Proceedings of 8th International Conference on Mechanical, Industrial and Energy Engineering 2024
02-04 January, 2025, Khulna, BANGLADESH
SciEn Conference Series: Engineering Vol. 3, 2025, pp 248-253 https://doi.org/10.38032/scse.2025.3.67

Analyzing the Barriers of Green Supply Chain Management of RMG Industry in Bangladesh Using DEMATEL Method

Sayed Fahmid Islam[1], Md. Golam Kibria[1], Hisham Uz Zaman[1], Md. Julkor Nayin[2]

[1]Department of Industrial Engineering and Management, Khulna University of Engineering and Technology, Khulna, Bangladesh
[2]Department of Chemical Engineering, Rajshahi University of Engineering and Technology, Rajshahi, Bangladesh

ABSTRACT
Millions of Bangladeshis work in the ready-to-wear industry, which is important to the country's economy. There are so many barriers in RMG (readymade garment) sectors for implementing green supply chain in Bangladesh. The study aims for analyzing the barriers of green supply chain management in RMG industries in Bangladesh. The use of environmentally sustainable methods in supply chain management procedures is referred to as "green supply chain management" (GSCM). Every stage of the supply chain, from the procurement of raw materials to the last point at which goods or services are delivered to clients, must be taken into account for its potential influence on the environment. A research methodology "DEMATEL MCDM" method is used in the study. Expert opinions are taken at first from those who are experienced at textile industries. Then among twenty-six barriers, total twelve barriers are selected as the major barriers. The barriers are prioritized and the main causes as well as effects of the barriers are also evaluated. Higher weight of the barrier indicates higher impacts on RMG industries. Total interrelation among the barriers are also described in a diagram. After the study, the seventh barrier "insufficient technology and infrastructure" is found to be the most inter related barriers. It has the most significant impact on other barriers as well as on the total RMG industries. On the other hand, Lack of green materials, process and technology (LGM), Lack of training courses and institutions to train specific personnel are the least impactful barriers for RMG sectors in Bangladesh. Casual relations among the barriers are also described graphically. Some limitations and future scopes are found in this study which are described briefly also.

Keywords: DEMATEL, MCDM, Green Supply Chain, RMG Industry, Bangladesh

1. Introduction

The textile and apparel industry pollutes the environment and consumes a lot of energy, water, and other natural resources. 200 gallons of water are needed to produce 1 kg of textiles. Scouring, bleaching, dyeing, finishing, and printing are all examples of wet processing of textiles, which often utilizes a lot of water and results in effluents that are eventually discharged into rivers or other bodies of water. These chemical processing facilities frequently produce brightly colored, compound-filled effluent. Therefore, before being released into the environment, wastewater must receive adequate treatment. Organic pollutants, dyestuffs, and acidic and alkaline pollutants present in textile effluents all have negative effects. Over 750 dyeing and printing factories in and around Tirupur, India, were ordered to close by the Madras High Court in 2010 due to noncompliance with the zero liquid discharge (ZLD) requirements [1-3].

Therefore, it is crucial to create a textile supply chain that complies with ecological requirements. It has the least detrimental effects on the environment and utilizes the fewest resources. The lack of consumer understanding of the green textile supply chain is a barrier to the growth of the market for green textile products. When strict environmental requirements are not put into place, top management typically shows reluctance to show their dedication to environmentally friendly supply chain design and management [4,5].

2. Methodology

2.1. Create the "A" matrix of average direct relationships

We use professional assessments of the interconnected relationships between the barriers to construct the direct-relation matrix A. This direct-relationship matrix takes into account how one barrier affects the other barriers found in a study. Let's say our system has a number of barriers in it $B = \{B_1, B_2, B_3\ldots\ldots B_n\}$. A mathematical relation t_{ij} is introduced to determine their pairwise comparison. Here $i, j \in \{1,2,3,(n-1),n\}$ .Here n is the quantity of barriers in this work. t_{ij} determines the wight at which B_i affects B_j. All diagonal element of the matrix will be summed zero.

$$A = \begin{array}{c} \\ B_1 \\ B_2 \\ \vdots \\ B_{n-1} \\ B_n \end{array} \begin{array}{c} \begin{array}{ccccc} B_1 & B_2 & \cdots & B_{n-1} & B_n \end{array} \\ \begin{bmatrix} 0 & b_{12} & \cdots & b_{1(n-1)} & b_{1n} \\ b_{21} & 0 & \cdots & b_{2(n-1)} & b_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ b_{(n-1)1} & b_{(n-1)2} & \cdots & 0 & b_{(n-1)n} \\ b_{n1} & b_{n2} & \cdots & b_{n(n-1)} & 0 \end{bmatrix} \end{array}$$

2.2. Normalized direct-relation matrix "N"

Through (1) and (2), we can determine the individual direct-relation matrix A for each expert, which is the basis for the normalized direct-relation matrix N[6]. We make sure that every element's value in this matrix is between 0 and 1.

$M = K.A$

*Corresponding Author Email Address: jnsaad5@gmail.com Published By: SciEn Publishing Group

$$K = \min\left\{\frac{1}{\max_{1\leqslant i\leqslant n}\sum_{j=1}^{n}|b_{ij}|}, \frac{1}{\max_{1\leqslant j\leqslant n}\sum_{i=1}^{n}|b_{ij}|}\right\}$$

in which i, j ∈ 1,2,. . ..(n-1),n},n denotes the number of the barriers, respectively.

2.3. Calculation to find total direct-relation matrix "T"

After creating the normalized direct-relation matrix N, we use (3) to get the total-relation matrix T. The identity matrix is indicated by the letter I [7].

$$T = N + N^2 + N^3 + \cdots = \sum_{i=1}^{\infty} N^i = N\cdot(1 - N)^{-1}$$

2.4. Create groups for the dispatcher and receiver

As shown in (4) and (5), we define a degree of influence and a degree of relationship with others using the values of (R+C) and (R-C), where C is the sum of columns in matrix T and R is the sum of rows[8]. Dispatchers are barriers with high R+C values because they have a greater impact on other people and are given more importance. The barriers with negative values of (R-C) are referred to as receivers because they are more susceptible to external impact and are given lesser priority. On the other hand, the value of R+C reveals the strength of the connection between each barrier. Accordingly, all such barriers with higher (R+C) values have a stronger relationship with one another, whereas those with lower (R-C) values have a weaker link with others [9].

$T = [t_{i,j}]_{n*n}$, (4)

i ,j ∈ {1,2,3,. …,(n-1,n} , 'n' denotes the quantity of barriers in the work.

$$T = \begin{array}{c c} & \begin{array}{ccccc} B_1 & B_2 & \cdots & B_{n-1} & B_n \end{array} \\ \begin{array}{c} B_1 \\ B_2 \\ \vdots \\ B_{n-1} \\ B_n \end{array} & \left[\begin{array}{ccccc} 0 & t_{12} & \cdots & t_{1(n-1)} & t_{1n} \\ t_{21} & 0 & \cdots & t_{2(n-1)} & t_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ t_{(n-1)1} & t_{(n-1)2} & \cdots & 0 & t_{(n-1)n} \\ t_{n1} & t_{n2} & \cdots & t_{n(n-1)} & 0 \end{array}\right] \end{array}$$

2.5. Determine the threshold value, get the causality map, and order the obstacles

The decision-maker must determine a threshold for the influence level and acquire a suitable causal map. Different approaches to setting the threshold value have been put forth by researchers in the past. that most common ones are :

(i) through discussion with experts

(ii) averaging the values of the total-relation matrix T

(iii) adding one standard deviation to the mean

(iv) adding two standard deviations to the

(v) applying the maximum mean de-entropy algorithm [10,11].

In this study, the threshold was determined to be the average of the elements of the total-relation matrix T, which is provided by (6).

$$\alpha = \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} t_{i,j} \qquad (6)$$

Then we take into account the elements whose influence level in the overall relationship matrix T is higher than the threshold and turn them into the causality map, also known as the impact digraph. Plotting (R+C,R-C)—where (R+C) stands for the horizontal axis and (R-C) for the vertical axis—allows us to create an impact-digraph map. Last but not least, we order the barriers according to their "degree of prominence" among themselves, as shown by (7), or the absolute value of (R+C).

$r(B_k)$ = order $\{B_k\}_{(R+C)}$,

k ∈ {1,2,3. ….,(n-1), n}', n'' denoted the number of barriers, (7)

Additionally, we can order the obstacles according to the "degree of relationship" between them, as shown by (8), or the absolute value of (R-C).

$r(B_k)$ = order $\{B_k\}_{(R-C)}$,

k ∈ {1,2,3. ….,(n-1), n}', n'' denoted the number of barriers.

2.6. Proposed framework

The suggested framework consists of a number of steps that is demonstrated in Fig 1.. With the aid of literature research and a pilot conversation with a group of specialists, the initial step entails choosing barriers and categorizing them into different categories (or matrices) in accordance with primary themes. The dissemination of questionnaires to all subject-area specialists constitutes the second phase. The third phase entails gathering feedback and creating the final direct-relationship matrix for every assessor. The fourth phase entails using the DEMATEL approach and analyzing the results. In order to ascertain the significance and causality of the barriers, it develops the final ranking and dependency map. Verifying the results that have been acquired and, if necessary, reviewing the literature that has already been published make up the fifth phase. If there are noticeable variations, the experts are informed, and their opinions are once again gathered. The third step includes managerial suggestions and implications for getting rid of those obstacles [12].

2.7. Application of the suggested framework

2.7.1. Collecting Experts opinion

Experts opinion were collected based on a structured questionnaire consisting to 17 questions. questions are listed below:

1.What is your field of expertise?
2.How many years have you been working in your field?
3.How much the barrier "Lack of collaboration among supply chain partners" influences over the barrier "Lack of interest and effective efforts of stakeholders"?
4.How much the barrier "Lack of collaboration among supply chain partners" influences over the barrier "Lack of top management commitment"?
5.How much the barrier "Lack of collaboration among supply chain partners" influences over the barrier "Lack of IT implementation for communication and coordination"?
6.How much the barrier "Lack of collaboration among supply chain partners" influences over the barrier "Low demand for green textile products and uncertainty of demand"?
7.How much the barrier "Lack of interest and effective efforts of stakeholders" influences over the barrier "Lack of collaboration among supply chain partners "?
8.How much the barrier "Lack of interest and effective efforts of stakeholders" influences over the barrier "Insufficient technology and infrastructure"?

9.How much the barrier “Lack of interest and effective efforts of stakeholders” influences over the barrier “Financial constraints”?
10.How much the barrier “Lack of interest and effective efforts of stakeholders” influences over the barrier “Restrictive company policies to change”?
11.How much the barrier “Lack of interest and effective efforts of stakeholders” influences over the barrier " Market competition and uncertainty of demand (MCU)"?
12.How much the barrier “Lack of interest and effective efforts of stakeholders” influences over the barrier “Absence of integrated policies”?
13.How much the barrier “Lack of top management commitment” influences over the barrier “Lack of interest and effective efforts of stakeholders”?
14.How much the barrier “Lack of top management commitment” influences over the barrier “Lack of IT implementation for communication and coordination”?
15.How much the barrier “Lack of top management commitment” influences over the barrier “Low demand for green textile products and uncertainty of demand”?
16.How much the barrier “Lack of top management commitment” influences over the barrier “Insufficient technology and infrastructure”?
17.How much the barrier “Lack of top management commitment” influences over the barrier “Lack of flexibility to switch over to green system (FSG)”?

Based on the expert’s opinion through the questionnaires, total twelve barriers are selected prioritized among the twenty six barriers for the study.

Table 1. Barriers of Green Supply Chain in RMG industries

Barrier No.	Selected barriers	Symbols
1)	Lack of collaboration among supply chain partners due to complex supply chain.	B1
2)	Lack of interest and effective efforts of stakeholders	B2
3)	Unskilled workforce	B3
4)	Organizational culture resistance to change	B4
5)	Lack of IT implementation for communication and coordination	B5
6)	Low demand for green textile products from customers due to lack of awareness	B6
7)	Insufficient technology and infrastructure	B7
8)	Financial constraints	B8
9)	Lack of training courses and institutions to train specific personnel	B9
10)	Lack of green materials, process and technology (LGM)	B10
11)	Lack of flexibility to switch over to green system (FSG)	B11
12)	Market competition and uncertainty of demand (MCU)	B12

Table 2. Influence level for experts’ opinion

Linguistic term	Influence rate
No influence	0
Low influence	1
Medium influence	2
High influence	3

Table 3. Expert opinion-1

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	1	2	0	1	2	1	2	0	2	3	1
B2	3	0	3	1	1	1	2	1	1	2	2	2
B3	1	2	0	2	0	2	1	0	3	2	3	1
B4	1	1	1	0	1	3	1	3	2	1	2	2
B5	2	2	3	2	0	2	2	1	3	1	2	1
B6	1	1	1	3	3	0	1	2	1	2	2	1
B7	3	2	2	3	2	3	0	3	3	3	3	2
B8	2	3	3	2	1	2	2	0	1	2	2	3
B9	3	2	2	3	3	2	3	1	0	1	1	2
B10	1	1	1	2	2	3	2	3	1	0	2	1
B11	3	2	2	1	3	1	3	2	2	2	0	1
B12	2	0	2	3	2	2	1	1	3	0	1	0

Table 4. Expert opinion-2

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	1	2	2	1	2	1	2	2	1	3	2
B2	2	0	3	2	1	2	2	3	2	3	2	1
B3	1	1	0	3	3	1	1	0	1	1	2	1
B4	3	2	3	0	2	3	0	2	3	2	2	2
B5	2	3	1	2	0	2	2	1	2	2	3	2
B6	3	2	2	1	3	0	2	1	0	1	2	3
B7	2	3	2	3	2	3	0	3	2	3	3	3
B8	3	2	3	1	2	2	2	0	2	1	2	1
B9	2	0	2	3	3	1	1	2	0	2	1	1
B10	0	1	2	0	1	1	2	2	2	0	3	2
B11	2	1	3	1	2	0	2	1	2	2	0	2
B12	1	2	0	2	1	2	1	1	3	2	3	0

Table 5. Expert opinion-3

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	1	2	1	2	1	1	2	1	1	2	1
B2	2	0	3	3	1	3	1	3	3	3	3	2
B3	2	3	0	2	1	2	2	2	2	2	3	3
B4	3	2	2	0	3	2	2	1	3	1	1	2
B5	2	1	1	3	0	3	1	2	1	2	2	2
B6	3	2	2	1	3	0	3	2	2	2	2	3
B7	2	3	1	3	2	3	0	3	2	3	2	3
B8	2	2	3	2	2	1	2	0	3	2	2	1
B9	2	1	2	3	3	2	1	1	0	1	1	2
B10	0	1	2	0	1	1	2	2	2	0	3	1
B11	3	1	3	1	2	2	2	1	2	2	0	3
B12	1	2	1	2	0	2	1	2	3	2	3	0

Table 6. Expert opinion-4

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	2	1	3	2	1	0	2	2	2	1	2
B2	2	0	3	2	1	2	2	1	3	2	3	3
B3	3	2	0	3	3	2	2	1	1	1	1	3
B4	1	2	3	0	2	1	1	3	1	2	1	2
B5	2	1	2	3	0	1	2	2	1	3	2	1
B6	2	1	3	1	1	0	2	1	1	2	3	2
B7	1	2	3	2	3	2	0	3	2	3	3	3
B8	1	1	1	1	1	3	1	0	2	1	2	2
B9	2	3	3	2	2	1	2	3	0	3	2	1
B10	3	2	2	1	3	1	3	2	2	0	2	1
B11	2	1	2	3	2	2	1	3	2	1	0	2
B12	1	1	0	2	3	0	2	2	1	0	2	0

Table 7. Expert Opinion-5

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	2	3	1	1	0	2	1	1	2	2	2
B2	1	0	1	2	0	2	1	2	3	2	1	1
B3	2	1	0	2	1	3	1	1	2	1	2	2
B4	2	2	1	0	1	1	2	3	1	3	1	1
B5	2	1	3	2	0	2	1	0	1	0	2	3
B6	1	3	2	3	2	0	3	3	1	3	2	2
B7	3	3	2	2	3	2	0	2	3	2	3	2
B8	2	0	2	3	2	2	1	0	3	0	1	1
B9	2	2	3	2	1	2	2	1	0	2	3	2
B10	3	2	2	3	3	2	2	0	2	0	1	3
B11	2	3	1	2	1	3	1	1	2	2	0	1
B12	1	2	2	3	2	2	0	2	1	1	2	0

Table 8. Expert Opinion-6

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	3	2	2	1	1	2	2	2	1	2	1
B2	1	0	1	3	2	2	1	2	1	2	2	1
B3	2	2	0	1	3	3	1	3	2	3	2	2
B4	2	3	3	0	1	2	3	2	3	2	3	2
B5	3	2	1	3	0	2	1	1	2	1	2	1
B6	3	1	3	1	1	0	2	1	2	2	3	2
B7	2	2	3	3	2	3	0	3	2	2	3	2
B8	1	1	1	1	1	3	1	0	2	1	3	1
B9	1	3	2	3	2	3	2	3	0	3	2	2
B10	0	1	2	0	1	0	2	2	1	0	3	1
B11	2	1	2	2	3	2	1	0	1	1	0	2
B12	3	2	1	1	2	1	2	1	2	2	1	0

Table 9. Expert Opinion-7

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0	1	1	2	3	1	2	2	1	2	2	1
B2	2	0	2	1	2	2	1	3	2	1	2	2
B3	2	3	0	2	1	2	2	2	3	2	2	3
B4	3	2	2	0	3	2	2	1	2	1	1	2
B5	1	2	3	2	0	3	2	3	1	3	2	1
B6	2	3	2	1	3	0	3	2	2	2	1	2
B7	2	3	2	3	3	3	0	2	3	2	2	3
B8	1	2	1	2	1	2	2	0	2	2	3	1
B9	3	2	2	1	2	1	3	1	0	2	2	3
B10	1	1	2	2	1	2	1	1	3	0	3	2
B11	2	2	1	3	1	2	3	2	2	1	0	2
B12	3	1	2	1	2	1	2	1	1	2	2	0

2.7.2. Creating average matrix

The average matrix is the average of all the seven matrix of expert's opinion described above. The calculation can be done in MS-excel or with the help of a programming language named python.

Table 10. Average matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	SUM
B1	0.000	1.571	1.857	1.571	1.571	1.143	1.286	1.857	1.286	1.571	2.143	1.429	17.286
B2	1.857	0.000	2.286	2.000	1.143	2.000	1.429	2.143	2.143	2.143	2.143	1.714	21.000
B3	1.857	2.000	0.000	2.143	1.714	2.143	1.429	1.286	2.000	1.714	2.143	2.143	20.571
B4	2.143	2.000	2.143	0.000	1.857	2.000	1.571	2.143	2.143	1.714	1.571	1.857	21.143
B5	2.000	1.714	2.000	2.429	0.000	2.143	1.571	1.429	1.571	1.714	2.143	1.571	20.286
B6	2.143	1.857	2.143	1.571	2.286	0.000	2.286	1.714	1.286	2.000	2.143	2.143	21.571
B7	2.143	2.571	2.143	2.714	2.429	2.714	0.000	2.714	2.429	2.571	2.714	2.571	27.714
B8	1.714	1.571	2.000	1.714	1.429	2.143	1.571	0.000	2.143	1.286	2.143	1.429	19.143
B9	2.143	1.857	2.286	2.429	2.286	1.714	2.000	1.714	0.000	2.000	1.714	1.857	22.000
B10	1.143	1.286	1.857	1.143	1.714	1.429	2.000	1.714	1.857	0.000	2.429	1.571	18.143
B11	2.286	1.571	2.000	1.857	2.000	1.714	1.857	1.429	1.857	1.571	0.000	1.857	20.000
B12	1.714	1.429	1.143	2.000	1.714	1.429	1.286	1.429	2.000	1.286	2.000	0.000	17.429
SUM	21.143	19.429	21.857	21.571	20.143	20.571	18.286	19.571	20.714	19.571	23.286	20.143	

2.7.3. Creating direct relation matrix (D)

Table 11. Initial direct relation matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0.000	0.057	0.067	0.057	0.057	0.041	0.046	0.067	0.046	0.057	0.077	0.052
B2	0.067	0.000	0.082	0.072	0.041	0.072	0.052	0.077	0.077	0.077	0.077	0.062
B3	0.067	0.072	0.000	0.077	0.062	0.077	0.052	0.046	0.072	0.062	0.077	0.077
B4	0.077	0.072	0.077	0.000	0.067	0.072	0.057	0.077	0.077	0.062	0.057	0.067
B5	0.072	0.062	0.072	0.088	0.000	0.077	0.057	0.052	0.057	0.062	0.077	0.057
B6	0.077	0.067	0.077	0.057	0.082	0.000	0.082	0.062	0.046	0.072	0.077	0.077
B7	0.077	0.093	0.077	0.098	0.088	0.098	0.000	0.098	0.088	0.093	0.098	0.093
B8	0.062	0.057	0.072	0.062	0.052	0.077	0.057	0.000	0.077	0.046	0.077	0.052
B9	0.077	0.067	0.082	0.088	0.082	0.062	0.072	0.062	0.000	0.072	0.062	0.067
B10	0.041	0.046	0.067	0.041	0.062	0.052	0.072	0.062	0.067	0.000	0.088	0.057
B11	0.082	0.057	0.072	0.067	0.072	0.062	0.067	0.052	0.067	0.057	0.000	0.067
B12	0.062	0.052	0.041	0.072	0.062	0.052	0.046	0.052	0.072	0.046	0.072	0.000

2.7.3. Creating total relation matrix (T)

Table 12. Initial direct relation matrix

	B1	B2		B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	1	0		0	0	0	0	0	0	0	0	0	0
B2	0	1		0	0	0	0	0	0	0	0	0	0
B3	0	0		1	0	0	0	0	0	0	0	0	0
B4	0	0		0	1	0	0	0	0	0	0	0	0
B5	0	0		0	0	1	0	0	0	0	0	0	0
B6	0	0		0	0	0	1	0	0	0	0	0	0
B7	0	0		0	0	0	0	1	0	0	0	0	0
B8	0	0		0	0	0	0	0	1	0	0	0	0
B9	0	0		0	0	0	0	0	0	1	0	0	0
B10	0	0		0	0	0	0	0	0	0	1	0	0
B11	0	0		0	0	0	0	0	0	0	0	1	0
B12	0	0		0	0	0	0	0	0	0	0	0	1

Table 13. (I-D) Matrix formation

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	1.000	-0.057	-0.067	-0.057	-0.057	-0.041	-0.046	-0.067	-0.046	-0.057	-0.077	-0.052
B2	-0.067	1.000	-0.082	-0.072	-0.041	-0.072	-0.052	-0.077	-0.077	-0.077	-0.077	-0.062
B3	-0.067	-0.072	1.000	-0.077	-0.062	-0.077	-0.052	-0.046	-0.072	-0.062	-0.077	-0.077
B4	-0.077	-0.072	-0.077	1.000	-0.067	-0.072	-0.057	-0.077	-0.077	-0.062	-0.057	-0.067
B5	-0.072	-0.062	-0.072	-0.088	1.000	-0.077	-0.057	-0.052	-0.057	-0.062	-0.077	-0.057
B6	-0.077	-0.067	-0.077	-0.057	-0.082	1.000	-0.082	-0.062	-0.046	-0.072	-0.077	-0.077
B7	-0.077	-0.093	-0.077	-0.098	-0.088	-0.098	1.000	-0.098	-0.088	-0.093	-0.098	-0.093
B8	-0.062	-0.057	-0.072	-0.062	-0.052	-0.077	-0.057	1.000	-0.077	-0.046	-0.077	-0.052
B9	-0.077	-0.067	-0.082	-0.088	-0.082	-0.062	-0.072	-0.062	1.000	-0.072	-0.062	-0.067
B10	-0.041	-0.046	-0.067	-0.041	-0.062	-0.052	-0.072	-0.062	-0.067	1.000	-0.088	-0.057
B11	-0.082	-0.057	-0.072	-0.067	-0.072	-0.062	-0.067	-0.052	-0.067	-0.057	1.000	-0.067
B12	-0.062	-0.052	-0.041	-0.072	-0.062	-0.052	-0.046	-0.052	-0.072	-0.046	-0.072	1.000

Inverse matrix of (I-D) matrix formation

Table 14. (I-D)^-1 matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	1.155	0.197	0.222	0.212	0.202	0.190	0.179	0.206	0.196	0.197	0.240	0.195
B2	0.249	1.171	0.267	0.256	0.218	0.247	0.212	0.244	0.253	0.244	0.274	0.234
B3	0.246	0.236	1.188	0.257	0.233	0.248	0.209	0.213	0.245	0.228	0.270	0.244
B4	0.257	0.239	0.263	1.189	0.240	0.247	0.216	0.243	0.253	0.230	0.256	0.229
B5	0.249	0.226	0.254	0.265	1.173	0.247	0.212	0.217	0.231	0.226	0.269	0.225
B6	0.263	0.240	0.268	0.249	0.259	1.186	0.243	0.236	0.231	0.245	0.281	0.253
B7	0.314	0.309	0.321	0.336	0.313	0.325	1.212	0.314	0.318	0.310	0.354	0.314
B8	0.231	0.213	0.245	0.234	0.215	0.239	0.205	1.159	0.240	0.204	0.259	0.212
B9	0.267	0.244	0.277	0.280	0.263	0.248	0.238	0.240	1.191	0.248	0.271	0.247
B10	0.205	0.196	0.232	0.208	0.216	0.210	0.211	0.210	0.224	1.152	0.261	0.210
B11	0.255	0.219	0.251	0.245	0.238	0.232	0.219	0.215	0.237	0.220	1.195	0.232
B12	0.216	0.194	0.201	0.227	0.208	0.201	0.181	0.195	0.220	0.189	0.237	1.147

2.7.3. Evaluating Cause-effect diagram from Ri-Ci table

Table 15. Cost effect table

Ri	Ci	(Ri +Ci)	(Ri-Ci)	Decision
0.128333084	0.193	0.322	-0.065	Effect
0.18784481	0.164	0.352	0.024	Cause
0.179238399	0.204	0.383	-0.024	Effect
0.186016791	0.201	0.387	-0.015	Effect
0.176503568	0.176	0.352	0.001	Cause
0.196829333	0.183	0.380	0.014	Cause
0.321186065	0.141	0.463	0.180	Cause
0.158630883	0.167	0.325	-0.008	Effect
0.204642253	0.183	0.387	0.022	Cause
0.143797064	0.167	0.311	-0.024	Effect
0.169160505	0.229	0.398	-0.060	Effect
0.131495283	0.175	0.307	-0.044	Effect

2.7.4. Creating total relation matrix (T)

Table 16. Total relation matrix (T) formation

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	Ri
B1	0.000	0.011	0.015	0.012	0.011	0.008	0.008	0.014	0.009	0.011	0.019	0.010	0.128
B2	0.017	0.000	0.022	0.018	0.009	0.018	0.011	0.019	0.020	0.019	0.021	0.014	0.188
B3	0.016	0.017	0.000	0.020	0.014	0.019	0.011	0.010	0.018	0.014	0.021	0.019	0.179
B4	0.020	0.017	0.020	0.000	0.016	0.018	0.012	0.019	0.020	0.014	0.015	0.015	0.186
B5	0.018	0.014	0.018	0.023	0.000	0.019	0.012	0.011	0.013	0.014	0.021	0.013	0.177
B6	0.020	0.016	0.021	0.014	0.021	0.000	0.020	0.015	0.011	0.018	0.022	0.020	0.197
B7	0.024	0.029	0.025	0.033	0.027	0.032	0.000	0.031	0.028	0.029	0.035	0.029	0.321
B8	0.014	0.012	0.018	0.014	0.011	0.018	0.012	0.000	0.019	0.009	0.020	0.011	0.159
B9	0.021	0.016	0.023	0.025	0.022	0.015	0.017	0.015	0.000	0.018	0.017	0.017	0.205
B10	0.008	0.009	0.016	0.009	0.013	0.011	0.015	0.013	0.015	0.000	0.023	0.012	0.144
B11	0.021	0.012	0.018	0.016	0.017	0.014	0.015	0.011	0.016	0.012	0.000	0.016	0.169
B12	0.013	0.010	0.008	0.016	0.013	0.010	0.008	0.010	0.016	0.009	0.017	0.000	0.131
Ci	0.193	0.164	0.204	0.201	0.176	0.183	0.141	0.167	0.183	0.167	0.229	0.175	

2.7.5. Creating inter-relationship model among the barriers

Table 17: Table for threshold (alpha) value

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	0.000	0.011	0.015	0.012	0.011	0.008	0.008	0.014	0.009	0.011	**0.019**	0.010
B2	**0.017**	0.000	**0.022**	**0.018**	0.009	**0.018**	0.011	**0.019**	**0.020**	**0.019**	**0.021**	0.014
B3	**0.016**	**0.017**	0.000	**0.020**	0.014	**0.019**	0.011	0.010	**0.018**	0.014	**0.021**	**0.019**
B4	**0.020**	**0.017**	**0.020**	0.000	**0.016**	**0.018**	0.012	**0.019**	**0.020**	0.014	0.015	0.015
B5	**0.018**	0.014	**0.018**	**0.023**	0.000	**0.019**	**0.012**	0.011	0.013	0.014	**0.021**	0.013
B6	**0.020**	**0.016**	**0.021**	0.014	**0.021**	0.000	**0.020**	0.015	0.011	**0.018**	**0.022**	**0.020**
B7	**0.024**	**0.029**	**0.025**	**0.033**	**0.027**	**0.032**	0.000	**0.031**	**0.028**	**0.029**	**0.035**	**0.029**
B8	0.014	0.012	**0.018**	0.014	0.011	**0.018**	0.012	0.000	**0.019**	0.009	**0.020**	0.011
B9	**0.021**	**0.016**	**0.023**	**0.025**	**0.022**	0.015	**0.017**	0.015	0.000	**0.018**	**0.017**	**0.017**
B10	0.008	0.009	**0.016**	0.009	0.013	0.011	0.015	0.013	0.015	0.000	**0.023**	0.012
B11	**0.021**	0.012	0.018	**0.016**	**0.017**	0.014	0.015	0.011	**0.016**	0.012	0.000	**0.016**
B12	0.013	0.010	0.008	**0.016**	0.013	0.010	0.008	0.010	**0.016**	0.009	**0.017**	0.000

Threshold value= 0.015644

3. Result & Discussion

Table 18. Ranking of barriers

Barriers No.	Value of (Ri + Ci)	Ranking
B1	0.322	10
B2	0.352	7
B3	0.383	5
B4	0.387	3
B5	0.352	8
B6	0.380	6
B7	0.463	1
B8	0.325	9
B9	0.387	4
B10	0.311	11
B11	0.398	2
B12	0.307	12

Table19: Table to evaluate cause & effect

Barriers	(Ri – Ci)	Decision
B1	-0.065	Effect
B2	0.024	Cause
B3	-0.024	Effect
B4	-0.015	Effect
B5	0.001	Cause
B6	0.014	Cause
B7	0.180	Cause
B8	-0.008	Effect
B9	0.022	Cause
B10	-0.024	Effect
B11	-0.060	Effect
B12	-0.044	Effect

Table 20. Interrelationship among the barriers

Barriers	Interrelated with the barriers
B1	B11
B2	B1,B3,B4,B6,B8,B9,B10,B11
B3	B1,B2,B4B,B6,B9,B11,B12
B4	B1,B2,B3,B5,B7,B8,B9
B5	B1,B3,B4,B6,B7,B11
B6	B1,B2,B3,B5,B7,B10,B11,B12
B7	B1,B2,B3,B4,B5,B6,B8,B9,B10,B11,B12
B8	B3,B6,B9,B11
B9	B1,B2,B3,B4,B5,B7,B10,B11,B12
B10	B3,B11
B11	B1,B4,B5,B9,B12
B12	B4,B9,B11

According to table 20, figure 4 and figure 5, barrier 7 “insufficient technology and infrastructure” has the highest relationship with other barriers. Barrier B1 has the least interrelation with other barriers. For that reason, barrier 7 is the major problems for RMG sectors in Bangladesh.

For a third world country like Bangladesh where green supply chain is yet to be a familiar technology, the top management considers insufficient technology and infrastructure is the major barrier. To reduce this barrier, awareness about the technology and government support will play a great role. Another way to reduce the maintenance cost is to collaborate with other countries and foreign companies who are more expert in green supply chain management. Efficient training to the workers and Government’s initiative to adopt green supply chain management in RMG sectors of our country will make this process more popular.

4. Conclusion

The goal of this study was to identify the most significant barriers to the implementation of a green supply chain within the Bangladeshi RMG industry, as well as to raise awareness among textile professionals in developing nations like Bangladesh about the potential significance of doing so. The relevant barriers to implementing green supply chain management in RMG industries in Bangladesh were identified according to expert’s opinion. The major barriers were evaluated and the root causes and effects of the barriers were also described. Casual relationship were shown graphically. DEMATEL MCDM method was used to identify the interrelations among the barriers. The cause effect diagram were also drawn using the value from total relation matrix. The process also evaluated the weights of the barriers. According to the weights of the barriers, they were ranked for prioritizing. Every objectives and aims for this study were achieved successfully.

References

[1] Majumdar, A., and S. K. Sinha. "Analyzing the barriers of green textile supply chain management in Southeast Asia using interpretive structural modeling. Sustain Prod Consum 17: 176–187." (2019).

[2] Majumdar, Abhijit, and Sanjib Sinha. "Modeling the barriers of green supply chain management in small and medium enterprises: A case of Indian clothing industry." *Management of Environmental Quality: An International Journal* (2018).

[3] Nikbakhsh, Ehsan. "Green supply chain management." *Supply Chain and Logistics in National, International and Governmental Environment: Concepts and Models* (2009): 195-220.

[4] Habib, Md Ahashan, Yukun Bao, and Aboobucker Ilmudeen. "The impact of green entrepreneurial orientation, market orientation and green supply chain management practices on sustainable firm performance." *Cogent Business & Management* 7.1 (2020): 1743616.

[5] Niinimäki, K.; Peters, G.; Dahlbo, H.; Perry, P.; Rissanen, T.; Gwilt, A. The Environmental Price of Fast Fashion. Nat. Rev. Earth Environ. 2020, 1, 189–200.

[6] Niinimäki, K.; Peters, G.; Dahlbo, H.; Perry, P.; Rissanen, T.; Gwilt, A. The Environmental Price of Fast Fashion. Nat. Rev. Earth Environ. 2020, 1, 189–200.

[7] Yadlapalli, A.; Rahman, S.; Gunasekaran, A. Socially Responsible Governance Mechanisms for Manufacturing Firms in Apparel Supply Chains. Int. J. Prod. Econ. 2018, 196, 135–149.

[8] Reza, A.K.; Islam, S.; Shimu, A.A. Green Industry in Bangladesh: An Overview. Environ. Manag. Sustain. Dev. 2017, 6.

[9] Majumdar, A.; Sinha, S. Modeling the Barriers of Green Supply Chain Management in Small and Medium Enterprises. Manag. En-viron. Qual. Int. J. 2018, 29, 1110-1122

[10] Tumpa, Tasmia Jannat, et al. "Barriers to green supply chain management: An emerging economy context." *Journal of Cleaner Production* 236 (2019): 117617.s

[11] RMG Exports Saw 8.76% Growth Last Fiscal Year. Dhaka Tribune. 4 July 2018. Available online: https: //www.dhakatribune.com/business/2018/07/05/rmg-exports-saw-8-76-growth-last-

[12] Biswas, Baidyanath, and Rohit Gupta. "Analysis of barriers to implement blockchain in industry and service sectors." *Computers & Industrial Engineering* 136 (2019): 225-241.