International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Using Multi-Criteria Decision-Making to Analyze Critical Success Factors for IoT Green Supply Chain Management

[1]Arvind Tiwar, [2] Arvind Jayant, [3] Kulwant Singh

Submitted: 07/02/2024 **Revised**: 15/03/2024 **Accepted**: 21/03/2024

Abstract: : More sophisticated Supply Chain Management Systems (SCMS) that are built on more recent technology can reduce expenses, enhance product quality, and expedite the manufacturing business' decision-making process. One objective of green supply chain management (GSCM) systems is to reduce the overall environmental effect. It is accomplished by including eco-friendly procedures into SCMS.It is accomplished by including eco-friendly procedures into SCMS. The GSCM practices are the primary and most important factor in accomplishing the objective of sustainable development. It has been demonstrated that integrating IoT into GSCM systems can improve productivity and performance. The purpose of this research is to investigate the Critical Success Factors (CSFs) for the effective implementation of IoT and environmentally friendly solutions across the industrial industry's supply chain. Manufacturers are now concentrating on GSCM that is enabled by IoT devices due to government pressure and growing consumer awareness of environmental issues. This research employs a bipolar neutrosophic-DEMATEL strategy for the identification and prioritization of IoT-enabled GSCM success variables.

Keywords: *Green Supply Chain Management, Critical Success Factors, G r a y - Dematel, IoT, Bipolar-Neutrosophic*

1. Introduction

Currently, because of the increased awareness of sustainability and environmental protection, Green Supply Chain Management (GSCM) has gained a lot of popularity [1]. Industries are required to consider eco-friendly strategies to improve the environment and their green reputation [2]. In this context, organizations around the world have implemented more dependable techniques to encourage sustainable and green management at all levels of their supply chain as a result of changes in rules, legislation, lifestyle, and notably customer tastes in society [3]. The major goals of GSCM are to minimize or eliminate the environmental harms caused by supply chain operations in order to accomplish sustainable development goals [4]. Design, buying, production, storage, and logistics processes should thus be restructured by businesses as a result of GSCM efforts [5]. Reverse logistics is also a crucial component of GSCM for recovering value from discarded goods and materials or properly recycling them [6]. For businesses and communities, there are several benefits to using GSCM. Waste output is minimized while environmental performance is enhanced with GSCM. GSCM will offer guidelines to businesses on how to become more environmentally proficient. Companies can stay up and increase their level of commercial performance since GCSM leads to the enhancement of activities in the economic and environmental fields [4]. The implementation of Internet of Things (IoT) technology in the GSCM parts can be viewed to add an intelligence and sustainability assets to GSCM systems [7]. Numerous definitions of GSCM have been provided in this context by scholars and students. For

1Research Scholar, Department of Mechanical Engineering, Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab, India,
2Professor, Department of Mechanical Engineering, Indira Gandhi Delhi Technical University for Women, Delhi, India,.
3Professor, Department of Mechanical Engineering, Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab, India.

instance, Hervani et al [8], explicitly used GSCM to integrate sustainable design, efficient material handling, green product procurement, environmentally conscious supplier cooperation, and waste management. However, according to Jayant and Tiwari [9], GCSM is a novel idea for determining the right course for developing products that are compliant with environmental laws and pre-established standards, and businesses require it as a tactic to collaborate on environmental challenges.

According to statistical data, GSCM can control 80% of environmental consequences by using ecologically friendly approaches [10]. Thus, determining and evaluating the Critical Success Factors (CSFs) is crucial to the successful deployment of the IoT-Enabled GSCM. This investigation's principal goal is to analyses the GSCM CSFs. Because of this, the organizations only pay attention to these crucial elements and ignore other elements that are part of the implementation process. You can offer each of the aspects your best effort to the greater extent that you concentrate on fewer of them. We will help this organization by using the opinions of three experienced experts to build an integrated strategy of the decision-making trial and evaluation laboratory (DEMATEL) and Bipolar- Neutrosophic sets (BNSs) to remove the vagueness of those opinions by using a wider scale to identify critical success factors by grouping them into cause and effect groups [11], [12]. DEMATEL is a method used to develop and analyze a structural model of relationships and interdependences between success factors into a matrices or digraphs [13]–[16]. By breaking down these components into cause and effect according to their values and importance, it will help the decision-makers identify the success factors that will have the biggest impact and be the important success factors.

The study article focuses mostly on the following objectives:

1. Determining the critical success factors (CSFs) for contemporary GSCM systems to give businesses a competitive edge.
2. In accordance with the judgements of three experts, this work also attempts to prioritize these CSFs by elucidating the contextual linkages between them through the combination of DEMTEL and BNS methodologies.
3. Considering the modern information technological (IT) paradigms such as IoT [17], [18], Big Data [19], [20], and Big Data Analytics (BDA) [21]–[23] that are now becoming a critical parts for implementing an intelligent and more productive GSCM systems.

The majority of publications in the literature used the fuzzy set, which has limitations because it only considers the membership function and ignores the non-membership function and indeterminacy function [24], [25]. Utilizing Smarandache's Neutrosophic sets (NSs), a generalization of intuitionistic fuzzy sets, we were able to overcome this flaw. While taking into consideration the indeterminacy function, NS focuses on the membership and non-membership functions. This strategy can deal with incomplete knowledge in the actual world because it is a generalization [26].

The following sections are arranged as follows: The literature review of the Internet of Things-enabled GSCM supply chain and associated CSFs is covered in Section 2. The fundamental ideas for the study are presented in Section 3. The research methodology—which combines the DEMATEL approach with bipolar neutrosophic sets—is presented in Section 4. In section 4, we also introduce the Application of BNS-DEMATEL technique for analyzing the CSFs of the IoT-enabled GSCM. The research's findings are covered in Section 5. The research is concluded in section 6.

1. Literature review

GSCM is becoming more and more well-liked in professional and academic areas. It is a relatively new idea that's gaining popularity with suppliers and producers centered on improving green processes, reducing waste through reverse logistics, raising the caliber of products across their entire life cycles, and reducing harmful environmental activities [27]. In this section we will focus on the key aspects examined in the related works of experimental GSCM implementation, one of the sustainability's branches [28], to determine the most important elements for its successful implementation. Traditional SCM methods, on the other hand, can have a negative influence on the environment and act as a source of pollution [29]. Raw material manufacturing, distribution, and waste are a few examples. Therefore, it is crucial to incorporate green practices like green manufacturing, green packaging, and reverse logistics into overall SCM activities in order to safeguard the environment [30]. Several countries aim to establish environmental standards and business laws in order to protect the environment from undesirable activity. In order to achieve sustainable environmental, economic, and social development, these standards mandate that enterprises use green and environmentally friendly practices throughout all SCM activities [31]. Because of this, a number of studies have shown in their work how crucial it is to adopt GSCM while also taking the organization's environment into account.

1.1 GSCM implementation with the use of MCDM tools.

Over the last many years, there has been an increase in the interest of researchers to use causal analysis in their investigations. The most common explanation for why issues occur is that they can have multiple causes. In order to identify the relative relevance of the components, decision-makers must adopt a technique known as the Multi- Criteria Decision Making (MCDM) approach when evaluating such an issue [10]. MCDM is subfield of operations research methodologies where the multifaceted decision-making problem can be reduced to a smaller problem [32]. The MCDM is a valuable tool for organizing and prioritizing the issues associated with decision-making. It also supports decision-makers in analyzing, choosing, and ranking options based on the assessment of numerous decision problem criteria [33]. An effective method to evaluate the different elements that serve as GSCM components is required. Thus, the MCDM methods continue to be the most effective option. The evaluation of green SCM decision problems makes extensive use of the MCDM approaches, including the DEMATEL method, Analytical Hierarchy Process (AHP), Analytic Hierarchy Process (ANP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Linear Programming, and Fuzzy Programming [1]. In order to determine the CSFs for the almost ideal implementation of the GSCM systems, this study uses an integrated methodology that combines the GRAY-DEMATEL method with BNSs.

1.2 Suggested CSFs for a successful GSCM implementation

This study identifies many important critical aspects that are necessary to execute IoT-Enabled GSCM processes. These green indicators are viewed as additional instruments for supply chain management. Using an extensive set of literature reviews, the goal of this study was to identify the important CSFS from the perspective of the practices used by green supply chains enabled by IoT technology. Following a comprehensive review of the literature, the twenty CSFs were classified into two main categories. Among the green drivers are the green enablers for putting the GSCM into practice, are the two primary dimensions. The second dimension pertains to the IoT enablers, encompassing the primary motivators behind facilitating the integration of IoT into the GSCM system. Table 1 presents the complete description of the CSFs. It has been shown that MCDM techniques are commonly used in the adoption of green SCM methods. These techniques are believed to be essential for addressing challenging decision-making problems. This research focuses on identifying the critical success factors (CSFs) for effectively implementing the IoT-enabled GSCM by classifying them into cause and effect groups. The CSFs are prioritised using an integrated approach that combines the DEMATEL method and BNSs to eliminate any ambiguity in those opinions

Table 1: Suggested CSFs for the Effective Use of IoT-Enabled GSCM

Code	CSF	DESCRIPTION	Source
A	**Green facilitators/ enablers**		
F1	Impact from stakeholders and investors	Investors or stakeholders have an interest in the company. They also have the right to obtain any revenues that the company publishes.	[34], [35]
F2	Sustainable waste management system	Wastes are materials that are not primary products and that the manufacturer wishes to get rid of since they are no longer required for the producer's own manufacturing, processing, or consumption.	[25], [36]
F3	Government rules and regulations	Government-established environmental rules, such as those pertaining to hazardous and dangerous materials, must be followed by organizations; failure to do so may result in penalties.	[37]–[40]
F4	Global competition factor	The use of sustainable business practices by organizations can yield significant competitive advantages over their non-sustainable counterparts, hence contributing to the latter's financial performance. Global competitiveness is a major force behind an organization's adoption of sustainable practices.	[41], [42]
F5	Management of toxic/ harmful/ hazardous materials and waste and pollution preventative measures	Sustainable business practices help organizations control their toxic waste production, which has a negative impact on both the environment and people, as well as their consumption of hazardous materials.	[43]–[45]

F6	Green packaging and transportation	Green transport was initiated because of the increasing greenhouse gas emissions from freight transport in the 1990s. Eco-friendly packaging is defined as being made completely of natural plants. It's safe for human health, the environment, and cattle welfare.	[46]–[48]
F7	Top management commitment	It occurs when individuals holding top rank positions directly contribute to a specific and critically important area of a business.	[49]–[51]
F8	Greening competition pressures	Competitive advantages associated with going green, better brand perception, and financial gains will all benefit competitors who have environmental management systems.	[52]
F9	Power negotiations along the supply chain	Requirements, advantages, and restrictions that the market imposes on the participants of a negotiation.	[53], [54]
F10	Green Advertising	Companies can advertise their products using their reputation as "green" brands, which gives them a competitive advantage in the global marketing industry. Furthermore, these companies now have access to new markets since they are abiding with environmental standards.	[55]
F11	Achieving and sustaining environmental (LEED, Higg FEM, ISO 14,001, ZDHC) certifications	Certifications incentivize companies to use green strategies and raise their quality standards. Usage of ISO 14000 is required for environmentally friendly supplier-customer operations.	[56], [57]
F12	Efficient reverse logistics management	It addresses the activities involved in product reuse. Remanufacturing and refurbishment activities are also included in reverse logistics.	[58]
F13	Availability of qualified and skilled manpower	SCM thought leaders advise businesses to take a more proactive approach to developing SCM people with the skills and industry-specific competences required to manage supply chain processes that are becoming more complicated and strategically significant. This will support	[59]

		the management of environmentally friendly procedures.	
F14	green practices, policies, and infrastructure	Companies must make considerable changes to their management policies, operations, infrastructure, and products to successfully implement supply chain greening, frequently by adopting new business models.	[60], [61]
F15	Cooperation with vendors	It is important to emphasize that supply chain integration and collaboration can more successfully promote sustainability, even while this CSF doesn't function as a direct primary driver. Including the ideas and recommendations supplied by suppliers might be quite advantageous.	[62], [63]
F16	Lifecycle Management and Recycling	Establish a set of standards for the collection, handling, and recovery of used electronics and electrical equipment, and hold producers financially accountable for these actions.	[64]
B	**IoT enablers**		
F17	Global positioning system (GPS) and radio frequency identification (RFID)	The smart GSCM systems enabled the real-time location of people and resources both indoors and outside thanks to RFID and GPS technologies. They enabled transportation, item monitoring, and stock updates.	[7], [65]
F18	Cloud computing and IoT applications and cloud computing	By providing services like platform, software, and infrastructure, cloud computing uses the Internet to lessen uncertainty for decision-makers. It allows decision-makers in any business's GSCM systems to choose the right product, quantity, place, and timing for their decisions. It serves as the host for the Internet of Things apps that allow GSCM entity tracking and administration..	[18], [66]–[69]
F19	Sensor technologies and sensor network	Sensor and sensors network allow for the real-time data collection and transmission in the IoT- Enabled GSCM systems.	[70]–[72]

F20	Big Data and Analytics Tools for Big Data (BDA)	The GSCM system needs to implement big data technology in order to manage the massive volumes of data that the IoT sensors have collected. BDA tools allow for the real-time analysis of the collected big data to provide GSCM decision makers with accurate and timely data.	[21], [23], [73]

2. Methodology-

This section is divided into three subsections to provide a comprehensive explanation of our recommended approach. First, we will provide a quick summary of the neutrosophic sets. After that, the DEMATEL method will be shown. Lastly, we will introduce our suggested DEMATEL method that makes use of BNS.

2.1 Neutrosophic Sets

This section discusses the idea of a neutrosophic set and some of its functions, such as the certainty, accuracy, and scoring functions that are used to compare BNSs. The fuzzy sets, intuitionistic fuzzy sets, bipolar fuzzy sets, and neutrosophic sets are all replaced by BNSs. A large number of articles in the literature used the fuzzy set, however it has limitations because it ignores the functions of non-membership and indeterminacy and only considers the membership function. By using the concept of Neutrosophic sets (NSs), this restriction was removed. The function of indeterminacy is considered, although the both of membership and non- membership methods are the main emphasis of NS [74], [75]. In general, this approach can address real-world information gaps.

Definition 1. Let S be a points' space. And s∈S. A neutrosophic set N in S is described by the following three functions:

1. The indeterminacy-membership function $IN(s)$.
2. The truth-membership function $TN(s)$.
3. The falsity-membership function $FN(s)$.

$TN(s)$, $IN(s)$, and $FN(s)$ are actual nonstandard or standard subsets of (s):S→]−0,1+[and $FN(s)$:S→]−0,1+[. Where the sum of TN (s), IN (s) and FN(s), so 0− ≤ sup (s) + sup s + sup s ≤3+ is not limited.

Definition 2: A BNS N in ᶓ is characterized as an item with the form N={<s, $T^p(s)$, $I^p(s)$, $F^p(s)$, $T^n(s)$, $I^n(s)$, $F^n(s)$>: s ∈ ᶓ}, where T^p, I^p , F^p : ᶓ →[1, 0] and T^n , I^n , F^n : ᶓ → [-1, 0] . The positive membership degree $T^p(s)$, $I^p(s)$, $F^p(s)$of an item ∈ ᶓ pointing to a BNS N and the negative membership degree $T^n(x)$, $I^n(x)$, $F^n(x)$of an item ∈ ᶓ identifies a counter-property that is implicit and comparable to a BNS A , Assume that Ã=< T^p, I^p , F^p, T^n , I^n , F^n > be a Bipolar Neutrosophic Number (BNN) following that, the score function S (Ã), accuracy function a (Ã), and certainty function c (Ã) of a BNN are described as in the following relations:

S (Ã) = 16 *[T^p+1- I^p +1- F^p +1+ T^n - I^n -F^n] (1)

a (Ã)= T^p- F^p + T^n -F^n (2)

c (Ã) = T^p -F^n (3

2.2 ***DEMATEL***

The DEMATEL approach was developed to assess and depict the nature and intensity of the direct and indirect relationships between complex real-world aspects in a study system [76]. DEMATEL is a method for group decision-making that involves gathering ideas and determining the relationship between causes and effects in complex problems [77]. The DEMATEL method helps to uncover the optimal answer in solving problems involving complex systems by assessing the overall relationships between the structural parts of a study system and grouping elements into cause and effect groups [13], [78]. It is constructed upon the foundation of graph theory [2].

4. Method for evaluating the CSFs of the IoT-enabled GSCM using the proposed BNS-DEMATEL approach

The objective of this section is to address the ambiguity in the expert opinions that will be incorporated into the DEMATEL matrices by integrating the DEMATEL approach with the BNS neutrosophic set. Figure 1 illustrates the steps in the recommended methodology

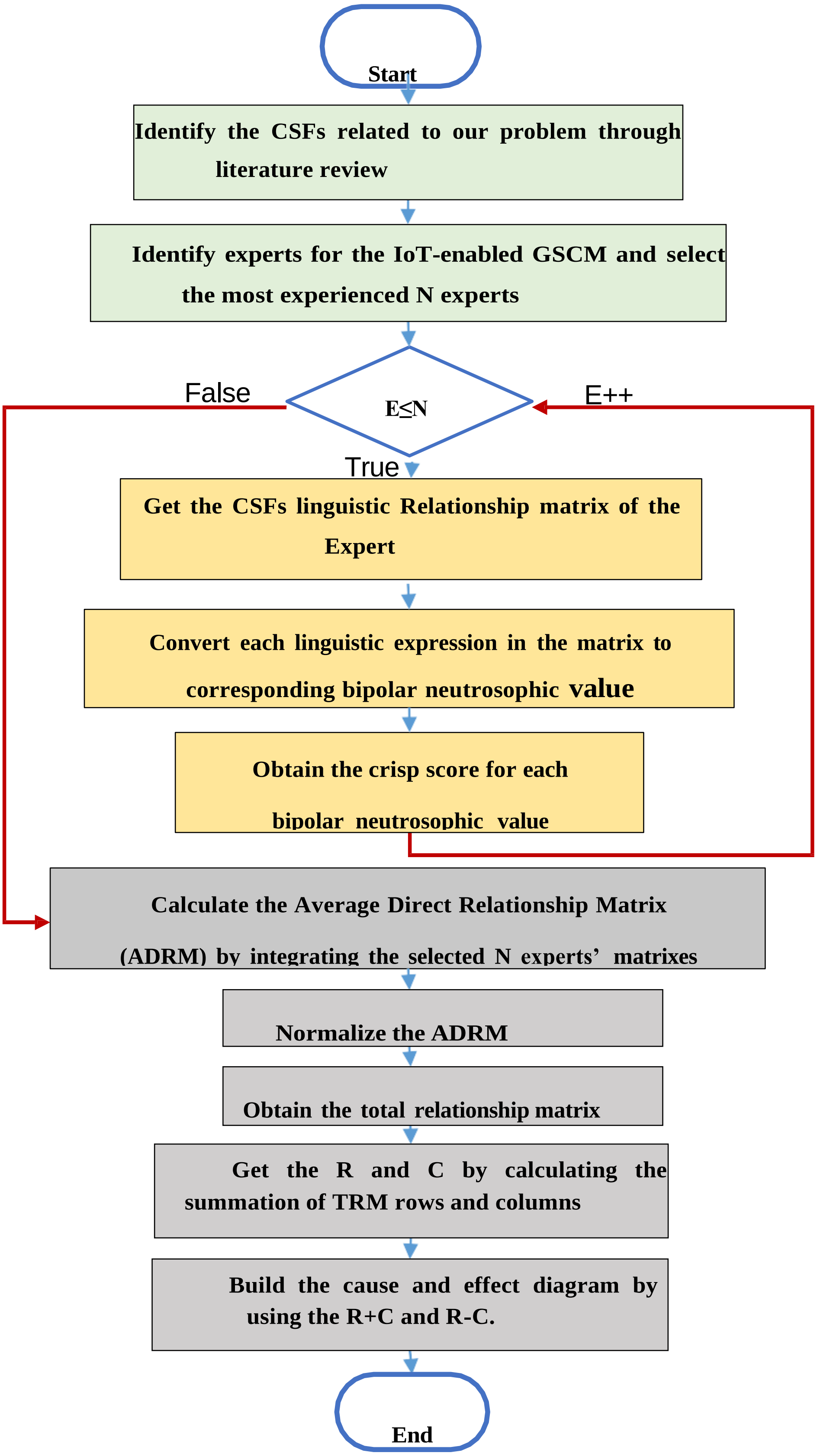


Figure 1: Phases of the DEMATEL method by Neutrosophic

Step 1: Identify the CSFs for the IoT-enabled GSCM

Finding the CSFs to execute the green supply chain made possible by IoT devices is the first stage in our model. Twenty CSFs for adopting the IoT-enabled GSCM have been found through a survey of the literature. Table 1 presents the identified factors. Two categories were created from the identification of CSFs. The first category consists of essential elements for environmentally friendly production. While the second group consists of the components needed for the IoT devices to enable the GSCM.

Step 2: Find professionals in the Internet of Things-enabled GSCM and choose the most seasoned N experts:

We looked for professionals with knowledge of Internet of Things and green supply chain management. We have chosen the three most seasoned specialists in the domains of GSCM and IoT after vetting the experts. Table 2 contains the metadata pertaining to the chosen experts. After that, we give our specialists a thorough explanation of the chosen CSFs. Following that, we ask each expert for a language Relationship matrix

.**Table 2:** Experts' metadata

Expert	Having experience in years)	Proficiency	Work	Profession	Gender
Ex1	11	Very good	In Industry	GSCM	Male
Ex2	10	Good	In Industry	GSCM	Male
Ex3	9	Medium	In Industry	IOT-GSCM	Male

Step 3: Obtain each expert's linguistic relationship matrix from CSF.

Based on the opinions of each expert, we create a pairwise comparison matrix between CSFs here by utilising the linguistic terms displayed in figure 2. Expert 1's linguistic relationship matrix is displayed in Table 3.

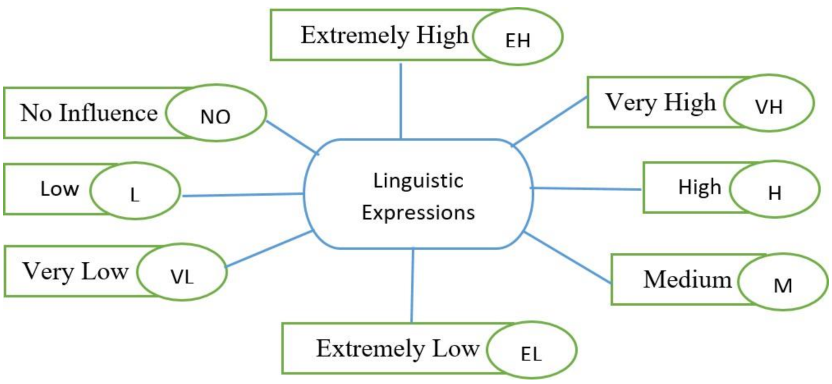


Figure 2: Linguistic expressions

Step4: Create a corresponding bipolar neutrosophic value for every language statement in the linguistic Relationship matrix.

As per Table 4, we will now substitute the verbal terms with their respective bipolar neutrosophic values.

Step 5: For every bipolar neutrosophic value, find the crisp score.

First, using equation (1), we determine the crisp score associated with each bipolar neutrosophic value. The computed crisp scores for the language expressions utilised in this investigation are displayed in Table 5. Tables 6 and 7 show the expert 1's crisp scoring matrix.

Step 6: Take the matrices of the chosen N experts and integrate them to get the Average Direct Relationship Matrix (ADRM).

$$ADRMi,j=\Sigma Vi,jENE=1N \quad (4)$$

Where Vi,jE represents the value of the crisp matrix at row i and column j for expert, and Ai,j denotes the degree to which the component i impacts the factor j There are N experts, or E. The three experts' ADRMs are displayed in Tables 8 and 9.

Step 7: Normalize the ADRM

The following equations will be used in this stage to normalize the initial direct relationship matrix.

$$S=Max \{\max 1\leq i\leq N\Sigma ADRMi, jNj=1, max 1\leq j\leq N\Sigma ADRMi, jNi=1\} \quad (5)$$

$$NADRM=ADRM/S \quad (6)$$

Normalized ADRM is displayed in Tables 10 and 11.

Step 8: Obtain the total relationship matrix

Here, we use the following equation to obtain the total relationship matrix

$$.TRM=NADRM*(I-NADRM)^{-1} \quad (7)$$

I represent the identity matrix here. The normalized ADRM is displayed in Tables 12 and 13

Step 9: Get the Ri and Cj by calculating the summation of TRM rows and columns

We shall compute Calculate R+C, which denotes importance, R-C, which divides CSFs into cause or effect groups; if the result is positive, it belongs in the cause group (which has a significant impact on the overall goal and requires more attention); if the result is negative, it belongs in the effect group (which is easily impacted by other factors, but doesn't mean it isn't important because every factor has an impact on other factors as we can consider F7, which has a high importance, high R+C, and negative R-C, which divides CSFs into cause and effect groups).

$$C=\Sigma TRMi,jNj=1 \quad (8)$$

$$R=\Sigma TRMi,jNi=1 \quad (9)$$

Table 14 show the summation of TRM rows and columns.

Step 10: Build the cause and effect diagram by using R+C and R-C

To construct the diagram, we will utilise the results from the previous step as a guide. The horizontal axes will be represented by the values of Ri + Cj, and the vertical axes by the values of Ri - Cj. CSFs with positive values, located above the x-axes, belong to the cause group, while those with negative values, located below the x-axes, belong to the effect group. The casual diagram is displayed in Figure 2.

Code	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10	F-11	F-12	F-13	F-14	F-15	F-16	F-17	F-18	F-19	F-20
F-1	0	M	H	M	M	H	M	L	H	VH	H	VH	L	EL	H	EH	VH	VH	VH	VH
F-2	H	0	EH	H	M	VH	H	M	VL	VL	M	EH	VH	H	M	L	VL	L	EL	L
F-3	VH	VH	0	VH	H	EH	H	M	H	H	M	M	VL	H	VH	H	H	H	H	H
F-4	M	EH	H	0	L	M	H	L	VL	H	VH	M	H	L	H	VH	H	H	H	H
F-5	H	H	M	H	0	M	H	H	H	M	L	H	VH	M	EH	VH	H	VH	M	EH
F-6	EH	M	VH	H	H	0	L	H	H	M	H	L	EH	H	H	H	EH	H	M	EH
F-7	VH	H	M	M	M	H	0	VH	VH	VH	EH	VH	VH	VH	M	H	VH	VH	VH	EH
F-8	L	M	M	M	H	M	H	0	M	EH	M	M	H	H	L	M	EH	EH	EH	EH
F-9	M	VL	M	H	H	L	M	H	0	H	VH	H	M	M	H	VL	H	H	H	VH
F-10	H	H	M	VH	M	VL	VH	L	H	0	M	M	H	H	M	L	EH	EH	EH	EH
F-11	EH	H	VH	M	VH	EH	H	VH	VH	M	0	M	M	VL	EH	VH	VL	M	L	M

Table 3: Linguistic relationship matrix for expert 1

F-12	H	VH	M	M	VL	VH	VH	VL	M	M	L	0	M	H	VL	H	EH	VH	EH	EH
F-13	M	H	H	H	H	H	VH	M	VL	M	M	H	0	VH	L	EL	M	M	M	M
F-14	M	M	H	EH	L	L	VL	EH	L	EH	M	VH	M	0	EH	M	VH	H	VH	VH
F-15	H	L	M	L	H	M	EL	L	M	H	VH	H	M	L	0	VL	VM	H	H	VH
F-16	M	M	VH	H	M	L	H	VL	VH	M	VL	VL	H	L	VH	0	VH	M	VH	H
F-17	EH	H	M	VH	M	M	VH	VH	M	EH	M	EH	M	H	H	EH	0	EH	EH	VH
F-18	VH	H	M	VH	H	H	H	VH	H	EH	M	VH	M	H	H	H	H	0	EH	EH
F-19	H	H	M	VH	M	H	VH	VH	M	EH	M	EH	M	H	H	H	EH	EH	0	M
F-20	VH	EH	H	VH	H	VH	EH	EH	VH	EH	H	EH	M	H	EH	H	H	EH	M	0

Table 4: Linguistic terms with its matching bipolar neutrosophic value.

Linguistic Expression	Bipolar Neutrosophic value
EH	(1.00,0.00,0.11,-0.11,-0.91,-1.01)
VH	(0.86,0.16,0.22,-0.20,-0.71,-0.91)
H	(0.76,0.25,0.30,-0.30,-0.66,-0.55)
M	(0.50,0.56,0.55,-0.56,-0.55,-0.55)
L	(0.40,0.30,0.65,-0.40,-0.30,-0.20)
VL	(0.35,0.80,0.70,-0.65,-0.25,-0.40)
EL	(0.25,0.80,0.90,-0.75,-0.20,-0.10)
NO	(0.00,1.00,1.00,-1.00,0.00,0.00)

Table 5: Crisp scores for the Study linguistic expressions

Neutrosophic Bipolar Number Scale	Crisp score
(1.00,0.00,0.10,-0.10,-0.90,-1.00)	0.9506
(0.75,0.25,0.20,-0.25,-0.70,-0.80)	0.8169
(0.85,0.25,0.20,-0.20,-0.50,-0.60)	0.6920
(0.60,0.50,0.60,-0.60,-0.50,-0.60)	0.5021
(0.40,0.30,0.80,-0.20,-0.10,-0.20)	0.3838
(0.35,0.70,0.70,-0.65,-0.25,-0.40)	0.2756
(0.25,0.80,0.90,-0.35,-0.20,-0.10)	0.1668
(0.00,1.00,1.00,-1.00,0.00,0.00)	0.0000

Table 6: Part 1 of the crisp score matrix of expert 1

Code	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10
F-1	0	0.5000	0.6917	0.5000	0.5000	0.6917	0.5000	0.3833	0.6917	0.8167
F-2	0.6917	0	0.9500	0.6917	0.5000	0.8167	0.6917	0.5000	0.2750	0.2750
F-3	0.8167	0.8167	0	0.8167	0.6917	0.9500	0.6917	0.5000	0.6917	0.6917
F-4	0.5000	0.9500	0.6917	0	0.3833	0.5000	0.6917	0.3833	0.2750	0.6917
F-5	0.6917	0.6917	0.5000	0.6917	0	0.5000	0.6917	0.6917	0.6917	0.5000
F-6	0.9500	0.5000	0.8167	0.6917	0.6917	0	0.3833	0.6917	0.6917	0.5000
F-7	0.8167	0.6917	0.5000	0.5000	0.5000	0.6917	0	0.8167	0.8167	0.8167
F-8	0.3833	0.5000	0.5000	0.5000	0.6917	0.5000	0.6917	0	0.5000	0.9500
F-9	0.5000	0.2750	0.5000	0.6917	0.6917	0.3833	0.5000	0.6917	0	0.6917
F-10	0.6917	0.6917	0.5000	0.8167	0.5000	0.2750	0.8167	0.3833	0.6917	0
F-11	0.9500	0.6917	0.8167	0.5000	0.8167	0.9500	0.6917	0.8167	0.8167	0.5000
F-12	0.6917	0.8167	0.5000	0.5000	0.2750	0.8167	0.8167	0.2750	0.5000	0.5000
F-13	0.5000	0.6917	0.6917	0.6917	0.6917	0.6917	0.8167	0.5000	0.2750	0.5000
F-14										

	0.5000	0.5000	0.6917	0.9500	0.3833	0.3833	0.2750	0.9500	0.3833	0.9500
F-15	0.6917	0.3833	0.5000	0.3833	0.6917	0.5000	0.1667	0.3833	0.5000	0.6917
F-16	0.5000	0.5000	0.8167	0.6917	0.5000	0.3833	0.6917	0.2750	0.8167	0.5000
F-17	0.9500	0.6917	0.5000	0.8167	0.5000	0.5000	0.8167	0.8167	0.5000	0.9500
F-18	0.8167	0.6917	0.5000	0.8167	0.6917	0.6917	0.6917	0.8167	0.6917	0.9500
F-19	0.6917	0.6917	0.5000	0.8167	0.5000	0.6917	0.8167	0.8167	0.5000	0.9500
F-20	0.8167	0.9500	0.6917	0.8167	0.6917	0.8167	0.9500	0.9500	0.8167	0.9500

Table 7: Part 2 of the crisp score matrix of expert 1

Code	F-11	F-12	F-13	F-14	F-15	F-16	F-17	F-18	F-19	F-20
F-1	0.6917	0.8167	0.3833	0.1667	0.6917	0.9500	0.8167	0.8167	0.8167	0.8167
F-2	0.5000	0.9500	0.8167	0.6917	0.5000	0.3833	0.2750	0.3833	0.1667	0.3833
F-3	0.5000	0.5000	0.2750	0.6917	0.8167	0.6917	0.6917	0.6917	0.6917	0.6917
F-4	0.8167	0.5000	0.6917	0.3833	0.6917	0.8167	0.6917	0.6917	0.6917	0.6917
F-5	0.3833	0.6917	0.8167	0.5000	0.9500	0.8167	0.6917	0.8167	0.5000	0.9500
F-6	0.6917	0.3833	0.9500	0.6917	0.6917	0.6917	0.9500	0.6917	0.5000	0.9500
F-7	0.9500	0.8167	0.8167	0.8167	0.5000	0.6917	0.8167	0.8167	0.8167	0.9500

F-8	0.5000	0.5000	0.6917	0.6917	0.3833	0.5000	0.9500	0.9500	0.9500	0.9500
F-9	0.8167	0.6917	0.5000	0.5000	0.6917	0.2750	0.6917	0.6917	0.6917	0.8167
F-10	0.5000	0.5000	0.6917	0.6917	0.5000	0.3833	0.9500	0.9500	0.9500	0.9500
F-11	0	0.5000	0.5000	0.2750	0.9500	0.8167	0.2750	0.5000	0.3833	0.5000
F-12	0.3833	0	0.5000	0.6917	0.2750	0.6917	0.9500	0.8167	0.9500	0.9500
F-13	0.5000	0.6917	0	0.8167	0.3833	0.1667	0.5000	0.5000	0.5000	0.5000
F-14	0.5000	0.8167	0.5000	0	0.9500	0.5000	0.8167	0.6917	0.8167	0.8167
F-15	0.8167	0.6917	0.5000	0.3833	0	0.2750	0.8167	0.6917	0.6917	0.8167
F-16	0.2750	0.2750	0.6917	0.3833	0.8167	0	0.8167	0.5000	0.8167	0.6917
F-17	0.5000	0.9500	0.5000	0.6917	0.6917	0.9500	0	0.9500	0.9500	0.8167
F-18	0.5000	0.8167	0.5000	0.6917	0.6917	0.6917	0.6917	0	0.9500	0.9500
F-19	0.5000	0.9500	0.5000	0.6917	0.6917	0.6917	0.9500	0.9500	0	0.5000
F-20	0.6917	0.9500	0.5000	0.6917	0.9500	0.6917	0.6917	0.9500	0.5000	0

Table 8: Part 1 of the average direct relationship matrix

Code	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10
F-1	0.0000	0.5000	0.6917	0.5000	0.5000	0.6917	0.5000	0.3833	0.6917	0.8167
F-2	0.6917	0.0000	0.9500	0.6917	0.5000	0.8167	0.6917	0.5000	0.2750	0.2750
F-3	0.8167	0.8167	0.0000	0.8167	0.6917	0.9500	0.6917	0.5000	0.6917	0.6917
F-4	0.5000	0.9500	0.6917	0.0000	0.3833	0.5000	0.6917	0.3833	0.2750	0.6917
F-5	0.6917	0.6917	0.5000	0.6917	0.0000	0.5000	0.6917	0.6917	0.6917	0.5000
F-6	0.9500	0.5000	0.8167	0.6917	0.6917	0.0000	0.3833	0.6917	0.6917	0.5000
F-7	0.8167	0.6917	0.5000	0.5000	0.5000	0.6917	0.0000	0.8167	0.8167	0.8167
F-8	0.3833	0.5000	0.5000	0.5000	0.6917	0.5000	0.6917	0.0000	0.5000	0.9500
F-9	0.5000	0.2750	0.5000	0.6917	0.6917	0.3833	0.5000	0.6917	0.0000	0.6917
F-10	0.6917	0.6917	0.5000	0.8167	0.5000	0.2750	0.8167	0.3833	0.6917	0.0000
F-11	0.9500	0.6917	0.8167	0.5000	0.8167	0.9500	0.6917	0.8167	0.8167	0.5000
F-12	0.6917	0.8167	0.5000	0.5000	0.2750	0.8167	0.8167	0.2750	0.5000	0.5000
F-13	0.5000	0.6917	0.6917	0.6917	0.6917	0.6917	0.8167	0.5000	0.2750	0.5000
F-14	0.5000	0.5000	0.6917	0.9500	0.3833	0.3833	0.2750	0.9500	0.3833	0.9500

F-15	0.6917	0.3833	0.5000	0.3833	0.6917	0.5000	0.1667	0.3833	0.5000	0.6917
F-16	0.5000	0.5000	0.8167	0.6917	0.5000	0.3833	0.6917	0.2750	0.8167	0.5000
F-17	0.9500	0.6917	0.5000	0.8611	0.5000	0.5000	0.8167	0.8167	0.5000	0.8000
F-18	0.8167	0.6917	0.5000	0.8167	0.6917	0.6917	0.6917	0.8167	0.6917	0.9500
F-19	0.6917	0.6917	0.5000	0.8167	0.5000	0.6917	0.8167	0.8167	0.5000	0.8000
F-20	0.8611	0.9500	0.6917	0.8167	0.6917	0.8167	0.9500	0.9500	0.8167	0.9500

Table 9: Part 2 of the average direct relationship matrix

Code	F-11	F-12	F-13	F-14	F-15	F-16	F-17	F-18	F-19	F-20
F-1	0.6917	0.8167	0.3833	0.1667	0.6917	0.9500	0.8167	0.8167	0.8167	0.8611
F-2	0.5000	0.9500	0.8167	0.6917	0.5000	0.3833	0.2750	0.3833	0.1667	0.3833
F-3	0.5000	0.5000	0.2750	0.6917	0.8167	0.6917	0.6917	0.6917	0.6917	0.6917
F-4	0.8167	0.5000	0.6917	0.3833	0.6917	0.8167	0.6917	0.6917	0.6917	0.6917
F-5	0.3833	0.6917	0.8167	0.5000	0.9500	0.8167	0.6917	0.8167	0.5000	0.9500
F-6	0.6917	0.3833	0.9500	0.6917	0.6917	0.6917	0.9500	0.6917	0.5000	0.9500
F-7	0.9500	0.8167	0.8167	0.8167	0.5000	0.6917	0.8167	0.8167	0.8167	0.9500
F-8	0.5000	0.5000	0.6917	0.6917	0.3833	0.5000	0.9500	0.9500	0.9500	0.9500
F-9	0.8167	0.6917	0.5000	0.5000	0.6917	0.2750	0.6917	0.6917	0.6917	0.8167
F-10	0.5000	0.5000	0.6917	0.6917	0.5000	0.3833	0.9500	0.9500	0.9500	0.9500
F-11	0.0000	0.5000	0.5000	0.2750	0.9500	0.8167	0.2750	0.5000	0.3833	0.5000
F-12	0.3833	0.0000	0.5000	0.6917	0.2750	0.6917	0.9500	0.8167	0.9500	0.9500
F-13	0.5000	0.6917	0.0000	0.8167	0.3833	0.1667	0.5000	0.5000	0.4611	0.5000
F-14	0.5000	0.8167	0.5000	0.0000	0.9500	0.5000	0.7111	0.6917	0.8167	0.8167
F-15	0.8167	0.6917	0.5000	0.3833	0.0000	0.2750	0.8167	0.6917	0.6917	0.8611
F-16	0.2750	0.2750	0.6917	0.3833	0.8167	0.0000	0.8167	0.5000	0.8167	0.6917
F-17	0.5000	0.9500	0.5000	0.6917	0.6917	0.9500	0.0000	0.9500	0.9500	0.8167
F-18	0.5000	0.8167	0.5000	0.6917	0.6917	0.6917	0.6917	0.0000	0.8000	0.9500
F-19	0.5000	0.9500	0.5000	0.6917	0.6917	0.6917	0.9500	0.9500	0.0000	0.5000
F-20	0.6917	0.9500	0.5000	0.6917	0.9500	0.6917	0.6917	0.9500	0.5000	0.0000

Table 10: Part 1 of the normalization matrix

Code	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10
F-1	0.0000	0.0331	0.0458	0.0331	0.0331	0.0458	0.0331	0.0254	0.0458	0.0540
F-2	0.0458	0.0000	0.0629	0.0458	0.0331	0.0540	0.0458	0.0331	0.0182	0.0182
F-3	0.0540	0.0540	0.0000	0.0540	0.0458	0.0629	0.0458	0.0331	0.0458	0.0458
F-4	0.0331	0.0629	0.0458	0.0000	0.0254	0.0331	0.0458	0.0254	0.0182	0.0458
F-5	0.0458	0.0458	0.0331	0.0458	0.0000	0.0331	0.0458	0.0458	0.0458	0.0331
F-6	0.0629	0.0331	0.0540	0.0458	0.0458	0.0000	0.0254	0.0458	0.0458	0.0331
F-7	0.0540	0.0458	0.0331	0.0331	0.0331	0.0458	0.0000	0.0540	0.0540	0.0540
F-8	0.0254	0.0331	0.0331	0.0331	0.0458	0.0331	0.0458	0.0000	0.0331	0.0629
F-9	0.0331	0.0182	0.0331	0.0458	0.0458	0.0254	0.0331	0.0458	0.0000	0.0458
F-10	0.0458	0.0458	0.0331	0.0540	0.0331	0.0182	0.0540	0.0254	0.0458	0.0000
F-11	0.0629	0.0458	0.0540	0.0331	0.0540	0.0629	0.0458	0.0540	0.0540	0.0331
F-12	0.0458	0.0540	0.0331	0.0331	0.0182	0.0540	0.0540	0.0182	0.0331	0.0331
F-13	0.0331	0.0458	0.0458	0.0458	0.0458	0.0458	0.0540	0.0331	0.0182	0.0331
F-14	0.0331	0.0331	0.0458	0.0629	0.0254	0.0254	0.0182	0.0629	0.0254	0.0629

F-15	0.0458	0.0254	0.0331	0.0254	0.0458	0.0331	0.0110	0.0254	0.0331	0.0458
F-16	0.0331	0.0331	0.0540	0.0458	0.0331	0.0254	0.0458	0.0182	0.0540	0.0331
F-17	0.0629	0.0458	0.0331	0.0570	0.0331	0.0331	0.0540	0.0540	0.0331	0.0529
F-18	0.0540	0.0458	0.0331	0.0540	0.0458	0.0458	0.0458	0.0540	0.0458	0.0629
F-19	0.0458	0.0458	0.0331	0.0540	0.0331	0.0458	0.0540	0.0540	0.0331	0.0529
F-20	0.0570	0.0629	0.0458	0.0540	0.0458	0.0540	0.0629	0.0629	0.0540	0.0629

Table 11: Part 2 of the normalization matrix

Code	F-11	F-12	F-13	F-14	F-15	F-16	F-17	F-18	F-19	F-20
F-1	0.0458	0.0540	0.0254	0.0110	0.0458	0.0629	0.0540	0.0540	0.0540	0.0570
F-2	0.0331	0.0629	0.0540	0.0458	0.0331	0.0254	0.0182	0.0254	0.0110	0.0254
F-3	0.0331	0.0331	0.0182	0.0458	0.0540	0.0458	0.0458	0.0458	0.0458	0.0458
F-4	0.0540	0.0331	0.0458	0.0254	0.0458	0.0540	0.0458	0.0458	0.0458	0.0458
F-5	0.0254	0.0458	0.0540	0.0331	0.0629	0.0540	0.0458	0.0540	0.0331	0.0629
F-6	0.0458	0.0254	0.0629	0.0458	0.0458	0.0458	0.0629	0.0458	0.0331	0.0629
F-7	0.0629	0.0540	0.0540	0.0540	0.0331	0.0458	0.0540	0.0540	0.0540	0.0629
F-8	0.0331	0.0331	0.0458	0.0458	0.0254	0.0331	0.0629	0.0629	0.0629	0.0629
F-9	0.0540	0.0458	0.0331	0.0331	0.0458	0.0182	0.0458	0.0458	0.0458	0.0540
F-10	0.0331	0.0331	0.0458	0.0458	0.0331	0.0254	0.0629	0.0629	0.0629	0.0629
F-11	0.0000	0.0331	0.0331	0.0182	0.0629	0.0540	0.0182	0.0331	0.0254	0.0331
F-12	0.0254	0.0000	0.0331	0.0458	0.0182	0.0458	0.0629	0.0540	0.0629	0.0629
F-13	0.0331	0.0458	0.0000	0.0540	0.0254	0.0110	0.0331	0.0331	0.0305	0.0331

F-14	0.0331	0.0540	0.0331	0.0000	0.0629	0.0331	0.0471	0.0458	0.0540	0.0540
F-15	0.0540	0.0458	0.0331	0.0254	0.0000	0.0182	0.0540	0.0458	0.0458	0.0570
F-16	0.0182	0.0182	0.0458	0.0254	0.0540	0.0000	0.0540	0.0331	0.0540	0.0458
F-17	0.0331	0.0629	0.0331	0.0458	0.0458	0.0629	0.0000	0.0629	0.0629	0.0540
F-18	0.0331	0.0540	0.0331	0.0458	0.0458	0.0458	0.0458	0.0000	0.0529	0.0629
F-19	0.0331	0.0629	0.0331	0.0458	0.0458	0.0458	0.0629	0.0629	0.0000	0.0331
F-20	0.0458	0.0629	0.0331	0.0458	0.0629	0.0458	0.0458	0.0629	0.0331	0.0000

Table 12: Part 1 of the total relationship matrix

Code	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10
F-1	0.2061	0.2233	0.2266	0.2324	0.2010	0.2266	0.2264	0.2053	0.2185	0.2548
F-2	0.2170	0.1619	0.2151	0.2123	0.1743	0.2071	0.2064	0.1837	0.1641	0.1894
F-3	0.2658	0.2503	0.1915	0.2606	0.2198	0.2496	0.2446	0.2209	0.2250	0.2564
F-4	0.2274	0.2414	0.2184	0.1900	0.1852	0.2063	0.2279	0.1961	0.1828	0.2361
F-5	0.2544	0.2402	0.2204	0.2495	0.1738	0.2198	0.2428	0.2295	0.2220	0.2420
F-6	0.2767	0.2343	0.2457	0.2563	0.2233	0.1934	0.2298	0.2357	0.2274	0.2485
F-7	0.2856	0.2617	0.2413	0.2610	0.2250	0.2524	0.2214	0.2589	0.2496	0.2844
F-8	0.2323	0.2257	0.2159	0.2356	0.2140	0.2158	0.2404	0.1843	0.2071	0.2664
F-9	0.2219	0.1955	0.2004	0.2287	0.2001	0.1938	0.2114	0.2118	0.1605	0.2330

F-10	0.2524	0.2388	0.2176	0.2558	0.2031	0.2040	0.2489	0.2102	0.2194	0.2083
F-11	0.2609	0.2301	0.2318	0.2275	0.2184	0.2391	0.2324	0.2279	0.2229	0.2314
F-12	0.2452	0.2386	0.2115	0.2290	0.1825	0.2304	0.2411	0.1965	0.2017	0.2318
F-13	0.2097	0.2098	0.2023	0.2171	0.1892	0.2024	0.2184	0.1890	0.1674	0.2080
F-14	0.2353	0.2226	0.2249	0.2586	0.1922	0.2058	0.2110	0.2385	0.1962	0.2630
F-15	0.2238	0.1921	0.1914	0.1999	0.1915	0.1920	0.1812	0.1834	0.1838	0.2217
F-16	0.2147	0.2022	0.2140	0.2226	0.1825	0.1872	0.2160	0.1795	0.2056	0.2139
F-17	0.2897	0.2590	0.2378	0.2793	0.2210	0.2372	0.2695	0.2543	0.2272	0.2805
F-18	0.2780	0.2554	0.2345	0.2731	0.2301	0.2452	0.2582	0.2515	0.2357	0.2856
F-19	0.2635	0.2486	0.2278	0.2659	0.2120	0.2389	0.2587	0.2449	0.2174	0.2692
F-20	0.3023	0.2903	0.2653	0.2931	0.2480	0.2722	0.2930	0.2778	0.2614	0.3061

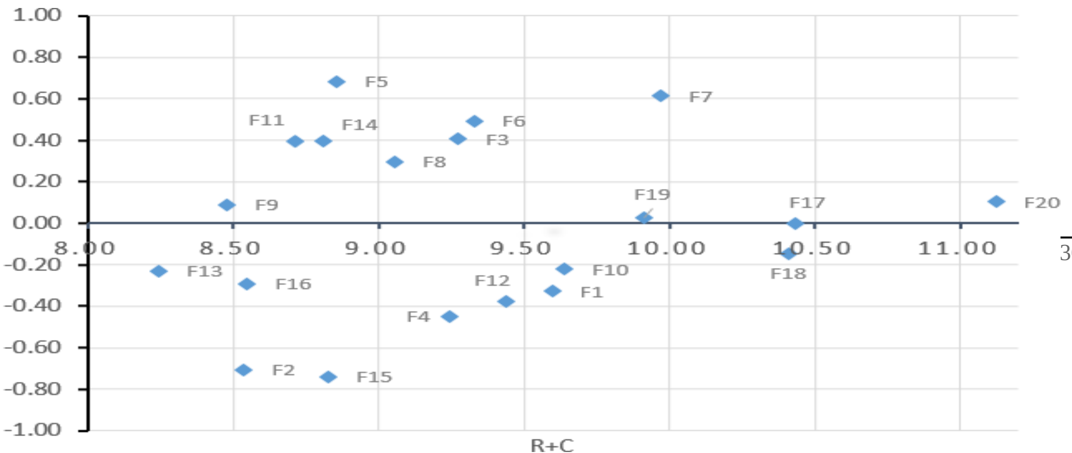
Table 13: Part 2 of the total relationship matrix

Code	F-11	F-12	F-13	F-14	F-15	F-16	F-17	F-18	F-19	F-20
F-1	0.2152	0.2538	0.1994	0.1852	0.2416	0.2430	0.2676	0.2699	0.2561	0.2817
F-2	0.1773	0.2299	0.1994	0.1909	0.1983	0.1794	0.2003	0.2082	0.1838	0.2174
F-3	0.2121	0.2438	0.2015	0.2246	0.2584	0.2351	0.2692	0.2715	0.2568	0.2818

F-4	0.2142	0.2245	0.2099	0.1899	0.2312	0.2247	0.2471	0.2497	0.2365	0.2583
F-5	0.2020	0.2529	0.2315	0.2110	0.2625	0.2387	0.2657	0.2758	0.2424	0.2939
F-6	0.2257	0.2399	0.2440	0.2272	0.2541	0.2376	0.2872	0.2748	0.2482	0.3002
F-7	0.2554	0.2833	0.2508	0.2500	0.2576	0.2523	0.2973	0.3007	0.2847	0.3190
F-8	0.2048	0.2380	0.2203	0.2207	0.2245	0.2166	0.2774	0.2809	0.2663	0.2893
F-9	0.2105	0.2316	0.1932	0.1925	0.2267	0.1877	0.2432	0.2465	0.2331	0.2622
F-10	0.2072	0.2404	0.2209	0.2210	0.2330	0.2111	0.2780	0.2818	0.2672	0.2901
F-11	0.1696	0.2299	0.2047	0.1879	0.2539	0.2306	0.2307	0.2459	0.2250	0.2565
F-12	0.1928	0.1998	0.2031	0.2147	0.2116	0.2234	0.2704	0.2649	0.2591	0.2814
F-13	0.1808	0.2195	0.1518	0.2026	0.1955	0.1701	0.2182	0.2206	0.2058	0.2291
F-14	0.2024	0.2527	0.2051	0.1728	0.2552	0.2133	0.2602	0.2616	0.2556	0.2776
F-15	0.2009	0.2214	0.1837	0.1761	0.1731	0.1787	0.2393	0.2349	0.2218	0.2527
F-16	0.1721	0.1997	0.1990	0.1799	0.2278	0.1622	0.2434	0.2266	0.2333	0.2459
F-17	0.2251	0.2880	0.2288	0.2392	0.2654	0.2657	0.2437	0.3056	0.2907	0.3078
F-18	0.2224	0.2761	0.2260	0.2362	0.2622	0.2462	0.2834	0.2425	0.2772	0.3119
F-19	0.2160	0.2769	0.2199	0.2305	0.2544	0.2401	0.2914	0.2938	0.2205	0.2770
F-20	0.2523	0.3047	0.2444	0.2541	0.2978	0.2647	0.3052	0.3236	0.2801	0.2766

Table 14: Summation of TRM rows and columns

Code	R	C	R+C	R-C
F-1	4.6342	4.9628	9.5970	-0.3286
F-2	3.9162	4.6219	8.5381	-0.7057
F-3	4.8394	4.4342	9.2736	0.4052
F-4	4.3978	4.8484	9.2462	-0.4506
F-5	4.7707	4.0868	8.8575	0.6839
F-6	4.9099	4.4193	9.3292	0.4907



F-7	5.2925	4.6792	9.9717	0.6133
F-8	4.6761	4.3798	9.0558	0.2963
F-9	4.2840	4.1954	8.4794	0.0885
F-10	4.7089	4.9304	9.6393	-0.2216
F-11	4.5571	4.1589	8.7159	0.3982
F-12	4.5296	4.9068	9.4364	-0.3772
F-13	4.0073	4.2377	8.2450	-0.2304
F-14	4.6044	4.2068	8.8112	0.3976
F-15	4.0431	4.7850	8.8281	-0.7419
F-16	4.1280	4.4211	8.5492	-0.2931
F-17	5.2154	5.2186	10.4340	-0.0032
F-18	5.1313	5.2797	10.4110	-0.1483
F-19	4.9675	4.9441	9.9116	0.0234
F-20	5.6134	5.5106	11.1240	0.1028

Figure 3: Causal diagram

5. Results and Discussions

This study attempts to list and prioritize the essential components of Internet of Things-enabled GSCM systems. Twenty CSFs that we considered were relevant to our problem were selected from the literature review. Following their detection, these 20 CSFs were categorized using the Neutrosophic DEMATEL approach, which is thought to be an efficient MCDM tool. It can transform the complex interrelationships between the demands of real-world issues into an organized, simply understood model. the conclusion obtained from the analysis of data obtained from the selected experts using the proposed model.

5.1 Ranking of the CSFs

Based on the R+C values shown in table 13, the ranking was completed. The availability of qualified and skilled manpower (F13), with a value of 8.2450, is the least influential CSF of the 20 factors that were chosen, but it is evident that Big Data and BDA tools (F20) were the most important factor, with the greatest importance value of 11.1240. Table 16 displays the degree of influence for each CSF that was taken into account throughout the computation. We advise the organizations to focus on these important CSFs, and the implementation process will be modified after IoT-enabled GSCM deployment reaches the proper degree. Through a continuous improvement process, the degree of implementation will now be increased, with the least important CSFs receiving attention commensurate with their significance. Figure 4 illustrates the CSFs' importance ranking for further explanation of the findings.

5.2 Cause/effect grouping of the CSFs

The CSFs were categorized into cause and effect groups based on the R-C values (Table 15). Ten CSFs (F-20, F-7, F-19, F-6, F-3, F-8, F-5, F-14, F-11, and F-9) were recognised to be in the cause group while rest ten CSFs (F-17, F-18, F-10, F-1, F-12, F-4, F-15, F-16, F-2, and F-13) were recognised to be in the effect group. This investigation revealed that F-5, with its highest R-C value of 0.6839, is the most influencing CSF, whereas F-15, with its lowest R-C value of minus 0.7419, is the most influenced CSF.

5.3 CSFs Interactions

Displaying all CSF interactions on an Impact Relationship Map (IRM) was challenging because the case scenario evaluated twenty CSFs. In order to track the ways in which each CSF influences and is influenced by other CSFs, the threshold (A), which is calculated by utilising the following expression, has been used to build the IRM each CSF.

$$\nabla = \Sigma\Sigma TRMi,jNj=1Ni=1 \qquad N*N \quad (10)$$

IRMs have been developed for every CSF; however, Figure 4 only shows an example of the F16 AMB IRM. A multitude of other CSFs also influence and are influenced by each other. All of the interactions between the CSFs are displayed in Table 16.

Table 15: Prioritizing CSFs and corresponding cause-and-effect associations

CSF	CSF Code	$Ri + Cj$	Ranking	$Ri - Cj$	Cause	Effect
Big Data and Analytics Tools for Big Data (BDA)	F-20	11.1240	1	0.1028	□	
Global positioning system (GPS) and Radio Frequency Identification (RFID)	F-17	10.4340	2	-0.0032		□
IoT applications and Cloud computing	F-18	10.4110	3	-0.1483		□
Top management commitment	F-7	9.9717	4	0.6133	□	
Sensor technologies and sensor network	F-19	9.9116	5	0.0234	□	
Green Advertising	F-10	9.6393	6	-0.2216		□
Impact from stakeholders and investors	F-1	9.5970	7	-0.3286		□
Efficient reverse logistics management	F-12	9.4364	8	-0.3772		□
Green packaging and transportation	F-6	9.3292	9	0.4907	□	
Government rules and regulations	F-3	9.2736	10	0.4052	□	
Global competition factor	F-4	9.2462	11	-0.4506		□
Greening competition pressures	F-8	9.0558	12	0.2963	□	

Management of toxic/ harmful/ hazardous materials and waste and pollution preventative measures	F-5	8.8575	13	0.6839	□	
Cooperation with vendors	F-15	8.8281	14	-0.7419		□
green practices, policies, and infrastructure	F-14	8.8112	15	0.3976	□	
Achieving and sustaining environmental (LEED, High FEM, ISO 14,001, ZDHC) certifications	F-11	8.7159	16	0.3982	□	
Lifecycle Management and Recycling	F-16	8.5492	17	-0.2931		□
Sustainable waste management system	F-2	8.5381	18	-0.7057		□
power negotiations along the supply chain	F-9	8.4794	19	0.0885	□	
Availability of qualified and skilled manpower	F-13	8.2450	20	-0.2304		□

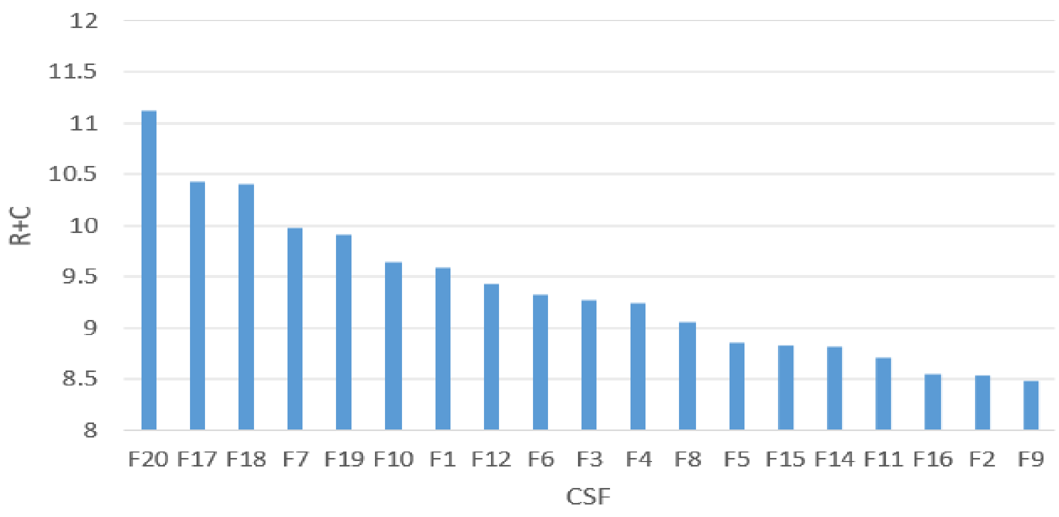


Figure 4: Identified CSFs ranking

Table 16: Interactions between CSFs

CSF	Influencing	In-influenced
F-1	F-11,F-13,F-16,F-17,F-18,F-19,F-20	F-3 , F-5 , F-6 , F-7 , F-10 , F-11, F-12, F-14 , F-17 , F-18 , F-19 , F-20
F-2	……..	F-3 , F-4 , F-5 , F-6 , F-7 , F-10 , F-12 , F-17 , F-18 , F-19 , F-20
F-3	F-1 , F-2 , F-4 , F-6 , F-7 , F-10 , F-11 , F-13 , F-16 , F-17 , F-18 , F-19 , F-20	F-6 , F-7 , F-17 , F-18 , F-20
F-4	F-2 , F-11 , F-18 , F-19 ,F-20	F-3 , F-5 , F-6 , F-7, F-8 , F-14 , F-17 , F-18 , F-19,F-20
F-5	F-1 , F-2 , F-4 , F-7 , F-10 , F-11 , F-13, F-16 , F-17 , F-18 , F-19 , F-20	F-20
F-6	F-1 , F-2 , F-3 , F-4 , F-8 , F-10 , F-11 , F-13 , F-14 ,F-16 ,F-17 , F-18 , F-19 , F-20	F-3,F-7 , F-11, F-17 , F-18 , F-19 , F-20
F-7	F-1, F-2, F-3, F-4, F-6, F-8, F-9, F-10, F-11, F-12, F-13, F-14, F-15, F-16, F-17, F-18 , F-19 , F-20	F-3 , F-5 , F-8 , F-10 , F-12 , F-17 , F-18 , F-19 , F-20
F-8	F-4 , F-7 , F-11 , F-13 , F-18 , F-19 , F-20	F-6 , F-1 , F-14 , F-17 , F-18 , F-19 , F-20
F-9	F-18 , F-19	F-7 , F-18 , F-20
F-10	F-1 , F-2 , F-4 , F-7 , F-10 , F-13 , F-18 , F-19 , F-20	F-3 , F-5 , F-6 , F-7, F-10 , F-11 ,F-12, F-14 , F-17,F-18 , F-19 , F-20
F-11	F-1 , F-6 , F-10 , F-16 , F-19	F-1 , F-3 , F-4 , F-5 , F-6 , F-7 , F-8 , F-14 , F-17 , F-18 , F-19 , F-20
F-12	F-1 , F-2 , F-7 , F-10 , F-18 , F-19 , F-20	F7 , F20
F-13	………….	F-1 , F-3 , F-5 , F-6 , F-7 , F-8 , F-10 , F-14 , F-17 , F-18 , F-19 , F-20
F-14	F-1 , F-4 , F-8 , F-10 , F-11 , F-13 , F-16 , F-18 , F-19 , F-20	F-6 , F-7 , F-20
F-15	F-18,F-19	F-7 , F-17 , F-18 , F-20
F-16	F-18,F-20	F-1 , F-3 , F-5 , F-6 , F-7 , F-11, F-14 , F-17 , F-18 , F-19 , F-20
F-17	F-1 , F-2 , F-3 , F-4 , F-6 , F-7,F-8 , F-10 , F-11 , F-13 , F-15 , F-16 , F-17 , F-18 , F-19	F-1 , F-3 , F-5 , F-6 , F-7 , F-17 , F-18 , F-19 , F-20
F-18	F-1, F-2, F-3, F-4, F-6, F-7, F-8, F-9, F-10, F-11, F-13, F-15, F-16, F-17, F-18, F-19, F-20	F-1, F-3, F-4, F-5, F-6, F-7, F-8, F-9, F-10, F-12, F-14, F-15, F-16, F-17 , F-18 , F-19 , F-20
F-19	F-1 , F-2 , F-4 , F-6 , F-7,F-8 , F-10 , F-11 , F-13 , F-16 , F-17 , F-18 , F-19	F-1, F-3, F-4, F-5, F-6, F-7, F-8, F-9 F-10, F-11 F-12, F-14, F-15,F-17 , F-18 , F-19 , F-20
F-20	F-1, F-2, F-3, F-4, F-5, F-6, F-7, F-8, F-9, F-10, F-11, F-12, F-13, F-14, F-15, F-16 ,F-17, F-18 , F-19 , F-20	F-1 , F-3 , F-5 , F-6 , F-7 , F-8 , F-10 , F-12 , F-14 , F-16 , F-17 , F-18 , F-20

6. Conclusion

Within the manufacturing operation, insufficient core skills and less information awareness are caused by inadequate strategic planning, ineffective management, and inadequate information management. System performance and productivity may clearly be increased by focusing more on the underlying causes of problems and effectively managing their impacts. To prioritize the CSFs accountable for the company's performance, a similar approach was applied in IoT-enabled GSCM systems utilizing the neutrosophic DEMATEL method. One important aspect of businesses' attempts to increase their performance has been seen as green supply chain management. Because of this, the main goal of this study was to find out what success factors are essential for managing environmentally friendly supply chains that are made possible by Internet of Things technology. After a literature review, 20 CSFs were identified and divided into two categories: IoT enablers and green enablers. We determined each factor's relative importance, the cause-and-effect grouping, and the ways in which each CSF influences and is influenced by other CSFs after using the neutrosophic DEMATEL technique. In conclusion, we advised the organizations to focus on particular CSFs, and to modify the implementation process once IoT-enabled GSCM implementation reaches the proper degree. Now, a continuous improvement method will be used to increase the degree of implementation, with the least important CSFs receiving attention commensurate with their significance.

References

[1] Y. Zhou, L. Xu, and G. M. Shaikh, "Evaluating and prioritizing the green supply chain management practices in Pakistan: Based on Delphi and fuzzy AHP approach," Symmetry (Basel)., vol. 11, no. 11, 2019, doi: 10.3390/sym11111346.

[2] R. J. Lin, "Using fuzzy DEMATEL to evaluate the green supply chain management practices," J. Clean. Prod., vol. 40, pp. 32–39, 2013, doi: 10.1016/j.jclepro.2011.06.010.

[3] S. M. Diab, F. A. AL-Bourini, and A. H. Abu-Rumman, "The Impact of Green Supply Chain Management Practices on Organizational Performance: A Study of Jordanian Food Industries," J. Manag. Sustain., vol. 5, no. 1, pp. 149–157, 2015, doi: 10.5539/jms.v5n1p149.

[4] S. Gandhi, S. K. Mangla, P. Kumar, and D. Kumar, Evaluating factors in implementation of successful green supply chain management using DEMATEL: A case study, vol. 3, no. 1–2. Holy Spirit University of Kaslik, 2015.

[5] J. F. Kirchoff, W. L. Tate, and D. A. Mollenkopf, "The impact of strategic organizational orientations on green supply chain management and firm performance," Int. J. Phys. Distrib. Logist. Manag., vol. 46, no. 3, pp. 269–292, 2016, doi: 10.1108/IJPDLM-03-2015-0055.

[6] A. Haji Vahabzadeh, A. Asiaei, and S. Zailani, "Green decision-making model in reverse logistics using FUZZY-VIKOR method," Resour. Conserv. Recycl., vol. 103, pp. 125–138, 2015, doi: 10.1016/j.resconrec.2015.05.023.

[7] T. Debicki and C. Guzman, Integration of Information Flow for Greening Supply Chain Management, no. July. 2020.

[8] A. A. Hervani, M. M. Helms, and J. Sarkis, "Performance measurement for green supply chain management," Benchmarking, vol. 12, no. 4, pp. 330–353, 2005, doi: 10.1108/14635770510609015.

[9] A. Jayant, B. F. Environment, and A. Jayant, "Impact of Green Supply Chain Management Practices in India," no. July, pp. 1–14, 2017.

[10] E. Taghavi, A. Fallahpour, K. Y. Wong, and S. Amirali Hoseini, "Identifying and prioritizing the effective factors in the implementation of green supply chain management in the construction industry," Sustain. Oper. Comput., vol. 2, no. April, pp. 97–106, 2021, doi: 10.1016/j.susoc.2021.05.003.

[11] I. Deli, M. Ali, and F. Smarandache, "Bipolar neutrosophic sets and their application based on multi-criteria decision making problems," Int. Conf. Adv. Mechatron. Syst. ICAMechS, vol. 2015-Octob, no. August, pp. 249– 254, 2015, doi: 10.1109/ICAMechS.2015.7287068.

[12] Abdullah Ali Salamai, Evaluation and Selection of Cloud Service: A neutrosophic model, Neutrosophic and Information Fusion, Vol. 1 , No. 2 , (2023) : 16-25 (Doi :

https://doi.org/10.54216/NIF.010202)

[13] S. Mahmoudi, A. Jalali, M. Ahmadi, P. Abasi, and N. Salari, "Identifying critical success factors in Heart Failure Self-Care using fuzzy DEMATEL method," Appl. Soft Comput. J., vol. 84, p. 105729, 2019, doi: 10.1016/j.asoc.2019.105729.

[14] A. Banik, H. M. M. Taqi, S. M. Ali, S. Ahmed, M. Garshasbi, and G. Kabir, "Critical success factors for implementing green supply chain management in the electronics industry: an emerging economy case," Int. J. Logist. Res. Appl., vol. 25, no. 4–5, pp. 493–520, 2022, doi: 10.1080/13675567.2020.1839029.

[15] K. P. Lin, M. L. Tseng, and P. F. Pai, "Sustainable supply chain management using approximate fuzzy DEMATEL method," Resour. Conserv. Recycl., vol. 128, pp. 134–142, 2018, doi: 10.1016/j.resconrec.2016.11.017.

[16] M. Jalali, B. Feng, and J. Feng, "An Analysis of Barriers to Sustainable Supply Chain Management Implementation: The Fuzzy DEMATEL Approach," Sustain., vol. 14, no. 20, pp. 1–30, 2022, doi: 10.3390/su142013622.

[17] Ahmed Sleem , Ibrahim Elhenawy, An Interval Valued Neutrosophic Sets Integrated with the AHP MCDM Methodology to Assess the Station of 5G Network, Neutrosophic and Information Fusion, Vol. 1 , No. 1 , (2023)

: 34-40 (Doi : https://doi.org/10.54216/NIF.010104)

[18] C. Ntinas, D. Gkortzis, A. Papadopoulos, and D. Ioannidis, "Industry 4.0 sustainable supply chains: An application of an IoT enabled scrap metal management solution," J. Clean. Prod., p. 122377, 2020, doi: 10.1016/j.jclepro.2020.122377.

[19] A. A. Vieira, L. M. Dias, M. Y. Santos, G. A. Pereira, and J. A. Oliveira, "On the use of simulation as a Big Data semantic validator for supply chain management," Simul. Model. Pract. Theory, vol. 98, no. April 2019, p. 101985, 2020, doi: 10.1016/j.simpat.2019.101985.

[20] R. Addo-Tenkorang and P. T. Helo, "Big data applications in operations/supply-chain management: A literature review," Comput. Ind. Eng., vol. 101, pp. 528–543, 2016, doi: 10.1016/j.cie.2016.09.023.

[21] S. Bag, L. C. Wood, L. Xu, P. Dhamija, and Y. Kayikci, "Big data analytics as an operational excellence approach to enhance sustainable supply chain performance," Resour. Conserv. Recycl., vol. 153, no. May 2019,

p. 104559, 2020, doi: 10.1016/j.resconrec.2019.104559.

[22] S. K. Singh and A. N. El-Kassar, "Role of big data analytics in developing sustainable capabilities," J. Clean. Prod., vol. 213, pp. 1264–1273, 2019, doi: 10.1016/j.jclepro.2018.12.199.

[23] J. Liu, M. Chen, and H. Liu, "The role of big data analytics in enabling green supply chain management : a literature review," 2020.

[24] E. Taghavi, A. Fallahpour, K. Y. Wong, and S. Amirali Hoseini, "Identifying and prioritizing the effective factors in the implementation of green supply chain management in the construction industry," Sustain. Oper. Comput., vol. 2, no. May, pp. 97–106, 2021, doi: 10.1016/j.susoc.2021.05.003.

[25] A. Banik, H. M. M. Taqi, S. M. Ali, S. Ahmed, M. Garshasbi, and G. Kabir, "Critical success factors for implementing green supply chain management in the electronics industry: an emerging economy case," Int. J. Logist. Res. Appl., vol. 25, no. 4–5, pp. 493–520, 2022, doi: 10.1080/13675567.2020.1839029.

[26] N. El-Hefenawy, M. A. Metwally, Z. M. Ahmed, and I. M. El-Henawy, "A review on the applications of neutrosophic sets," J. Comput. Theor. Nanosci., vol. 13, no. 1, pp. 936–944, 2016, doi: 10.1166/jctn.2016.4896.

[27] U. R. de Oliveira, L. S. Espindola, I. R. da Silva, I. N. da Silva, and H. M. Rocha, "A systematic literature review on green supply chain management: Research implications and future perspectives," J. Clean. Prod., vol. 187, pp. 537–561, 2018, doi: 10.1016/j.jclepro.2018.03.083.

[28] Q. Zhu, J. Sarkis, and K. H. Lai, "Green supply chain management innovation diffusion and its relationship to organizational improvement: An ecological modernization perspective," J. Eng. Technol. Manag. - JET-M, vol. 29, no. 1, pp. 168–185, 2012, doi: 10.1016/j.jengtecman.2011.09.012.

[29] S. K. Srivastava, "Green supply-chain management: A state-of-the-art literature review," Int. J. Manag. Rev., vol. 9, no. 1, pp. 53–80, 2007, doi: 10.1111/j.1468-2370.2007.00202.x.

[30] P. Rao and D. Holt, "Do green supply chains lead to competitiveness and economic performance?," Int. J. Oper. Prod. Manag., vol. 25, no. 9, pp. 898–916, 2005, doi: 10.1108/01443570510613956.

[31] S. Gandhi, S. K. Mangla, P. Kumar, and D. Kumar, "A combined approach using AHP and DEMATEL for evaluating success factors in implementation of green supply chain management in Indian manufacturing industries," Int. J. Logist. Res. Appl., vol. 19, no. 6, pp. 537–561, 2016, doi: 10.1080/13675567.2016.1164126.

[32] Y. A. Solangi, Q. Tan, N. H. Mirjat, and S. Ali, "Evaluating the strategies for sustainable energy planning in Pakistan: An integrated SWOT-AHP and Fuzzy-TOPSIS approach," J. Clean. Prod., vol. 236, p. 117655, 2019, doi: 10.1016/j.jclepro.2019.117655.

[33] Y. A. Solangi, Q. Tan, M. W. A. Khan, N. H. Mirjat, and I. Ahmed, "The selection of wind power project location in the Southeastern Corridor of Pakistan: A factor analysis, AHP, and fuzzy-TOPSIS application," Energies, vol. 11, no. 8, 2018, doi: 10.3390/en11081940.

[34] A. Jazairy and R. von Haartman, "Analysing the institutional pressures on shippers and logistics service providers to implement green supply chain management practices," Int. J. Logist. Res. Appl., vol. 23, no. 1, pp. 44–84, 2020, doi: 10.1080/13675567.2019.1584163.

[35] Q. Zhu, J. Sarkis, and K. H. Lai, "An institutional theoretic investigation on the links between internationalization of Chinese manufacturers and their environmental supply chain management," Resour. Conserv. Recycl., vol. 55, no. 6, pp. 623–630, 2011, doi: 10.1016/j.resconrec.2010.12.003.

[36] E. M. Abalo, P. Peprah, J. Nyonyo, R. Ampomah-Sarpong, and W. Agyemang-Duah, "A Review of the Triple Gains of Waste and the Way Forward for Ghana," J. Renew. Energy, vol. 2018, pp. 1–12, 2018, doi: 10.1155/2018/9737683.

[37] M. K. Chien and L. H. Shih, "An empirical study of the implementation of green supply chain management practices in the electrical and electronic industry and their relation to organizational performances," Int. J. Environ. Sci. Technol., vol. 4, no. 3, pp. 383–394, 2007.

[38] P. H. Ketikidis, O. P. Hayes, L. Lazuras, A. Gunasekaran, and S. C. L. Koh, "Environmental practices and performance and their relationships among Kosovo construction companies: A framework for analysis in transition economies," Int. J. Serv. Oper. Manag., vol. 14, no. 1, pp. 115–130, 2013, doi: 10.1504/IJSOM.2013.050565.

[39] S. Luthra, V. Kumar, S. Kumar, and A. Haleem, "Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique-an Indian perspective," J. Ind. Eng. Manag., vol. 4, no. 2, pp. 231–257, 2011, doi: 10.3926/jiem.2011.v4n2.p231-257.

[40] F. Z. Wang, "The study on performance measurement of green supply chain management," Appl. Mech. Mater., vol. 411–414, pp. 2742–2745, 2013, doi: 10.4028/www.scientific.net/AMM.411-414.2742.

[41] V. H. Lee, K. B. Ooi, A. Y. L. Chong, and B. Lin, "A structural analysis of greening the supplier, environmental performance and competitive advantage," Prod. Plan. Control, vol. 26, no. 2, pp. 116–130, 2015, doi: 10.1080/09537287.2013.859324.

[42] Y. S. Chen, S. B. Lai, and C. T. Wen, "The influence of green innovation performance on corporate advantage in Taiwan," J. Bus. Ethics, vol. 67, no. 4, pp. 331–339, 2006, doi: 10.1007/s10551-006-9025-5.

[43] P. De Giovanni and V. Esposito Vinzi, "Covariance versus component-based estimations of performance in green supply chain management," Int. J. Prod. Econ., vol. 135, no. 2, pp. 907–916, 2012, doi: 10.1016/j.ijpe.2011.11.001.

[44] C. Ninlawan, P. Seksan, K. Tossapol, and W. Pilada, "The implementation of green supply chain management practices in electronics industry," Proc. Int. MultiConference Eng. Comput. Sci. 2010, IMECS 2010, vol. III, pp. 1563–1568, 2010.

[45] J. C. Ho, M. K. Shalishali, T. L. Tseng, and D. Ang, "Opportunities in Green Supply Chain Management," Coast. Bus. J., vol. 8, no. 1, pp. 18–31, 2009.

[46] W. Nasution, "Role of Logistics and Transportation in green supply."

[47] G. Zhang and Z. Zhao, "Green Packaging Management of Logistics Enterprises," Phys. Procedia, vol. 24,

pp. 900–905, 2012, doi: 10.1016/j.phpro.2012.02.135.

[48] B. R. A. Hurley, A. Ouzts, J. Fischer, and T. Gomes, "PAPER PRESENTED AT IAPRI WORLD CONFERENCE 2012 Effects of Private and Public Label Packaging on Consumer Purchase Patterns," Packag. Technol. Sci., vol. 29, no. January, pp. 399–412, 2013, doi: 10.1002/pts.

[49] E. Sandberg and M. Abrahamsson, "The

role of top management in supply chain management practices," Int. J. Retail Distrib. Manag., vol. 38, no. 1, pp. 57–69, 2010, doi: 10.1108/09590551011016331.

[50] H. Wang and Liu Zuoming, "The Impact of Top Management Commitment on Companies ' Performance in Green Supply Chain Management," pp. 1–15, 2019.

[51] M. A. Moktadir, T. Rahman, and S. M. Ali, "Critical Success Factors in Implementing Green Supply Chain Management Practices in Footwear Industry in Bangladesh – An Interpretive Structural Modeling Approach," Proc. the1st Int. Conf. Buinsess Manag. (ICBM); 2017 sep 20-21, no. Dhaka, Bangladesh, p. Dhaka, Bangladesh, pp.447–452, 2017.

[52] C. Chen, H. Shih, H. Shyur, and K. Wu, "A business strategy selection of green supply chain management via an," Comput. Math. with Appl., vol. 64, no. 8, pp. 2544–2557, 2012, doi: 10.1016/j.camwa.2012.06.013.

[53] S. Prasad, R. Shankar, and S. Roy, "Impact of bargaining power on supply chain profit allocation: a game- theoretic study," J. Adv. Manag. Res., vol. 16, no. 3, pp. 398–416, 2019, doi: 10.1108/JAMR-10-2018-0096.

[54] O. Baron, O. Berman, and D. Wu, "Bargaining within the Supply Chain and Its Implications in an Industry," Decis. Sci., vol. 47, no. 2, pp. 193–218, 2016, doi: 10.1111/deci.12189.

[55] D. Sugandini, M. Muafi, C. Susilowati, Y. Siswanti, and W. Syafri, "Green supply chain management and green marketing strategy on green purchase intention: SMEs cases," J. Ind. Eng. Manag., vol. 13, no. 1, pp. 79– 92, 2020, doi: 10.3926/jiem.2795.

[56] A. Diabat and K. Govindan, "An analysis of the drivers affecting the implementation of green supply chain management," Resour. Conserv. Recycl., vol. 55, no. 6, pp. 659–667, 2011, doi: 10.1016/j.resconrec.2010.12.002.

[57] S. Vachon, "Green supply chain practices and the selection of environmental technologies," Int. J. Prod. Res., vol. 45, no. 18–19, pp. 4357–4379, 2007, doi: 10.1080/00207540701440303.

[58] M. Mutingi, "The impact of reverse logistics in green supply chain management: A system dynamics analysis," Int. J. Ind. Syst. Eng., vol. 17, no. 2, pp. 186–201, 2014, doi: 10.1504/IJISE.2014.061993.

[59] A. E. Ellinger and A. D. Ellinger, "Leveraging human resource development expertise to improve supply chain managers' skills and competencies," Eur. J. Train. Dev., vol. 38, no. 1–2, pp. 118–135, 2014, doi: 10.1108/EJTD-09-2013-0093.

[60] J. J. Assumpção, L. M. S. Campos, J. A. Plaza-Úbeda, S. Sehnem, and D. A. Vazquez-Brust, "Green Supply Chain Management and business innovation," J. Clean. Prod., vol. 367, no. June, 2022, doi: 10.1016/j.jclepro.2022.132877.

[61] J. Morana, Sustainable supply chain management. 2013.

[62] N. A. Chowdhury, S. M. Ali, S. K. Paul, Z. Mahtab, and G. Kabir, "A hierarchical model for critical success factors in apparel supply chain," Bus. Process Manag. J., vol. 26, no. 7, pp. 1761–1788, 2020, doi: 10.1108/BPMJ- 08-2019-0323.

[63] H. Cheng, C. Chen, S. Wu, Z. A. Mirza, and Z. Liu, "Emergy evaluation of cropping, poultry rearing, and fish raising systems in the drawdown zone of Three Gorges Reservoir of China," J. Clean. Prod., vol. 144, pp. 559–571, 2017, doi: 10.1016/j.jclepro.2016.12.053.

[64] A. H. Hu and C. W. Hsu, "Critical factors for implementing green supply chain management practice: An empirical study of electrical and electronics industries in Taiwan," Manag. Res. Rev., vol. 33, no. 6, pp. 586–608, 2010, doi: 10.1108/01409171011050208.

[65] K. R. Prasanna and M. Hemalatha, "RFID GPS and GSM based logistics vehicle load balancing and tracking mechanism," Procedia Eng., vol. 30, pp. 726–729, 2012, doi: 10.1016/j.proeng.2012.01.920.

[66] M. K. Lim, J. Wang, C. Wang, and M. L. Tseng, "A novel method for green delivery mode considering shared vehicles in the IoT environment," Ind. Manag. Data Syst., vol. 120, no. 9, pp. 1733–1757, 2020, doi: 10.1108/IMDS-02-2020-0078.

[67] M. A. Ferrag, L. Shu, X. Yang, A. Derhab, and L. Maglaras, "Security and Privacy for Green IoT-Based Agriculture: Review, Blockchain Solutions, and Challenges," IEEE Access, vol. 8, pp. 32031–32053, 2020, doi: 10.1109/ACCESS.2020.2973178.

[68] N. Rajkumar and R. M. Satheesh Kumar, "Cloud Computing for Green Supply Chain Management," Glob. Res. Dev. J. Eng., no. August, pp. 2455–5703, 2016.

[69] A. I. Awad, M. M. Fouda, M. M. Khashaba, E. R. Mohamed, and K. M. Hosny, "Utilization of

mobile edge computing on the Internet of Medical Things: A survey," ICT Express, no. xxxx, 2022, doi: 10.1016/j.icte.2022.05.006.

[70] S. B. Rane, S. V. Thakker, and R. Kant, "Stakeholders' involvement in green supply chain: a perspective of blockchain IoT-integrated architecture," Manag. Environ. Qual. An Int. J., vol. 32, no. 6, pp. 1166–1191, 2021, doi: 10.1108/MEQ-11-2019-0248.

[71] J. Ruan et al., "A Life Cycle Framework of Green IoT-Based Agriculture and Its Finance, Operation, and Management Issues," IEEE Commun. Mag., vol. 57, no. 3, pp. 90–96, 2019, doi: 10.1109/MCOM.2019.1800332.

[72] M. N. Shafique, A. Rashid, I. S. Bajwa, R. Kazmi, M. M. Khurshid, and W. A. Tahir, "Effect of IoT capabilities and energy consumption behavior on green supply chain integration," Appl. Sci., vol. 8, no. 12, pp. 1–18, 2018, doi: 10.3390/app8122481.

[73] R. Zhao, Y. Liu, N. Zhang, and T. Huang, "An optimization model for green supply chain management by using a big data analytic approach," J. Clean. Prod., vol. 142, pp. 1085–1097, 2017, doi: 10.1016/j.jclepro.2016.03.006.

[74] H. Wang, F. Smarandache, R. Sunderraman, and Y.-Q. Zhang, "Single valued neutrosophic sets," Multisp. Multistructure, vol. 4, pp. 410–413, 2010.

[75] P. E. Ebenanjar, H. J. Immaculate, and C. B. Wilfred, "On Neutrosophic b-open sets in Neutrosophic topological space," J. Phys. Conf. Ser., vol. 1139, no. 1, 2018, doi: 10.1088/1742-6596/1139/1/012062.

[76] S. Subasri and K. Selvakumari, "Neutrosophic travelling salesman problem in trapezoidal fuzzy number using branch and bound technique," J. Phys. Conf. Ser., vol. 1362, no. 1, 2019, doi: 10.1088/1742- 6596/1362/1/012098.

[77] S. Seker and E. K. Zavadskas, "Application of fuzzy DEMATEL method for analyzing occupational risks on construction sites," Sustain., vol. 9, no. 11, 2017, doi: 10.3390/su9112083.

[78] D. Dalalah, M. Hayajneh, and F. Batieha, "A fuzzy multi-criteria decision making model for supplier selection," Expert Syst. Appl., vol. 38, no. 7, pp. 8384–8391, 2011, doi: 10.1016/j.eswa.2011.01.031.

[79] P. K. Potdar, S. Routroy, and A. Behera, "Analyzing the agile manufacturing barriers using fuzzy DEMATEL," Benchmarking, vol. 24, no. 7, pp. 1912–1936, 2017, doi: 10.1108/BIJ-02-2016-0024.