the absolute expense of possession is a significant element. All out the cost of ownership incorporates the unit cost of the material, instalment terms, cash rebate, requesting cost, conveying cost, coordinated factors costs, upkeep costs, and other more subjective costs that may not be easy to evaluate.

2. **DELIVERY:** During the determination stage, in some cases, associations need an organized method for assessing evaluate suppliers. This can be especially hard when the rules incorporate not simply quantitative measures (like expenses and on-time delivery rates) but other, more subjective elements, like administration strength or dependability. A supplier's determination scorecard might be utilized as a choice help instrument. The assessment group will dole out a load to the various classes and foster a mathematical score for every supplier in every classification, consequently fostering the last presentation score.

3. **SERVICE:** Providers should have the option to back up their items by offering great types of assistance when required. For instance, when item data or guarantee administration is required, providers should answer on a convenient premise.

4. **QUALITY AND RELIABILITY**: Quality levels of the acquirement thing ought to be a vital element in supplier determination. Item quality ought to reliably meet indicated necessities since it can straightforwardly influence the nature of the completed merchandise. Other than dependable quality levels, dependability additionally indicate to other supplier attributes. For instance, is the supplier's conveyance lead-time solid? Any other way, creation might need to be interrupted on because of lack of material.

5. **TECHNICAL CAPABILITY:** Surveying a potential supplier's administration capacity is a convoluted, however significant stage. The various parts of the executive's capacity incorporate the administration's obligation to ceaseless cycle and quality improvement, its general proficient capacity, and experience, its capacity to keep up with positive associations with its labour force, and its ability to foster a nearer working relationship with the buyer.

- **[**Source: BLC 304/05 Procurement Management]

2. LITERATURE REVIEW

The literature review is a vital need for all research methods since it illuminates the strategy, and present state of any study topic. The purpose of this study is to design supplier selection procedures for railway tracking parts and select the best choices using AHP and MCDM methods. The fundamental methods for increasing rail capacity are to upgrade or extend the system's infrastructure and enhance operating aspects. The many technical capacities and methodologies that are involved in each approach's analysis are introduced. These also include enhancing, describing, and organizing the usage of the limit.

Rouyendegh, B et al. (2014) The author of this research gives a summary of AHP and Multi-Decision Objective Programming for Multi Standards Navigation (MCDM) difficulties in an uncertain environment. This study applies the suggested AHP strategy to manage the questionable and uncertain judgment of the decision-maker with the example taken by the mathematical case is given to explain the main outcome created in this paper. This study manages the ideal decision-making for selecting a supplier and allocating requests.

Kannan, D. et al. (2014) In this investigation, the author finds a network of green inventories for an electronic organization and built a structure using the AHP method. Information is obtained for an exploratory investigation from a group of 12 readily available vendors. To rank the providers, we use a fuzzy AHP technique. The results of the suggested system are compared, as are the positions attained by both the mathematical mean and the assessed mean AHP methodologies. The four main standards identified by the results are senior management commitment to GSCM; Product plans that reduce, reuse, reuse, or recover materials, parts, or energy; Compliance with legal ecological requirements and project review; and Product plans that avoid or reduce the use of hazardous materials.

Mokhtari M et al. (2013) The author of this study applies fuzzy AHP techniques to the supplier selection process in the manufacturing and textile industries, where the economic order quantity is always 1. The author's goal is to represent and create a highly reliable supplier selection model for the textile sector. The outcome demonstrates

that five standards—quality, area, cost, trust, and conveyance—are the most effective ones in the region where material providers are chosen. The best providers, according to our proposed method, are s9, s15, s16, s4, and s5.

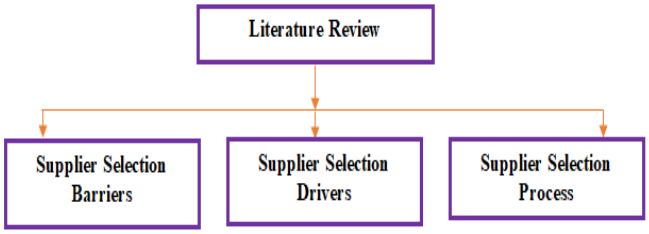

Figure 3. Roadmap for Literature Review

SUPPLIER SELECTION BARRIERS

Sunil Kumar C. V. et al (2017) In the current scenario, the author compares perspectives and strategic approaches for managing suppliers that have unfathomably altered and are growing more quickly. Even the explicit expenditures made by suppliers are focused on improving and altering the suppliers' capacity to satisfy the changing demands of the final consumers. To study the relationships between the borders and SDPs, a thorough and objective industry-wide survey of the Indian manufacturing sector was carried out for this assessment. The evaluation has thoroughly compiled the obvious barriers coming from numerous angles (such as the provider, maker, producer supplier, and external environment) and provided a maker with a foundation to lead the supplier development.

Biswas, Tapas Kumar et al. (2020) Whether all necessary emergency supplies and services are unavailable, this author has discussed the effects of supplier choice in all industrial sectors during the COVID-19 pandemic. The supply chain has encountered a variety of challenges. The five main obstacles to the production network have been identified by this research, including the lack of labour, the need to comply with local ordinances, the lack of transportation, the scarcity of raw materials, and the loss of income for Indian industrial sectors during the shutdown. This research developed a system based on a triangular fuzzy number pairwise comparison matrix and a fuzzy scientific ordered progression process (Fuzzy-AHP). Manpower shortages have been seen to have heavier weight barriers than others. The administrative repercussions of the results are also provided, which will help assemble areas in making sensible decisions to overcome these impediments.

DRIVERS FOR SUPPLIER SELECTIONS

Recognizing the supplier assessment criteria, such as cost, quality, and on-time delivery, which are the important fundamental models that have a substantial impact on the buyer, is the first stage of this cycle. To the contrary, it is crucial for basic items that the supplier does a thorough study into their cycle capacity, machinability, and commercial acumen. Therefore, further supplier assessment research is needed. These requirements frequently accompany Supplier management competence., abilities of the workforce as a whole, Total quality management system, cost structure Systems for planning and controlling production.

Schoenherr, T et al. (2008) In this piece of study, the author describes the analytical hierarchy process (AHP), which is crucial for the progress of supplier selections in large, contemporary German organizations. Author-led exploratory sessions, crucial supplier improvement guidelines, and a program's success component for supplier advancement.

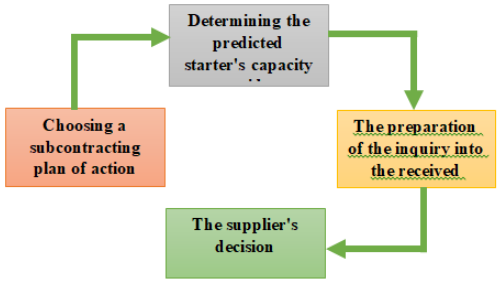

Figure 4. Supplier Selection Processes

STEPS FOR THE PROCESS OF SELECTING AND EVALUATING SUPPLIERS

The buyer starts the supplier evaluation process by deciding which "aspects" it will use to evaluate the provider. The two characteristics of supplier appraisal that were most frequently noted were quality and conveyance. Gives a thorough breakdown of these factors, arranged in order of how frequently they appear in purchase literature. Frequently, dimensions factors include [15].

- **Price**: The cost of goods or services offered by the supplier.
- **Quality**: The quality of the products or services provided by the supplier.
- **Reliability**: The supplier's track record in delivering goods or services on time and as promised.
- **Reputation**: The supplier's reputation in the industry or among its customers.
- **Financial Stability**: The financial health and stability of the supplier.
- **Technical Capabilities**: The supplier's technical expertise and ability to meet specific requirements.
- **Innovation**: The supplier's ability to innovate and offer new solutions or technologies.

3. OBJECTIVE OF THE RESEARCH

For executives to move goods and maintain operations, spare parts support is essential. The on-going supplier selection model selects the provider after evaluating a certain aspect of the measurements. The identification of suppliers that performed poorly between 2018 and 2020 with the delivery of goods after the deadline and items that didn't fulfil specifications. With the assistance of INTEGRA Engineering India Limited, the main goal of this investigation is to analyse and determine the appropriate need models for selecting suppliers of moving spare parts for railroad enterprises (IEIL). With such a massive complexity happening in each field of production network in the organizations, it becomes significant for the organizations to zero in on how and where to diminish the risk. One essential variable where organizations should be extremely cautious is the provider choice. This will give by and large upper hand to the firm on the lookout. The analysis method used in this study is analytical hierarchical process (AHP).To survey supplier evaluations, AHP is used. For railroad businesses, specifically in selecting suppliers of moving stock spare parts, a total of 5 criteria from 4 attribute standards have been chosen. This is because the organizations need to have

- long term relationship with the suppliers
- A supplier who consistently meets the criteria established during the selection process can be deemed as a reliable and compatible partner.
- A supplier with minimal risk exposure in business transactions can be described as low-risk
- A supplier that provides the maximum overall value delivers the most beneficial

combination of quality, reliability, cost-effectiveness

- Identifying a supplier with minimal risk and maximum overall value is crucial for fostering a long-term relationship and maximizing benefits for the manufacturer.

4. RESEARCH METHODOLOGY

The AHP approach, as previously noted, may be used to choose an appropriate supplier for the firm (client). The AHP is a methodical process for choosing suppliers. Instead of prescribing the "right option," the AHP assists people in making complicated judgments. Based on both human psychology and mathematics, It was created by Saaty (1980), and since then, it has undergone substantial research and improvement. When various criteria must be taken into account, AHP is a decision-making technique that helps the decision-maker organizes complicated issues into a hierarchy or a series of connected levels. The hierarchy typically consists of three levels: the aim, the criteria, and the options. The best overall provider must be chosen in the supplier selection problem. Quality, pricing, service, and delivery are only a few examples of the criteria. The many recommendations that the providers have provided as options. This approach helps to streamline and expedite the decision-making process naturally and offers the framework for making smart selections in challenging circumstances (such as supplier selection).

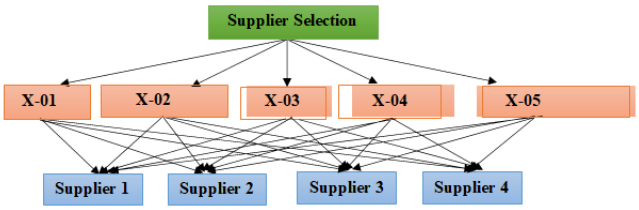

Figure 5. Supplier selection diagram

COMPANY PROFILE

With access to air, train, and road 24 hours a day, IEIL is located near Halol, some 45 kilometres from the design centre in Vadodara. The company's annual revenue is $100 million. Since the company was listed on the Bombay Stock Exchange in 2012, it has gradually filled up tremendously. Integra Engineering India Limited (IEIL) currently has three entirely operational units: Design, engineering, and production of modified sheet metal products in SS, MS, GI, and Al are the main tasks of Unit I.

There are problems with supplier performance at a significant Integra Engineering India Limited (IEIL) assembly facility. Its administration selects suppliers of raw materials to achieve the upper hand in the search. Due to the concerned Integra Engineering India Limited (IEIL) Company's confidential approach, neither the name of the unit nor the names of its suppliers are disclosed. Five standards are taken into consideration to evaluate provider selection for the entire arrangement of models for IEIL.

1. Quality of product (X-01)

2. Performance (X-02)

3. Reputation (X-03)

4. Cost (X-04)

5. Delivery capabilities (X-05)

The stepwise procedure was chosen to assess the relative weights of the criterion. The following list of AHP's several steps is provided.

Step 1: Identifying the decision-making issue.

Step 2: Creating the matrix for pair-wise comparison.

Step 3: Matrix normalisation through calculation.

Step 4: Find the criteria's weighting coefficient.

Step 5: The consistency ratio is computed.

Table 1. Fundamental Scale for Pair- Wise Comparison

Intensity of importance	Definition	Explanation	Membership functions
1	Equal Importance	Two factors contribute equally to the objective	(1,1,1)
3	Somewhat more important	Experience and judgment slightly favor one over the other	(2,3,4)
5	Much more important	Experience and judgment strongly favor one over the other	(4,5,6)
7	Very much more important	Experience and judgment very strongly favor one over the other. Its importance is demonstrated in practice.	(6,7,8)
9	Absolutely more important	The evidence favoring one over the other is of the highest possible validity.	(9,9,9)
2,4,6,8	Intermediate value	When compromise is needed.	(1,2,3)(3,4,5)(5,6,7)(7,8,9)

Table 2. Randomly Generated Consistency Index for different size of matrix

n	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 3. Pairwise Comparison Matrix

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	1	5	4	7	3
X-02	1/5	1	5	5	4
X-03	1/4	1/5	1	4	7
X-04	1/7	1/5	1/4	1	6
X-05	1/3	1/4	1/7	1/6	1

Table 4. Pairwise Comparison Matrix

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	1	5	4	7	3
X-02	0.20	1	5	5	4
X-03	0.25	0.20	1	4	7
X-04	0.14	0.20	0.25	1	6
X-05	0.33	0.25	0.14	0.17	1

Table 5. Pairwise Comparison Matrix with Geometric Mean

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	1	5	4	7	3
X-02	0.20	1	5	5	4
X-03	0.25	0.20	1	4	7
X-04	0.14	0.20	.0.25	1	6
X-05	0.33	0.25	0.14	0.17	1
TOTAL SUM	1.92	6.65	10.39	17.16	21

Table 6. Pairwise Comparison Matrix with Geometric Mean

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	0.52	0.75	0.28	0.4	0.14
X-02	0.10	0.15	0.35	0.29	0.19
X-03	0.13	0.03	0.07	0.23	0.33
X-04	0.07	0.03	0.28	0.05	0.29
X-05	0.17	0.03	0.01	0.01	0.04
TOTAL SUM	1.92	6.65	10.39	17.16	21

Table 7. Comparison Matrix with Criteria Weights

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05	Criteria Weights
X-01	0.52	0.75	0.28	0.4	0.14	0.42
X-02	0.10	0.15	0.35	0.29	0.19	0.22
X-03	0.13	0.03	0.07	0.23	0.33	0.16
X-04	0.07	0.03	0.28	0.05	0.29	0.14
X-05	0.17	0.03	0.01	0.01	0.04	0.05
TOTAL SUM	1.92	6.65	10.39	17.16	21	

Table 8. Calculation the Separation Measure for Each Row

Criteria Weights	0.42	0.22	0.16	0.14	0.05
Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	0.52	0.75	0.28	0.4	0.14
X-02	0.10	0.15	0.35	0.29	0.19
X-03	0.13	0.03	0.07	0.23	0.33
X-04	0.07	0.03	0.28	0.05	0.29
X-05	0.17	0.03	0.01	0.01	0.04
TOTAL SUM	1.92	6.65	10.39	17.16	21

Table 9. Calculation of Each Column with Criteria Weights

Criteria Weights	0.42	0.22	0.16	0.14	0.05
Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	1*0.42	5*0.22	4*0.16	7*0.14	3*0.05
X-02	0.20*0.42	1*0.22	5*0.16	5*0.14	4*005
X-03	0.25*0.42	0.20*0.22	1*0.16	4*0.14	7*0.05
X-04	0.14*0.42	0.20*0.22	4*0.16	1*0.14	6*0.05
X-05	0.14*0.42	0.25*0.22	0.14*0.16	0.17*0.14	1*0.05

Table 10. Calculation of Criteria Weights

Supplier Alternatives	Criteria Weights	Weightage Preference
X-01	0.42	42%
X-02	0.22	22%
X-03	0.16	16%
X-04	0.14	14%
X-05	0.05	5%

Table 11. Calculation of Weighted Sum Value

Criteria Weights	0.42	0.22	0.16	0.14	0.05
Supplier Alternatives	X-01	X-02	X-03	X-04	X-05
X-01	0.42	1.1	0.64	0.98	0.15
X-02	0.08	0.22	0.8	0.7	0.20
X-03	0.10	0.04	0.16	0.56	0.35
X-04	0.05	0.04	0.64	0.14	0.30
X-05	0.05	0.05	0.02	0.02	0.05

Table 12. Calculation of Criteria Weights & Weighted Sum Value

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05	Weighted Sum Value
X-01	0.42	1.1	0.64	0.98	0.15	3.29
X-02	0.08	0.22	0.8	0.7	0.20	2.00
X-03	0.10	0.04	0.16	0.56	0.35	1.21
X-04	0.05	0.04	0.64	0.14	0.30	1.17
X-05	0.05	0.05	0.02	0.02	0.05	0.19

Table 13. Calculation of Criteria Weights & Weighted Sum Value

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05	Weighted Sum Value	Criteria Weights
X-01	0.42	1.1	0.64	0.98	0.15	3.29	0.42
X-02	0.08	0.22	0.8	0.7	0.20	2.00	0.22
X-03	0.10	0.04	0.16	0.56	0.35	1.21	0.16
X-04	0.05	0.04	0.64	0.14	0.30	1.17	0.14
X-05	0.05	0.05	0.02	0.02	0.05	0.19	0.05

Table 14. Weightage Preference for Supplier Alternatives

Supplier Alternatives	X-01	X-02	X-03	X-04	X-05	Weighted Sum Value	Criteria Weights	W/C
X-01	0.42	1.1	0.64	0.98	0.15	3.29	0.42	7.86
X-02	0.08	0.22	0.8	0.7	0.20	2.00	0.22	9.26
X-03	0.10	0.04	0.16	0.56	0.35	1.21	0.16	7.63
X-04	0.05	0.04	0.64	0.14	0.30	1.17	0.14	8.17
X-05	0.05	0.05	0.02	0.02	0.05	0.19	0.05	3.68

Proposed utilizing a consistency index (CI) to verify the consistency of the comparison matrix. The consistency index (CI) of the derived weights can then be calculated by: CI = (λmax−n)/ n−1. In general, if CI is less than 0.10, the satisfaction of judgments may be derived.

Now Calculate

λ_{max} = [7.86+9.26+7.63+8.17+3.68)/5 =5.1007

Consistency Index (CI) = λ_{max} - n/ (n-1) = 0.02517

Consistency Ratio (CR) = CI/ RI =0.02517/1.12 =0.0224 which is < 0.10

5. CONCLUSION

One of the main reasons supplier selection is difficult is that there are suppliers in the group and the purchasing team focuses on only one set of selection criteria. It is important to note that other parameters are important in vendor-specific terms and this need to be considered. It is for this reason that the purchasing group's expert panel comes up with a comprehensive list of supplier selection criteria and they are grouped based on the relationships between them, then all suppliers are evaluated against all Supplier-defined criteria. The selection was mentioned with maintainable Suppliers as one of the supportable processes that affect all functional activities inside an organization. It might be challenging to choose the ideal Supplier(s) who are suitable for acquiring components or parts in light of predetermined sensible models and hierarchical demands. To develop a sound approach for the Supplier Selection dynamic cycle, the SS problem at INTEGRA Engineering India Limited (IEIL) was investigated in this study project. The goal of this research is to develop a very comprehensive and effective supplier evaluation and selection model. In recent times, companies have been aiming to reduce the number of suppliers as it becomes difficult to manage too many suppliers. Thus, having fewer suppliers not only increases trust and relationships between buyers and suppliers but also allows for better monitoring and control of work progress. This helps develop long-term relationships with suppliers that deliver overall value to

the buyer. The best maintainable supplier was determined by applying an Intuitionistic AHP technique.

The key highlights of this research are: -

- Selecting criteria carefully is indeed crucial for making informed decisions. Analysing market feedback and historical data to generate probabilities can significantly.
- These experts bring specialized knowledge and skills that are essential for making informed decisions in complex environments.
- Overall, leveraging the expertise of individuals for data analysis and probability estimation offers smaller companies a cost-effective way to enhance their decision-making processes

6 .OUTCOME AND SUGGESTIONS

To stay serious and respond to quickly changing markets in the contemporary global environment, businesses must increase their flexibility. Therefore, the ability to demonstrate supplier selection effectively is essential for businesses to remain serious by achieving exceptional results in every cycle both inside and outside the company. The goal of this study is to learn more about supplier selection, particularly as it relates to SMEs' potential as suppliers in the Indian railway sector. It also examines the challenges SMEs encounter in becoming suppliers, as well as the steps they take to become preferred suppliers among customers.

The analysis showed that suppliers in the Indian railway sector are aware of constraints. The goal of this research was to establish that the most important sustainable supplier improvement factors are assets, industry-specific human resources, and industry rules. Integra Engineering India Limited (IEIL) relationship was identified as one of the reasonable practices that have a positive influence on all functional activities inside a business when it comes to economical Supplier choice interaction. Therefore, providing precise DMs with decision-making assistance would be beneficial for helpful organizational growth in carrying out the practicable getting activity.

The future works related to this study are as follows: -

- Integrating environmental criteria or green aspects into supplier selection processes is crucial for promoting sustainability within supply chains. Here's an approach you could consider for future studies
- By incorporating secondary criteria such as product design, packaging, and warehouse management into the supplier selection process, future research can advance sustainability
- By focusing on how different modes of transportation can be effectively utilized to achieve cost savings while maintaining or enhancing operational effectiveness
- By recognizing the importance of the interaction between transportation networks and community networks, future research can contribute to the development of more inclusive, equitable, and resilient communities.

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