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Evaluating Green Supplier Selection Using the Weighted Sum Method for Sustainable Supply Chain Development

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ABSTRACT

Assessing vendors based on their environmental performance and practices is known as "green supplier selection." The supplier's energy efficiency, waste management practices, carbon footprint, usage of renewable resources, and compliance with environmental standards are just a few of the variables taken into account in this evaluation. Suppliers who commit to sustainability and make an effort to lessen their environmental effect are given preference by organizations. Environmental Impact: Research on green supplier selection focuses on finding vendors that value sustainable practices. Sustainable Supply Chains: Research on green supplier selection aids in the development of sustainable supply chains for businesses. Risk management: Research on ecofriendly supplier selection aids businesses in controlling environmental hazards in their supply chains. Research on green supplier selection encourages collaboration and innovation throughout supply chains. Regulation Compliance: Environmental rules are tightening, and businesses must abide by them to stay out of trouble with the law. Research on green supplier selection supports the overarching objective of sustainable development. The primary premise of the technique is that the structural material acts in a linear elastic fashion, and that appropriate safety may be maintained by adequately limiting stresses in the material caused by the anticipated "working loads" on the framework. Define Criteria and Objectives, Supplier Identification, Data collection, evaluation and scoring, supplier engagement, Decision making, performance monitoring, Supplier Development Supplier1, Supplier2, supplier 3, supplier 4, supplier 5, supplier 6 Green capability, Price, Quality, Green design, green material, Environmental, Personnel teaching, Waste management, Re-use rate, Re-cycle rate. Among all the suppliers, supplier 6 gets first rank in green supplier selection with the weighted sum method we are able to find the best green supplier it has been evaluated with various parameters and methodology.

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INTRODUCTION

The useful tool for evaluating possibilities in regard to the criteria when faced with challenges in making decisions involving several criteria. It stands out for using a wide range of preference functions to divide up the differences between possibilities in evaluations. This study suggests employing the under the common criteria preference functions to select green suppliers. To examine the impact of several preference functions on the ultimate preference, comparable findings are provided. Four vendors, five decision makers, and seven economic and environmental factors made up the bulk of the green supplier selection challenge. Direct conversations with decision-makers were used to collect data using a five-point Liker scale. Supplier A1 appears to be the front-runner when the technique was used with the conventional criterion function [1]. Four suppliers' data were gathered by speaking with decision-makers directly. Supplier A1 is the most desired option, according to the results of the algorithm when used with standard criteria. In spite of the many preference functions that were employed, comparative results indicate that supplier A1 is the most desired alternative [2]. Concerns about how manufacturing operations affect the environment are widespread. To strike a balance between financial success and environmental sustainability, businesses applied as a result, selecting a reliable green supplier is challenging, and DMs typically find it impossible to assess different values. Because hesitation and uncertainty are constant in green supplier selection practise, the classic fuzzy sets are unable to describe the situation. The reluctance and subjective ambiguity of the DM are well-captured by the hesitant fuzzy set (HFS) (Torra 2010).[3] Due to growing concern for environmental preservation, green supply chain management (GSCM) has become a crucial topic. The environmental performance of a company's suppliers is equally essential in terms of relevance to the business as its own internal environmental efforts. The goal of this study is to propose an integrated multi-criteria decision-making (MCDM) approach for choosing green suppliers that is based on intuitionistic fuzzy sets and grey relational analysis (GRA). Arrangement, approach, and strategy Numerous forms of uncertainty are present in the "green supplier selection" MCDM technique. IFS and GRA are used to solve these problems since decision makers' assessments are hazy and imprecise, and the criteria are subjective. Findings A numerical illustration of the suggested strategy is given. Studies of the results show that the challenges of selecting a green supplier under uncertain conditions can be solved using fuzzy set theory and grey theory. Originality/value There are several types of uncertainty while choosing a provider. This work is distinctive in that it uses appropriate uncertainty approaches at various times throughout the selection process rather than describing the entire process using a single uncertainty theory. In the operations research literature supplier selection issues are often discussed. In various articles, various criteria are applied. In this study, a thorough assessment of the literature was conducted, and several often-encountered criteria were presented the choice of a company's suppliers is one of the necessary phases in handling its supply chain in the present competitive and international climate, where most firms are evolving. The final product's price, quality, and other factors are significantly influenced by this procedure. This has caused the process of choosing the best suppliers to work with when making purchases of tangible goods or services to become a multi-criteria choice. More specifically, in order to choose the best suppliers, companies must consider a number of factors relating to potential suppliers (such as price and lead time), the product (such as quality and materials), and, more recently, factors relating to the environment and society (such as the amount of carbon dioxide emitted during production and transportation).Given the growing significance of suppliers to a company's performance, selection and assessment of suppliers are essential components of supplier management (Wagner and Johnson, 2004). The goal of contemporary supply management is to utilise fewer, trustworthy suppliers and to preserve long-term relationships with them (Hoetal, 2010). The key is to not view decision models as a strict format that replaces everything in the supplier selection field, but rather as tools for eliciting, conveying, and assessing one's unique and subjective preference structure and uncertainties (de Boer et al., 2001). To keep a competitive advantage in the trend towards globalisation, businesses should frequently use an assessment technique of supplier selection while looking for potential and suitable partners [6]. The foundation of a strategic partnershipe is the choice of green suppliers. Whether the green suppliers operate well or poorly will directly affect how well the core businesses preserve the environment and how much and how well their goods are delivered. The green supply chain's overall efficacy will be negatively harmed. The decision on which supplier to work with is important A successful company has a crucial decision-making challenge when choosing suppliers in a market that is competitive (Noci, 1997; Sarkis, 2003). Over the past 20 years, society has paid a lot of attention to the environmental problem. Suppliers must implement effective green strategies and reduce environmental impacts throughout the entire supply chain during the production, sale, after-sale service, and disposal of recycled products in order to achieve sustainable development that strikes a balance between environmental, economic, and social performance (Min and Galle, 1997; P. Rao, 2002; Walton, et al., 1998). Purba Rao and Holt (2005) and Zhu et al. (2005) note the significance of taking environmental effect into account when choosing a supplier in addition to aspects like price, service, and quality[8] The green challenge has become more significant in chain management over the past few years as companies have been more concerned with environmental protection and sustainable development. Data envelopment analysis (DEA) and analytic network proced, two multi-attribute decision analysis (MADA) methodologies, are combined with an artificial neural network to construct a model for selecting green suppliers.[10] This hybrid strategy is called ANNeMADA. The ANNeMADA hybrid approach considers both the applicability of traditional supplier selection criteria and environmental norms. It also overcomes limitations imposed by conventional DEAs on the quantity of decision-making units (DMUs) and data accuracy. An internationally recognised camera manufacturer's model assessment results show that the ANNeMADA hybrid technique outperforms the ANNeDEA and ANPeDEA hybrid approaches. Furthermore, it was demonstrated that ANNeMADA had greater noise immunity and discriminating skills while evaluating the effectiveness of green service providers [11] [12][13]. decision matrix with hesitant uncertainty. Results - The Hong Kong-Zhuhai-Macau Bridge project's CB02 contract section provides as an illustration of how the recommended framework has been successfully used. The results show that the recommended approach may be used to a range of difficult decision-making situations. The synthetic (in)consistent indexes can compute all prospective providers by normalising the tentative fuzzy decision matrix.[14]Making green supplier choices (GSS) is crucial for promoting business expansion. By using quality function deployment (QFD), it is ensured that the criteria used to assess green suppliers are compatible with the characteristics that products being purchased should have. All criteria are assumed to be separated into many clusters by the partitioned Bon ferronimean (PBM) operator. where criteria within the same clusters are connected and irrelevant. [15]

2. MATERIALS AND METHOD

'Green' ability: Organisations looking to include sustainability into their supply chain management must carefully choose their suppliers. The goal of this paper study is to investigate and evaluate the idea of "green capability" as a deciding element when choosing green suppliers. The term "green capability" describes a supplier's capacity to adopt and use eco-friendly procedures across their whole business. The importance of green capacity in supplier selection and its effect on the effectiveness of sustainable supply chains will be examined in the study.

Price: This study paper seeks to look at the integration of cost factors in the choice of green suppliers and analyse the harmony between sustainability and cost effectiveness. The study will look at the trade-offs between sustainable practises and economic viability and how pricing considerations affect supplier selection decisions.

Quality: This study intends to look at the incorporation of quality factors in the choice of green suppliers and analyse the connection between sustainability, quality, and overall supply chain performance. green architecture

Incorporating green design principles into the choice of green suppliers and its effect on the development of sustainable products are the subjects of this research report. The study will look into the possibilities for supplier and organisation cooperation to promote the development of sustainable products, as well as how green design aspects affect supplier selection decisions. The goal of green substance is to examine the value of taking into account green material factors when choosing a green supplier and how this affects improving sustainable material sourcing. The study will look into the consequences for reaching sustainability goals as well as how green material considerations affect supplier selection decisions. Environmental strives to investigate the value of environmental factors in choosing environmentally friendly suppliers and how they affect improving sustainability in the supply chain. The study will look at how environmental considerations affect supplier selection choices and what it means for accomplishing environmental objectives.

personnel education:

The purpose of this article is to examine the value of staff training in green supplier selection and how it influences the adoption of sustainable supply chain practises. The purpose of the study is to determine how supplier selection decisions are influenced by staff training elements and what it means for improving sustainability performance. Waste management Examine the value of waste management in choosing eco-friendly suppliers and its contribution to the advancement of sustainability goals. The study will look at the implications for creating a more circular supply chain and how waste management variables affect supplier selection decisions.Re-use rate examines the value of re-use rate in choosing environmentally friendly suppliers and how it influences the development of sustainable resource management practises. The study will look into the implications for creating a circular supply chain as well as how re-use rate parameters affect supplier selection decisions.

Cycle frequency: The purpose of this research study is to examine the value of recycling rate in choosing environmentally friendly suppliers and how it affects the development of sustainable materials management practices. The study will look at the implications for creating a more circular supply chain as well as how re-cycle rate parameters affect supplier selection decisions.

Method: An intelligent reflecting surface has been suggested as a way to increase wireless networks' throughput and efficiency. To change the environment of signal propagation so that users can receive both desirable signals and interfering signals in both positive and negative ways, the IRS, in particular, comprises several reflecting components that may independently govern incident signals. Due to a metallic patch unit's small structural size, which produces a significant passive beamforming gain, the IRS is possible to attach hundreds of them in practise [1]. It has been proposed to improve the spectral efficiency and throughput of wireless networks by using an intelligent reflecting surface (IRS). The IRS, in instance, consists of numerous reflecting components that may independently manage incident signals in order to alter the environment of signal propagation so that users can receive both desired messages and interfering signals in both positive and negative ways. In practise, the IRS may be attached to hundreds of metallic patch units due to their modest structural size, which results in a considerable passive beamforming gain. Additionally, the use of multiple-IRS for data transmission was investigated in Utilising numerous IRSs' short-range coverage allows one to position them sufficiently apart from one another, which is the main goal. Minimising a weighted sum is a popular idea in multi-objective optimisation and may be both a stand-alone approach and a part of other methods. Therefore, understanding the properties of the weighted sum approach has broad ramifications. Despite the many published tasks for the method in question and papers dealing with the limitations with the goal of depicting the characteristics of the Pareto optimal collection there is little comprehensive research regarding the philosophical significance of the the weights and strategies for maximising the success of the method when it comes to a priori expression of preferences [4]. As a result, this study examines the underlying value of the weights in terms of preferences, the Pareto set, and objective-function values. We identify the factors that affect which solution point shows up in a certain collection. Analysis is completed to select the best weighting for this investigation. An efficiency metric based on least average error is used to determine the index for each weighting set. The PID controllers for both sections are set simultaneously to guarantee efficient compensation in the system output. By contrasting the performance of the suggested controller with that of traditional PI and PID controllers the tuning performance of the algorithm is assessed.[7] The system reaction to simultaneous phase load disturbance (SLP), changing load demand, and generally fluctuating system variables in the range of 50% are explored in order to further explore the endurance of the suggested method. The simulation highlights the controller's dynamic reactivity through a trade-off between the greatest overshoot of the rate of response or the settling time. The recommended method is also adaptable enough to work in various operating settings and system parameter modifications.[8] The system reaction to simultaneously step by step load perturb (SLP), changing demands for load, and collectively rising parameter values in the range of 50% are explored in order to further explore the robustness of the suggested method. A trade-off between the greatest excess of the frequency action and the time needed to settle draws attention to the controller's dynamic responsiveness in the simulation. The system reaction to simultaneously step by step load perturb (SLP), changing demands for load, and collectively rising parameter values in the range of 50% are explored in order to further explore the robustness of the suggested method.A trade-off between the greatest excess of the frequency action and the time needed to settle draws attention to the controller's dynamic responsiveness in the simulation.. Additionally, the suggested technique is resilient enough to function in a variety of operating environments and system parameter changes.[15] There has been substantial analysis of the LFC, and more study is still being done on how to improve the LFC's control strategy and functioning. Researchers have been motivated to further improve the modelling and design of LFC as a result of physical constraints, dynamic behaviour, and system non-linearities [16]. Researchers have used a variety of techniques and plans of action to enhance LFC performance. The design techniques may be divided into several categories, including digital control techniques, adaptive and variable structure techniques, resilient control strategies, and intelligence-based algorithms[17]. The LFC has been the subject of several assessments, and work on how to enhance its functioning and control approach is ongoing. Due to physical limitations, dynamic behaviour, and system non-linearities, researchers are attempting to enhance LFC models and design [18]. Researchers have increased LFC's performance by utilising a range of strategies and methodologies. Some of the subcategories of design approaches include traditional design methods, adaptive and changeable structure methods, resilient control strategies, intelligence-based algorithms, and digital control methods[19]. Numerous analyses of the LFC have been conducted, and more study is continuously being done on how to improve the LFC's control strategy and functioning. Researchers are working to improve LFC modelling and design due to physical constraints, dynamic behaviour, and system non-linearities [20]. The performance of LFC has been improved by researchers using a variety of techniques and tactics. Classical design techniques, adaptive and variable structure techniques, resilient control strategies, intelligence-based algorithms, and digital control techniques are some of the subcategories of design techniques [21]. This paper establishes a modular design framework for a variety isotropic plate using the "adaptive weighted sum" technique. Design variables comprise the elemental depths of slabs that were successfully simulated with finite elements, and the design objective is to reduce weight and static dispersion. Here, the analytical sensitivity methodology, the finite element method, and optimisation algorithms are combined to create the multicriteria optimisation framework.[22]. The adaptive weighted sum approach is used in this study to establish a multicriteria design framework for variable thickness isotropic plates. The reduction of weight and static displacement is the design goal, and the design variables are the elemental thicknesses of plates that have been simulated using finite elements. Here, the analytical sensitivity methodology, the finite element method, and optimisation algorithms are combined to create the multicriteria optimisation framework.[23]. In order to study multicriteria optimising plate plates as well, the weighted sum approach is first utilised, which produces sparsely distributed Pareto optimal solutions. After creating a coarser representation of Optimal optimum solutions using the weighted sum method, the adaptive weighted sum approach is then applied, where fewer crowded areas are selected for further refining [24]. In these areas, the sub optimization issues are resolved to produce a fresh set of Pareto optimum solutions. Under various restrictions, the adaptive weighted sum technique's Pareto optimum curves are also contrasted with those derived using the traditional weighted sum approach. Investigations are also done into how border conditions affect the thickness distributions of plates and Pareto optimum solutions.[25]. The aerospace, automotive, and civil industries primarily rely on mathematical modelling. The optimization problems in structural design are frequently represented as a single objective constrained by particular behavioral rules. One goal function should be considered in practical applications, albeit [26]. seldom provides an accurate reflection of the structure's performance. The best structural designs must take into account a number of (often competing) design objectives. One can solve each optimization of a single design target in turn in order to encompass multiple design objectives. Due to the fact that each optimization step only addresses one aim, this approach is unable to produce an optimal result. To find solutions, these goal functions should be optimised concurrently. [27]

3. **RESULTS AND DISSCUSSION**

TABLE 1. Green supplier selection

green supplier selection										
	Green capability	Price	Quality	Green design	Green material	Environmental	Personnel training	Waste management	Re-use rate	Re-cycle rate
Supplier1	1.3	8.5	5.9	2.1	3.7	4.0	5.3	3.8	6.9	1.6
Supplier2	5.1	4.7	5.7	8.1	3.4	5.4	2.6	1.8	5.6	2.5
Supplier3	8.1	8.5	5.0	6.5	2.4	3.4	4.7	1.2	3.5	1.4
Supplier4	3.4	5.1	8.2	7.8	8.8	6.4	3.5	4.5	5.3	5.3
Supplier5	5.7	8.0	1.4	1.9	5.6	2.9	1.7	8.4	6.1	8.7
Supplier6	1.4	7.8	7.6	2.8	2.6	7.9	4.3	5.4	8.3	4.0

Table 1 shows the displaying the analysis technique in WSM alternative in use, green capabilities, price, quality, environment, personal training, waste management, re-use rate, recycling rate, and assessment preference for choosing green suppliers: Suppliers 1, 2, 3, 4, 5, and 6 all make up the supply chain.

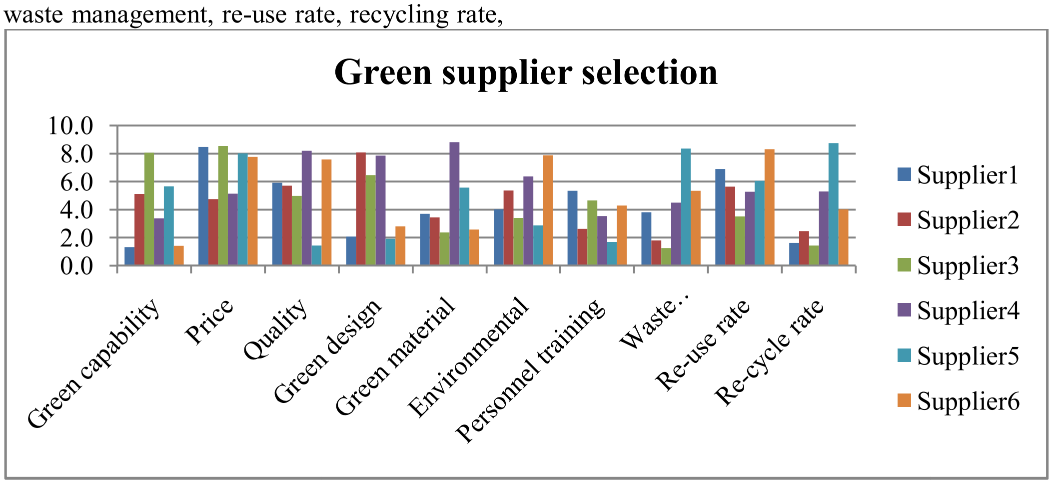

FIGURE1. Green supplier selection

Figure1 Green supplier selection shows the displaying the analysis technique in WSM alternative in use, green capabilities, price, quality, environment, personal training, waste management, re-use rate, recycling rate, and assessment preference for choosing green suppliers: Suppliers 1, 2, 3, 4, 5, and 6 all make up the supply chain.

TABLE 2. Normalized Data

	Green capability	**Price**	**Quality**	**Green design**	**Green material**	**Environ mental**	**Personnel training**	**Waste management**	**Re-use rate**	**Re-cycle rate**
Supplier1	0.16406	1.0522	0.7343	0.258	0.45944	0.5003	0.6642	0.4725	0.855	0.20104
Supplier2	0.63451	0.5894	0.7098	1.003	0.42715	0.6667	0.3256	0.2254	0.701	0.3075
Supplier3	1	1.0591	0.6192	0.804	0.29408	0.4237	0.5798	0.155	0.437	0.17964
Supplier4	0.41883	0.6388	1.0193	0.975	1.09395	0.7918	0.4381	0.5598	0.655	0.65757
Supplier5	0.70403	0.9946	0.1783	0.237	0.69071	0.358	0.2086	1.0372	0.752	1.08477
Supplier6	0.17625	0.9644	0.9424	0.349	0.3195	0.977	0.5336	0.6646	1.032	0.49869

Table 2 shows the Normalized Data displaying the analysis technique in WSM alternative in use, green capabilities, price, quality, environment, personal training, waste management, re-use rate, recycling rate, and assessment preference for choosing green suppliers: Suppliers 1, 2, 3, 4, 5, and 6 all make up the supply chain Normalized Data value.

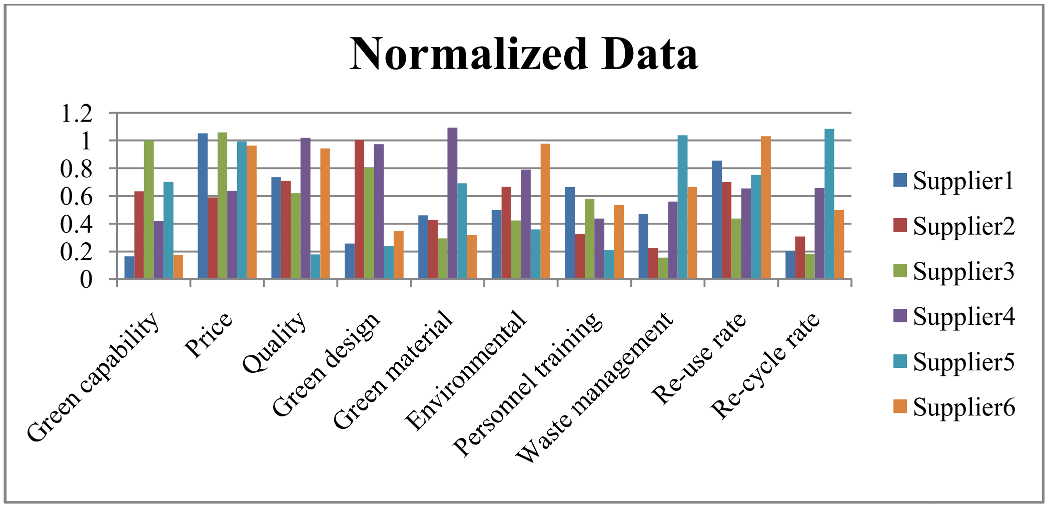

FIGURE 2. Normalized Data

Figure 2 Shows the Normalized Data Supplier 3 has more green capability than other supplier 2 had more price than other supplier 4 has more green design than other supplier 4 has more green material supplier 6 is more environmental than of other suppliers' supplier 1 has more personnel training supplier 5 has more waste management Normalized Data value.

TABLE3. Weightages

	Green capability	Price	Quality	Green design	Green material	Environmental	Personnel training	Waste management	Re-use rate	Re-cycle rate
Supplier1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Supplier2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Supplier3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Supplier4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Supplier5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Supplier6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 3 Shows the Weightages displaying the analysis technique in WSM alternative in use, green capabilities, price, quality, environment, personal training, waste management, re-use rate, recycling rate, and assessment preference for choosing green suppliers: Suppliers 1, 2, 3, 4, 5, and 6 all make up the supply chain Common value.

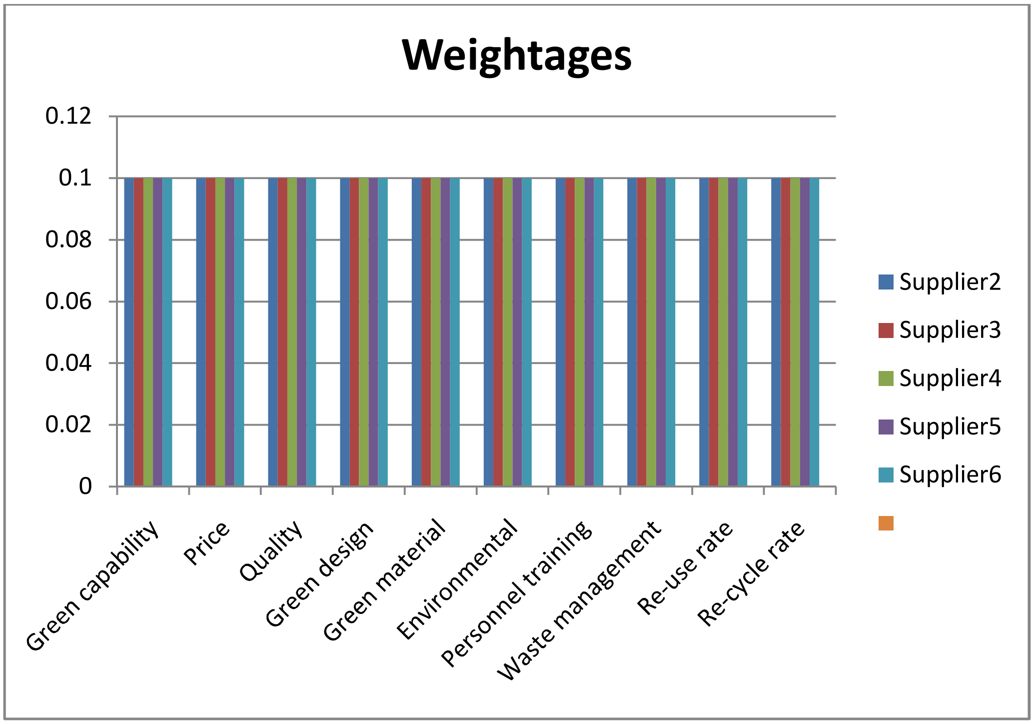

FIGURE 3. Weightages

Figure 3 shows the Weightages All suppliers value remain same in terms of green capability price, quality, green design,

TABLE 4. Weight Normalized Decision Matrix

	Green capability	Price	Quality	Green design	Green material	Environ mental	Personnel training	Waste management	Re-use rate	Re-cycle rate
Supplier1	0.016406	0.105216	0.0734334	0.02576	0.04594	0.05	0.0664	0.04725	0.0855	0.02
Supplier2	0.063451	0.058937	0.0709755	0.10027	0.04272	0.0667	0.0326	0.02254	0.0701	0.031
Supplier3	0.1	0.105915	0.0619243	0.08037	0.02941	0.0424	0.058	0.0155	0.0437	0.018
Supplier4	0.041883	0.063882	0.101933	0.09745	0.1094	0.0792	0.0438	0.05598	0.0655	0.066
Supplier5	0.070403	0.099463	0.0178307	0.02374	0.06907	0.0358	0.0209	0.10372	0.0752	0.108
Supplier6	0.017625	0.096444	0.0942394	0.03486	0.03195	0.0977	0.0534	0.06646	0.1032	0.05

Table 4 shows the weight normalized decision matrix displaying the analysis technique in WSM alternative in use, green capabilities, price, quality, environment, personal training, waste management, re-use rate, recycling rate, and assessment preference for choosing green suppliers: Suppliers 1, 2, 3, 4, 5, and 6 all make up the supply chain is also Multiple value.

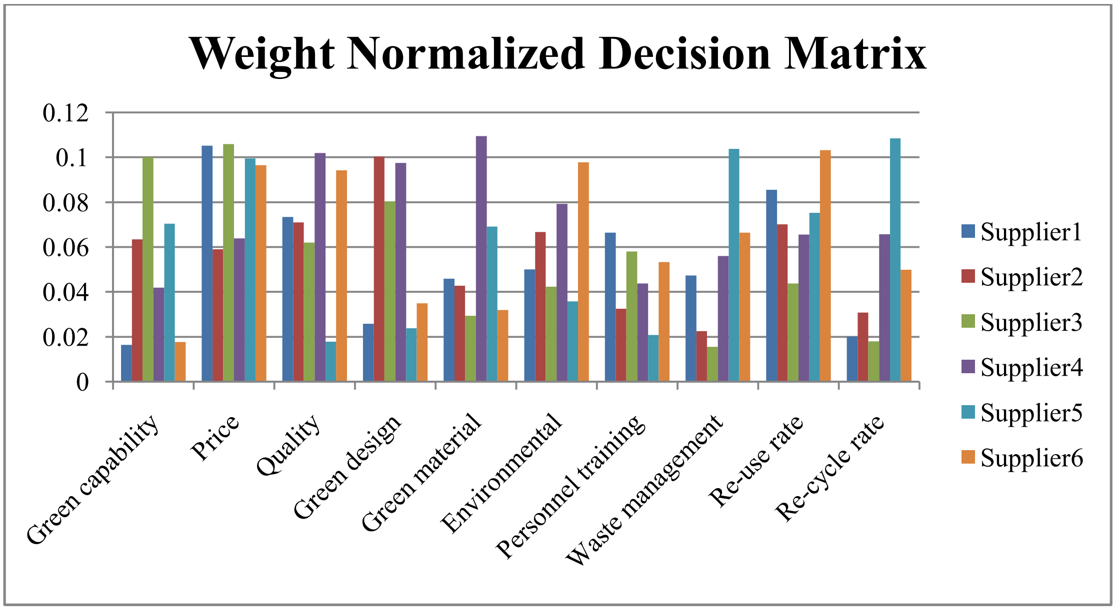

FIGURE 4. Weight Normalized Decision Matrix

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TABLE 5. Preference Score

	Preference Score
Supplier1	0.536116
Supplier2	0.558946
Supplier3	0.555164
Supplier4	0.724785
Supplier5	0.624606
Supplier6	0.645749

Table 5 Shows the Preference Score displaying the analysis technique in WSM alternative in use, green capabilities, price, quality, environment, personal training, waste management, re-use rate, recycling rate, and assessment preference for choosing green suppliers: Suppliers 1, 2, 3, 4, 5, and 6 all make up the supply chain Preference Score is calculated using the Supplier 4 is having is Higher Value and Supplier 1 is having Lower value.

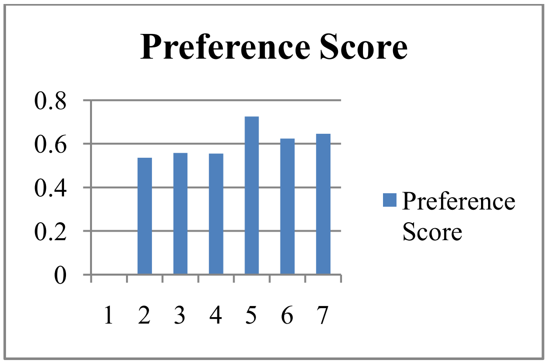

FIGURE 5. Preference score

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TABLE 6. Rank

SUPPLIERS	**Rank**
Supplier1	6
Supplier2	4
Supplier3	5
Supplier4	1
Supplier5	3
Supplier6	2

Table 6 shows the final result of rank WSM for Green supplier selection. Green supplier selection 4 is got the first rank whereas is the green supplier selection 1is having the Lowest rank

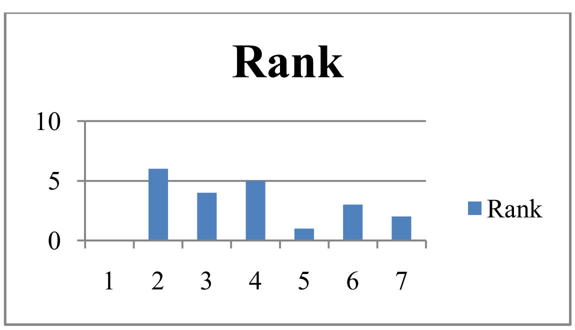

FIGURE 6. Green supplier selection

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4. CONCLUSION

Assessing vendors based on their environmental performance and practises is known as "green supplier selection." Environmental Impact: Research on green supplier selection focuses on finding vendors that value sustainable practises. Sustainable Supply Chains: Research on green supplier selection aids in the development of sustainable supply chains for businesses. This hybrid approach is known as ANNeMADA. The ANNeMADA hybrid technique takes into account environmental standards as well as the practicality of conventional supplier selection criteria. Additionally, it solves the shortcomings of conventional DEA, including data accuracy and decision-making unit (DMU) quantities restrictions. constraint A proposed method to improve the through put and spectral efficiency of wireless networks, is an intelligent reflecting surface (IRS). To change the signal propagation environment, the IRS, in particular, has a number of reflecting components that may separately govern the incident signal The primary premise of the technique is that the structural material acts in a linear elastic fashion, and that appropriate safety may be maintained by adequately limiting stresses in the material caused by the anticipated "working loads" on the framework. Define Criteria and Objectives, Supplier Identification, Data collection, evaluation and scoring, supplier engagement, Decision making, performance monitoring, Waste management, Re-use rate, Re-cycle rate. Among all the suppliers, supplier 6 gets first rank in green supplier selection with the weighted sum method we are able to find the best green supplier it has been evaluated with various parameters and methodology. the final result of rank WSM for Green supplier selection. Green supplier selection 4 is got the first rank whereas is the green supplier selection 1is having the Lowest rank

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