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Assessing the Risk Factors of Sustainable Supply Chain Management in the Developing Countries: Some Exploratory Findings

Kazi Humayra Shams[1], Fardeen Islam[2], Tausif Jakir[3]

[1, 2, 3]Department of Industrial Engineering and Management,
Khulna University of Engineering & Technology (KUET), Khulna, Bangladesh
[1]humayra.kuet.ac.bd@gmail.com, [2]islamfardeen@gmail.com, [3]tausif41214@gmail.com

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ABSTRACT

The strategic economic benefits of sustainability have catapulted it to the forefront of supply chain management (SCM). Supply chain sustainability risks from a wide variety of sources have become more prevalent in today's complicated economic climate. However, there is a lack of researches on the topic of sustainability risk assessment at the moment. Unfortunately, existing risk assessment methods are not equipped to deal with the complexity, unpredictability, and fuzziness of the information that makes up supply chain (SC) risks in Bangladesh apparel industry. When supply- and demand-side restrictions aren't addressed, it can have a domino effect on the whole supply chain's efficiency. The report classifies the 21 potential threats to sustainability into six distinct categories. Based on the relative importance of each risk, the categories are as follows: environmental, social, economic, supplier, logistical, and information technology. Results also suggests supply 'lack of business information', 'insolvency of suppliers' and 'increased price of raw materials' are the top three sustainable supply chain risk factors. The report also ranks the 21 potential threats to sustainability and determines the top three. This research is important because it will help professionals analyze and manage sustainability risks in their supply chains.

Key words: Sustainable Supply Chain Management, Fuzzy AHP, Risks, Sustainability

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INTRODUCTION

Sustainable supply chain management (SSCM) is a strategy that includes the social, economic, and environmental effect of a company's supply chain operations [1]. It is a proactive strategy to ensure that the supply chain functions responsibly and sustainably, while offering value to stakeholders. Sustainability has started to emerge in the literature of business disciplines such as operations and management. This growing importance of it may be attributed to a number of factors, such as the supply and demand dynamics of energy consumption, progress in our knowledge of the science behind climate change, and more openness about the environmental and social impacts of businesses. [2] The relevance of supply chain management (SCM) has been on the rise since the early 1990s, despite the fact that the method itself (or, more accurately, the concept) was first proposed in the early 1980s [3]. Several authors agree that the SCM method is predicated on the observation that there are interdependencies between stages in distribution channels from production to final consumption [4]. This strategy demands organizations to create and execute sustainable practices that decrease waste, save resources, and enhance working conditions in collaboration with their suppliers and other stakeholders [5]. Recent years have seen a meteoric growth in the study and implementation of SSCM in both the academic and business communities. Recent concern toward sustainability and the environment may be found in the writings of economists and philosophers. There is obviously enough movement and progress being made in the domain of sustainability for scholars and practitioners to think about the implications and repercussions of sustainability on the standard assumptions and practices of the discipline [6].

Risks of Supply chain means the probable threats and inconsistencies that can impede products, services, and information move through a supply chain [7]. It involves variety of issues, including natural disasters, geopolitical instability, economic turbulence, and operational failures. Supply chain practitioners and academics have begun to explore the many facets of supply chain risk management because of the vulnerability and severity of those. A recent study in 2021 indicated that 73% of companies reported that they have supply chain risk management solutions [8]. Strikes, legal conflicts, political instability and natural disasters are some of the external factors that may disrupt a supply chain, but internal factors like accidents, theft, contamination, and sabotage can also play a role [8]. The company's image, goodwill, and bottom line are all negatively impacted by these interruptions [9]. This indicates that companies must devote substantial efforts to addressing these risks.

The apparel sector in Bangladesh is one of the country's most dynamic and rapidly expanding economic sectors. Over 80% of the country's export revenues come from this sector, and it employs more than 4 million people [10]. The cheap cost of labour, supporting government restrictions, and strong demand from worldwide retailers and brands have all contributed to the fast expansion of the company over the last two decades. According to the results of a number of other pieces of research, a significant proportion of businesses operating in this sector do not adhere to the environmental and social standards that are in place [11]. This tendency has been disturbed, however, by recent key events in the sector, which has led to an increasing demand from the public and customers for sustainable practices [12]. With so many environmental and socioeconomic problems plaguing the country, sustainable supply chain methods have taken on greater significance in recent years in Bangladesh. The supply chain of Bangladesh apparel sector is multi-layered, beginning with producers of raw materials and ending with merchants or customers. Subcontracting and informal labour may create problems with regard to transparency and workers' rights [13]. However, in recent years the Bangladeshi apparel industry has also been plagued by several difficulties and controversies, notably in the areas of working conditions and workers' rights. Increased supply chain openness and accountability has been called for in response to concerns about the industry's inadequate safety standards, low salaries, and limited employees' rights. The decision-making process may be complicated and difficult, especially when several factors are involved and subjective and unclear information must be included.

The main objectives of this project works are to investigate and prioritize the sustainability risks for supply chain in Bangladeshi apparel sector using Fuzzy Analytical Hierarchy Process (FAHP). This method can provide a systematic and organized approach to decision-making [14].

LITERATURE REVIEW

Sustainable Supply Chain

Sustainable supply chain management (SSCM) is an alternative to conventional SCM that prioritizes the needs of all parties involved in the supply chain, not just the ones that benefit financially [15]. SSCM practices have been characterized in many ways in the literature; for example, Pagell and Wu argue that SSCM refers to the set of management actions taken in relation to a supply chain that are meant to make that network really sustainable [16]. On the other hand, numerous writers Ahi & Searcy define SSCM as supply chain management, the goal of which is to preserve environmental, economic, and social stability in order to foster continued long-term sustainable development [1].

Sustainable Supply Chain Risks

Supply Chain (SC) risk is an exposure to an incident that creates disruption, hence impacting the effective operation of a supply chain network. Risk management is increasingly included into comprehensive SCM designs [17]. In the literature, supply chain risks are classified in a variety of ways. Juettner described supply chain risk as "change in the distribution of conceivable supply chain outcomes, their likelihood, and their subjective values" [18]. However, sustainability risk differs significantly from conventional supply chain risk. According to Hofmann, Traditional supply chain risks result from disruptive events, whereas supply chain sustainability risks depend on the responses of important parties [19]. Researches have utilized both conceptual and quantitative methods to characterize supply chain risk.

Bangladesh Apparel Industry's Supply Chain Viability

The backbone of the economy of Bangladesh is the garment sector, providing jobs for more than 4 million people directly and making up around 78.6 percent of the export revenues. In addition, in 2011, clothing exports totalled $19.90 billion, second highest export revenue. [20]. There are, however, a number of threats to supply chains in the nation, including a lack of infrastructure, skilled workers, natural catastrophes, and stable governments. In order to be competitive and sustainable in the Bangladeshi market, organizations must understand how to control those risks. Two incidents - almost 112 people lost their lives in the Tazreen fashion factory for fire accident and nearly 1100 people died in the Rana Plaza building collapse, occurred for neglecting potential risks [21]. Damage to the industry's image and substantial supply-side hurdles throughout the whole supply chain are the results of such incidents. Therefore, a decision model to recognize and rank the

problems currently plaguing the garment supply chain in Bangladesh, as well as to choose appropriate responses, is essential. It is crucial to systematically and comprehensively identify the obstacles and prioritize the mitigation methods in this particular sector [22].

TECHNIQUE OR METHODS

Fuzzy AHP

The Fuzzy Analytical Hierarchy Process (FAHP) provides a comprehensive and adaptable approach that considers both quantitative and qualitative data and permits the incorporation of subjective data into the decision-making process [23]. There are several places where the Fuzzy AHP method finds utility, such as in the allocation of resources, the selection of projects, and the creation of new products when the decision-maker has few data to work with, when the criteria to be examined are ambiguous or open to several interpretations, or when time is of the essence in making a call [24]. For the purposes of using Fuzzy AHP, Buckley's technique is a widely used practice.

Research Framework

This research began with a literature analysis and expert input to identify supply chain sustainability issues in practices. Twenty-one sustainability hazards were found across six categories, which are listed in the Table 1. Email was used to distribute a collection of surveys to responders. Using linguistic variables represented by triangular numbers, the Fuzzy AHP performs pair-wise comparisons of each criterion and option. Despite the fact that there are other strategies integrated in Fuzzy AHP, the Buckley method is employed in this area of research owing to its ease of use [25]. In addition, a cause-and-effect diagram was shown to reveal the underlying reasons of the most significant sustainability issues. Lastly, findings, management implications, constraints, and the scope of future study are explored in order. Fig. 1 illustrates the proposed study framework.

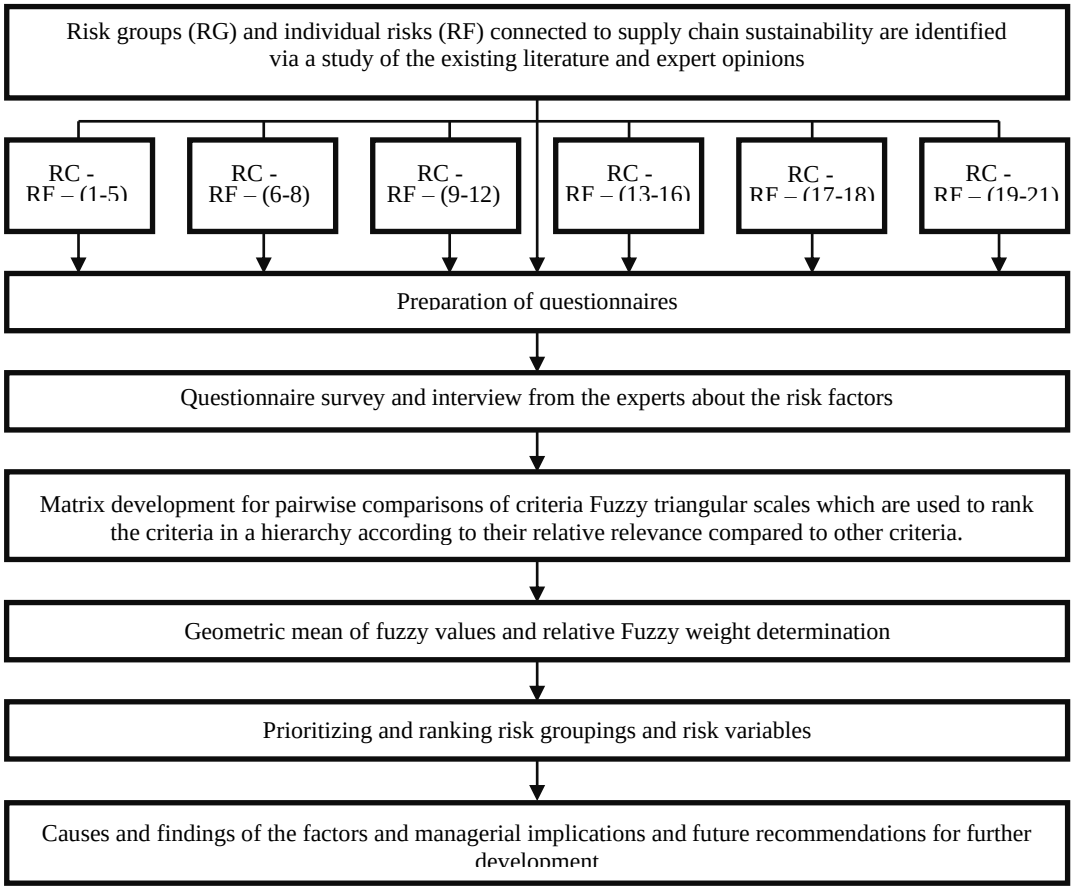

Fig. 1 Fuzzy AHP (Buckley's method) steps

Step 1: Through a study of the available literature, a total of 21 risk variables, categorized into six risk categories were found showed in Table 1. The expert group played a crucial role in validating the identified factors because of their understanding of sustainability and supply chain challenges. On the basis of the risk groupings and risk variables, a series of risk rating questionnaires were developed.

Step 2: Pairwise comparison matrices between criteria. We employ fuzzy triangular scales to rank the criteria in a hierarchy, where the weight of each criterion is determined by its relative relevance to the others in Table 2. Pairwise comparisons were done across all categories using data from sets of questionnaires completed by three employees involved in the setup procedure. A consensus view held by all three decision makers was generated by averaging the available data. Table 3 is a synthesis of the pair-wise comparison data of each criterion towards each other in triangular scale from Table 2. For instance, the triangular scale in the pair wise contribution matrix might look like this if the decision maker ranked criterion 1 as "Weakly Important" compared to criterion 2. (2, 3, 4). However, the matrix (1/4, 1/3, 1/2) represents the inverse pair wise comparison for Criteria 2 relative to Criteria 1.

Table -1 Risk Category and Risk Factors

Risk Category	Risk Factors	Description
Environmental (ENV)	Air, dust and water pollution	Rising pollution levels in air, water, and soil for unhygienic working atmosphere
	Natural disasters/demographic changes	Geographical location, Climate Change, Deforestation, Erosion of the Soil, and Overpopulation
	Working conditions	Lack of proper infrastructure in the company layout
	Factory fire	Not enough precautions or safety guidelines for the workers and the employees
	Human health of workers	Presence of hazardous substances in the factory area
Social (SOC)	Wage discriminations	Inequitable policy for workers
	Excessive working time	Consequences for disobeying regulations, include the imposition of excessive labor loads and duties.
	Sexual and religious discrimination of workers	Unfair treatment due to the race, religion etc. of the workers
Economical (ECO)	Incorrect or faulty claims	Fault claims of the supplier parties and incorrect claims
	Increased price of raw materials	Sudden rise in the raw materials for the market change or price manipulation
	Currency fluctuations/price volatility	Unpredictable price fluctuation or government policy change
	Syndicate pricing	Conspiracy among Collusion between suppliers and customers to raise prices by engineering a scarcity and reap additional profits.
Supplier (SUP)	Supplier quality problem	Deterioration in product quality caused by improper processing
	Insolvency of suppliers	Economic downturns of the supplier party
	Delivery delays of supplier	Supplier parties' irresponsible behaviour which causes the organization to face issues
	Material shortages	Lack of the right material in the time of emergency situations
Logistics (LOG)	Port and Border delays	Delays at the road and borders due to the instability of the borders
	Troubling third-party logistics	Insufficient automation, unfit vehicles
Information Technology (IT)	Lack of business information	Gap in the information flow- both internal and external
	Planning and forecasting errors	Errors in demand or supply forecasting due to a sudden change
	Internal system disruptions	Internal issues which causes the information system to breakdown

Table -2 Fuzzy Triangular Scaling

Saaty Scale [25]	Linguistic Terms	Fuzzy Triangular Scale
1	Equally Important	(1, 1, 1)
2	Weakly Important	(2, 3, 4)
3	Fairly Important	(4, 5, 6)
4	Strongly Important	(6, 7, 8)
5	Absolute Important	(9, 9, 9)

Step 3: Normalized relative weights of criteria. Specifically, the fuzzy comparison geometric means values were determined using the formulas in Table 4, with an illustrative calculation for 'Criteria 1' presented in Equation 1.

$$r_i = \left(\prod_{j=1}^{n} \widetilde{d_{ij}}\right)^{\frac{1}{n}} \qquad (1)$$

Step 4: Relative fuzzy of weight. According to Table 5, the geometric means of the fuzzy values were calculated and then those values were converted to relative fuzzy of weight. An average of these fuzzy numbers for each criterion were taken to determine its non-fuzzy weight (Mi). In order to arrive at the normalized weights of each criterion (Ni), the value of each criterion was divided by the sum of all criterion values. Therefore, Table 5 displays the mean and standard deviation of criterion weights.

RESULT AND DISCUSSION

Data Analysis

Expert opinions: The expert views for the pairwise comparison of the risk variables was obtained using a 5-point Likert scale that assigned relative weight to the risk factors depending on how they influence one another: Equally important, weakly important, fairly important, strongly important, and absolutely important. A total of 23 replies were obtained from industry professionals in response to an online and offline survey.

Pair wise contribution matrices for all criteria: The average was calculated by compiling the opinion from all the responses. Based on the Fuzzy AHP Buckley's method, the factors were organized in a way in a matrix which shows the importance of one individual factor on other 20 factors.

Geometric Mean, Fuzzy Weight and Normalized Weight Criterion (Ni): The geometric means of fuzzy set for each individual factor were calculated based on the Equation 1 and shown on the Table 3 [26]. For example,

ENV 1= [$(1 * 0.11 * 0.17 * 9 * 0.25 * 0.17 * 1 * 0.125 * 0.11 * 6 * 1 * 4 * 0.11 * 0.125 * 2 * 6 * 0.11 * 0.17 * 1 * 2)^{\frac{1}{21}}$; $(1 * 5 * .11 * .2 * 9 * .33 * .2 * 1 * .147 * .11 * 7 * 1 * 5 * .11 * 147 * 3 * 7 * .11 * .2 * 1 * 3)^{\frac{1}{21}}$; $(1 * 6 * .11 * .25 * 9 * .5 * .25 * 1 * .17 * .11 * 8 * 1 * 6 * .11 * .2 * 4 * 8 * .11 * .25 * 1 * 4)^{\frac{1}{21}}$]

= [0.628568338; 0.712341185 ; 0.805941255]

Table -3 Geometric mean of fuzzy

Factors	Ri		
ENV 1	0.6285683	0.712341	0.805941
ENV 2	0.7212447	0.82615	0.956614
ENV 3	0.7836291	0.94069	1.116196
ENV 4	0.44614	0.541587	0.675249
ENV 5	0.623214	0.726914	0.845094
SOC 1	0.8734657	1.102537	1.358744
SOC 2	1.0777937	1.288137	1.532766
SOC 3	0.6591345	0.759555	0.875624
ECO 1	1.059112	1.228072	1.426804
ECO 2	1.2073319	1.40616	1.641241
ECO 3	0.7142278	0.822001	0.960923
ECO 4	1.1561915	1.390097	1.654573
SUP 1	0.9190699	1.109057	1.345881
SUP 2	1.3175025	1.617223	1.994088
SUP 3	0.9014948	1.10515	1.346009

SUP 4	0.6177996	0.746807	0.908933
LOG 1	0.7024965	0.837562	0.986086
LOG 2	0.6457346	0.74617	0.873983
IT 1	1.5356592	1.726425	1.928195
IT 2	1.1583741	1.397061	1.670085
IT 3	1.0530799	1.233299	1.403683
Total	18.801265	22.26299	26.30671
P(-1)	0.0531879	0.044918	0.038013
INCR	0.0380131	0.111	0.053188

The fuzzy weight is calculated based on the r_i values and shown on Table 4. For example,
$\text{ENV } 1 = [\,(0.628568 * 0.038013);\ (0.71234 * 0.111);\ (0.805941 * 0.053188)] =$
$[0.023893841\ ;\ 0.079069872\ ;\ 0.042866332\ ]$
Finally, the average weight criterion (Mi) and normalized weight criterion (Ni) were calculated and ranked on Table 5 and Table 6.

Risk Factors Ranking for Risk Groups: Based on the Fuzzy AHP Buckley's method, the 6 identified risk groups were organized in a way in a matrix which shows the importance of one individual factor on other 5 factors. The geometric means of fuzzy set for each individual factor were calculated based on the equation 1 and shown on the Table 7. The fuzzy weight is calculated based on the r_i values and shown on Table 8. Finally, the average weight criterion (Mi) and normalized weight criterion (Ni) were calculated and ranked on Table 9 and Table 10.

Table -4 Fuzzy Weight

Factors	**Wi**		
ENV 1	0.0239	0.0791	0.0429
ENV 2	0.0274	0.0917	0.0509
ENV 3	0.0298	0.1044	0.0594
ENV 4	0.017	0.0601	0.0359
ENV 5	0.0237	0.0807	0.0449
SOC 1	0.0332	0.1224	0.0723
SOC 2	0.041	0.143	0.0815
SOC 3	0.0251	0.0843	0.0466
ECO 1	0.0403	0.1363	0.0759
ECO 2	0.0459	0.1561	0.0873
ECO 3	0.0272	0.0912	0.0511
ECO 4	0.044	0.1543	0.088
SUP 1	0.0349	0.1231	0.0716
SUP 2	0.0501	0.1795	0.1061
SUP 3	0.0343	0.1227	0.0716
SUP 4	0.0235	0.0829	0.0483
LOG 1	0.0267	0.093	0.0524
LOG 2	0.0245	0.0828	0.0465
IT 1	0.0584	0.1916	0.1026
IT 2	0.044	0.1551	0.0888
IT 3	0.04	0.1369	0.0747

Table -5 Average weight criterion (Mi) and Normalized weight criterion (Ni)

Factors	**Mi**	**Ni**	**Rank**
ENV 1	0.049	0.03181	20
ENV 2	0.057	0.03708	14
ENV 3	0.065	0.04222	12
ENV 4	0.038	0.02464	21
ENV 5	0.05	0.03257	19
SOC 1	0.076	0.04969	11

SOC 2	0.088	0.0579	6
SOC 3	0.052	0.03401	16
ECO 1	0.084	0.05506	7
ECO 2	0.096	0.06309	3
ECO 3	0.057	0.03697	15
ECO 4	0.095	0.06243	5
SUP 1	0.077	0.05008	9
SUP 2	0.112	0.07321	2
SUP 3	0.076	0.04984	10
SUP 4	0.052	0.03375	17
LOG 1	0.057	0.03754	13
LOG 2	0.051	0.03356	18
IT 1	0.118	0.07689	1
IT 2	0.096	0.0628	4
IT 3	0.084	0.05487	8
Total	**1.528**	**1**	

Table -6 Ranking of the individual risk factors according to N_i value

Risk Code	Individual Risk Factors	Ni Value	Rank
IT 1	Lack of business information	0.07689	1
SUP 2	Insolvency of suppliers	0.07321	2
ECO 2	Increased price of raw materials	0.06309	3
IT 2	Planning and forecasting errors	0.0628	4
ECO 4	Syndicate pricing	0.06243	5
SOC 2	Excessive working time	0.0579	6
ECO 1	Incorrect or faulty claims	0.05506	7
IT 3	Internal system disruptions	0.05487	8
SUP 1	Supplier quality problem	0.05008	9
SUP 3	Delivery delays of supplier	0.04984	10
SOC 1	Wage discriminations	0.04969	11
ENV 3	Working conditions	0.04222	12
LOG 1	Port and border delays	0.03754	13
ENV 2	Natural disasters / demographic changes	0.03708	14
ECO 3	Currency fluctuations / price volatility	0.03697	15
SOC 3	Sexual and religious discrimination of workers	0.03401	16
SUP 4	Material shortages	0.03375	17
LOG 2	Troubling third-party logistics	0.03356	18
ENV 5	Human health of workers	0.03257	19
ENV 1	Air, dust and water pollution	0.03181	20
ENV 4	Factory fire	0.02464	21

Table -7 Geometric mean of fuzzy (Risk groups)

Factors	r_i		
ENV	0.4451519	0.528545	0.661121
SOC	0.7963244	0.955772	1.200937
ECO	1.6983813	2.16839	2.696012
SUP	0.8354359	1.101078	1.414214
LOG	0.5494002	0.653465	0.777228
IT	0.8908987	1.138957	1.418889
Total	5.2155925	6.546207	8.168401
P(-1)	0.1917328	0.15276	0.122423
INCR	0.122423	0.111	0.191733

Table -8 Fuzzy weight (Risk groups)

Factors	w_i		
ENV	0.0545	0.0587	0.1268
SOC	0.0975	0.1061	0.2303
ECO	0.2079	0.2407	0.5169
SUP	0.1023	0.1222	0.2712
LOG	0.0673	0.0725	0.149
IT	0.1091	0.1264	0.272

Table -9 Averaged weight criterion (Mi) and Normalized weight criterion (Ni)

Factors	Mi	Ni	Rank
ENV	0.08	0.08185	6
SOC	0.145	0.148	4
ECO	0.322	0.32939	1
SUP	0.165	0.16909	3
LOG	0.096	0.09853	5
IT	0.169	0.17315	2

Table -10 Ranking of risk groups according to N_i value.

Risk Code	Risk Group	Ni Value	Rank
ECO	Economical Risks	0.07689	1
IT	Information Technology Risks	0.07321	2
SUP	Supplier Risks	0.06309	3
SOC	Social Risks	0.0628	4
LOG	Logistics Risks	0.06243	5
ENV	Environmental Risk	0.0579	6

Analysis of Sustainability Risk Factors

According to the findings, "Increased price of raw materials (ECO 2)" is the most consequential risk factor, with a Ni value of 0.07689. The sustainable supply chain in Bangladesh's apparel industry faces an increased risk of raw materials scarcity and price volatility due to several factors, including climate change, geopolitical tensions, and changing consumer preferences. This threat poses a number of potential problems for a company's supply chain. If supplies of essential materials decrease or their prices rise, manufacturers may need to raise prices to cover the additional expenses. It's possible that this danger will also happen production halts, diminished competitiveness, and further ecological and monetary repercussions.

The second most significant one is "Lack of business information (IT-1)", having Ni value 0.07321. Data flow is one of the most vital element of Supply Chain, which improves the coordination of operations between multiple parties and enables efficient decision-making both internally and externally. However, a lack of adequate information flow can have substantial negative implications on operations and overall success. Distrust and misconceptions between suppliers and customers may affect supply chain performance as a whole if there is a communication breakdown or a lack of information. This can cause delays in manufacturing as well as increased expenses and resource waste. Also Supply chain firms risk legal and financial repercussions if regulatory and compliance obligations are not effectively communicated and tracked.

With a Ni value of 0.06309, "Insolvency of suppliers (SUP-2)" is the third most substantial risk factor. The viability of a supply chain might be seriously jeopardized if there is a threat of insolvency among suppliers. Quality problems, late deliveries, limited capacity, or a shaky financial foundation may all stem from suppliers' insolvency. To maintain a streamlined and effective supply chain, it is crucial that managers be proactive in spotting, preventing, and fixing issues with their suppliers. If a supplier goes insolvent, it might cause a halt in the delivery of materials and services, which can negatively impact both production and customer satisfaction. The financial and environmental sustainability of a supply chain might be jeopardized if it has to spend time and money locating a new source.

Analysis of Sustainability Risk Groups

Economic Group (N_i value = 0.07689)

Sustainability management increases a business's SC costs, so economic permanence is vital. Furthermore, the Bangladeshi clothing business is susceptible to environmental catastrophes as well as a number of hazards for its insufficient infrastructure. When there is a disruption in the supply chain, firms run the danger of experiencing financial issues as they fail to meet client lead times. As one of the requirements for SSCM, Oelze indicated that monetary support is necessary for the adjustment of new qualifications related to social and environmental compatibility. [27]. This study identifies increased price of raw materials, financial crises, syndicate pricing, tax evasion as the most crucial risk factors for financial sustainability barrier.

Information Technology Group (N_i value = 0.07321)

The undisrupted exchange of information between all parties engaged in the supply chain is crucial for retaining a competitive edge in the market. Immediate sales losses, emergency service expenses, data recovery charges, and long-term harm to client relationships are all possible outcomes of such occurrences. The monetary stakes involved in failing information systems call for a tight coupling of risk assessment and cost-benefit evaluation [28].

The term "risks due to lack of information" refers to the potential consequences that may arise from the absence or ineffective transmission of crucial data in the context of supply chain. Inaccurate planning and decision-making, poor quality, higher expenses, interrupted supply chains, and noncompliance with regulations are just some of the challenges that can arise from a lack of knowledge. Information sharing is essential in a highly interdependent and complicated supply chain to maintain effective operations and satisfy consumer needs. Information gaps in the supply chain make it harder for businesses to make educated decisions and respond swiftly to potential threats.

Supplier Group (N_i value = 0.0639)

The textile industry heavily relies on foreign vendors for importing large amounts of raw supplies, apparatus, and other items, making it challenging to meet appropriate lead times and secure sufficient quantities of high-quality raw resources within the required timeframe [29]. Supplier quality problems may disrupt the flow of supply chain, leading to increased costs, decreased competitiveness, and damage to the company's reputation [30]. Suppliers' delivery delays can occur for a variety of reasons, including production problems, logistics issues, and unexpected demand. These delays can result in increased costs, decreased competitiveness. Material shortages on the part of suppliers can result in interruptions and higher prices. Material shortages can be caused by a number of factors, including increasing demand for raw resources, manufacturing concerns, and logistics problems. This research identifies four major risk issues related to suppliers: inadequate communication between suppliers and organizations, subpar product quality, a lack of product safety, and frequent adjustments to the manufacturing procedure. The success of SSCM hinges on the close partnership between the company and its suppliers in today's cutthroat business environment. Lack of communication and cooperation between a company and its vendors can be a major obstacle on the path to sustainability. According to Oelze, effective SC collaboration speeds up the adoption of SCM policies that promote sustainability [27]. The quality of the products produced is crucial to the success of a business since it helps cut down on waste. Our research shows that low-quality products pose a threat to long-term viability.

Social Risk Group (N_i value = 0.0628)

Social Risk group includes various social issues which can have an impact on Supply Chain. Sexual discrimination, excessive working period for the workers, wage discriminations are the factors that are identified in this group. Bangladeshi businesses are slow to address social concerns. Human resource strategies in the business world need to accommodate the growing concern for workers' welfare expressed by both customers and businesses [31]. Despite Bangladesh being the world's second-largest exporter of apparel sector, there have been allegations of unfair wages to workers, particularly women. In addition, long working hours, and claims of workplace violence and discrimination have generated concerns about the treatment of employees in the supply chains of Bangladesh.

Logistics Risk Group (N_i value = 0.06243)

A major influence on SC may be realized if the logistics involved in moving, storing, and handling items are interrupted. Poorly maintained highways and roads in Bangladesh delay the delivery of goods. The Chittagong port is the primary export gateway for Bangladesh, and as a result, it is frequently stressed beyond capacity. This means that industries frequently miss their lead times. High risks to the SC system as a whole should be expected if transportation activities are disrupted or delayed [32].

Environmental Risk Group (N_i value = 0.0579)

The environmental risk group is the final of the five classifications of sustainability risk groups. The absence of environmental safety in the Bangladeshi textile sector was illustrated by the Rana Plaza collapse and the Tazreen Fashions fire catastrophe, both of which occurred in the textile industry. Environmental mishaps, such as industrial fires, are recognized as an SSC risk element in our research; Giannakis and Papadopoulos also highlighted 33 environmental incidents as a sustainability risk factor. These poisonous chemicals from textile manufacturing directly can pollute water, air and soil. Product waste was recognized by Giannakis and Papadopoulos as a source of SSC risk [33].

CONCLUSION

Addressing the issues which can hinder the successful implementation of sustainable supply chain management is significant as apparel sector contributes the majority of the economy. The growth and survival of a business depend on effective supply chain risk management, and more specifically, supply chain risk assessment. Thus, it is crucial for decision-makers in Bangladesh's garment supply chain to prioritize speedy responses to obstacles if they are to achieve their goal of implementing sustainable supply chain methods. The most consequential sustainability risk factors were analysed to better inform the efforts of industrial managers to mitigate them. Additionally, this study can be useful for further research implications to find connections between risk variables and categories.

REFERENCES

[1] P Ahi and C Searcy, A comparative literature analysis of definitions for green and sustainable supply chain management, *Journal of cleaner production*, **2013,** *52*, 329-341.

[2] CR Carter and P Liane Easton, Sustainable supply chain management: evolution and future directions, *International journal of physical distribution & logistics management*, **2011**, *41*(1), 46-62.

[3] M Christopher, *Logistics and supply chain management*. Pearson Uk, **2022**.

[4] DM Lambert, MC Cooper and JD Pagh, Supply chain management: implementation issues and research opportunities, *The international journal of logistics management*, **1998**, *9*(2), 1-20.

[5] MI Rakib, R Saidur, EN Mohamad and AM Afifi, Waste-heat utilization–the sustainable technologies to minimize energy consumption in Bangladesh textile sector, *Journal of cleaner production*, **2017**, *142*, 1867-1876.

[6] CR Carter and DS Rogers, A framework of sustainable supply chain management: moving toward new theory, *International journal of physical distribution & logistics management*, **2008**, *38*(5), 360-387.

[7] C Speier, JM Whipple, DJ Closs and MD Voss, Global supply chain design considerations: Mitigating product safety and security risks, *Journal of operations management*, **2011**, *29*(7-8), 721-736.

[8] G Riglietti, A Avatefipour, and P Trucco, The impact of business continuity management on the components of supply chain resilience: A quantitative analysis. *Journal of business continuity & emergency planning*, **2021**, *15*(2), pp.182-195.

[9] KB Hendricks and VR Singhal, The effect of supply chain glitches on shareholder wealth, *Journal of operations Management*, **2003**, *21*(5), 501-522.

[10] MS Islam and GQ Liang, Supply chain management on apparel order process: a case study in Bangladesh garment industry, *Asian Journal of Business and Management Sciences*, **2012,** *2*(8), 60-72.

[11] MMH Chowdhury, S Rahman, MA Quaddus and Y Shi, Strategies to mitigate barriers to supply chain sustainability: an apparel manufacturing case study, *Journal of Business & Industrial Marketing*, **2023**, *38*(4), 869-885.

[12] M Anner, Squeezing workers' rights in global supply chains: Purchasing practices in the Bangladesh garment export sector in comparative perspective, *Review of international political economy*, **2020**, *27*(2), 320-347.

[13] MMH Chowdhury and MA Quaddus, A multiple objective optimization based QFD approach for efficient resilient strategies to mitigate supply chain vulnerabilities: The case of garment industry of Bangladesh, *Omega The International Journal of Management Science*, **2015,** *57*, 5-21.

[14] MSF Soberi and R Ahmad, Application of fuzzy AHP for setup reduction in manufacturing industry, *Journal of Engineering Research and Education*, **2016**, *8*, 73-84.

[15] R Steurer and ME Langer and A Konrad and A Martinuzzi, Corporations, stakeholders and sustainable development I: a theoretical exploration of business–society relations, *Journal of business ethics*, **2005**, *61*, 263-281.

[16] M Pagell and Z Wu, Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars, *Journal of supply chain management*, **2009**, *45*(2), 37-56.

[17] M Christopher and H Lee, Mitigating supply chain risk through improved confidence, *International journal of physical distribution & logistics management*, **2004**, *34*(5), 388-396.

[18] U Juettner, K Windler, A Podleisek, M Gander, and S Meldau, (2020). Implementing supplier management strategies for supply chain sustainability risks in multinational companies. *The TQM Journal*. **2020,** *32*(5), 923-938.

[19] M Kruse-Plass and F Hofmann and U Kuhn and M Otto and U Schlechtriemen and B Schröder and R Vögel and W Wosniok, Reply to the EFSA (2016) on the relevance of recent publications (Hofmann et al. 2014, 2016) on environmental risk assessment and management of Bt-maize events (MON810, Bt11 and 1507), *Environmental Sciences Europe*, **2017**, *29*(1), 1-12.

[20] N Ahmad and J Hossen and SM Ali, Improvement of overall equipment efficiency of ring frame through total productive maintenance: a textile case, *The international journal of advanced manufacturing technology*, **2018**, *94*, 239-256.
[21] IJ Antara, M Sultan, *The Daily Star*, Web. https://www.thedailystar.net/opinion/views/news/let-not-rana-plaza-fade-public-memory-3374061, **2023**.
[22] M Ali and SM Rahman and GF Frederico, Capability components of supply chain resilience for readymade garments (RMG) sector in Bangladesh during COVID-19, *Modern Supply Chain Research and Applications*, **2021**, *3*(2), 127-144.
[23] M Nazma, M Rahman and UK Dey, Comparative Analysis of AHP and Fuzzy-AHP in Supplier Selection: A Case Study on a Cement Industry. *International Conference on Mechanical, Industrial and Energy Engineering*, **2014**
[24] MB Ayhan, A fuzzy AHP approach for supplier selection problem: A case study in a Gear motor company, *International Journal of Managing Value and Supply Chains (IJMVSC)*, **2013,** 4(3).
[25] A Radionovs and O Uzhga-Rebrov, "Comparison of different fuzzy ahp methodologies in risk assessment." *ENVIRONMENT. TECHNOLOGIES. RESOURCES. Proceedings of the International Scientific and Practical Conference*. **2017**, *2*, 137-142
[26] LA Zadeh, Fuzzy sets, *Information and control*, **1965**, *8*(3), 338-353.
[27] N Oelze, Sustainable supply chain management implementation–enablers and barriers in the textile industry, *Sustainability*, **2017**, 9(8), 1435.
[28] S Maguire, Identifying risks during information system development: managing the process, *Information Management & Computer Security*, **2002**, *10*(3), 126-134.
[29] P Raj Sinha and LE Whitman and D Malzahn, Methodology to mitigate supplier risk in an aerospace supply chain, *Supply Chain Management: an international journal*, **2004**, *9*(2), 154-168.
[30] W Ho and T Zheng and H Yildiz and S Talluri, Supply chain risk management: a literature review, *International journal of production research*, **2015,** *53*(16), 5031-5069.
[31] RD Klassen and A Vereecke, Social issues in supply chains: Capabilities link responsibility, risk (opportunity), and performance, *International Journal of production economics*, **2012**, *140*(1), 103-115.
[32] R Rathore and JJ Thakkar and JK Jha, A quantitative risk assessment methodology and evaluation of food supply chain, *The International Journal of Logistics Management*, **2017**, *28*(4), 1272-1293.
[33] M Giannakis and T Papadopoulos, Supply chain sustainability: A risk management approach, *International Journal of Production Economics*, **2016,** *171*, 455-470.