Analysis of the Adoption Decisions of the Components of the Internet of Things in the Ready-Made Garment Industry

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Abstract

The ready-made garment (RMG) industry is one of the largest industrial sectors in Bangladesh in terms of economy and employment. As the world economy moves forward, this highly people-dense industry needs to be digitalized. However, the importance of digital technology, particularly the Internet of Things (IoT), has just lately been recognized by most industries, which is also an important part of Industry 4.0. The IoT has seven important elements. Though IoT has the potential to grow businesses, it is difficult to implement all the elements of IoT simultaneously. Thus, the study aims to build a hierarchy model of IoT elements to be implemented in the RMG industry of Bangladesh. Through an extensive literature review, fourteen significant elements of IoT were identified. Then the study employs an integrated multi-criteria decision-making (MCDM) framework to rank the elements of IoT based on their potential for application in the Bangladeshi RMG industry. The weights of the evaluation criteria were determined using a fuzzy analytical hierarchy process (FAHP), and the elements of IoT were ranked using a preference ranking organization method for enrichment evaluations (PROMETHEE II) based on the criteria weights obtained from FAHP. The study findings suggest that the **Sensors** are the most significant component of IoT, while **Network Interconnection** is the least significant component for IoT implementation. This study is expected to assist the stakeholders in the RMG and other related industrial sectors in formulating appropriate strategies and policies for the proper deployment of IoT.

Keywords
RMG Industries, Industry 4.0, IoT components, FAHP, PROMETHEE II

1. Introduction
The Ready-made Garment (RMG) industry is the largest industrial sector of Bangladesh and is vital to the country's economic development (Kumar et al. 2020). This industry is the country's largest export earner as well, with nearly $27.9 billion in exports in the 2019-20 fiscal year (BGMEA, n.d.). This sector accounts for over 80% of Bangladesh's total export revenues. Approximately 4 million workers are currently working in this sector (Chowdhury et al. 2019). Therefore, these industries greatly impact Bangladesh's economy and employment. Therefore, the RMG sector should be properly managed and analyzed to maintain its economic growth.

Fashion is changing every moment. Hence, this industry is more dynamic than any other sector. Moreover, in today's market, organizations are becoming more competitive in an ever-changing commercial climate (Banerjee & Mishra 2017). For this reason, in the era of the 4th industrial revolution (Industry 4.0), industries are moving towards digitalized systems and adopting new technologies to ramp up their market shares. The Internet of Things (IoT) is one of the most important elements of Industry 4.0 (Tay et al. 2018).

The IoT is made up of a variety of connected devices, ranging from simple sensors to smartphones and wearables. It is possible to collect all the information, evaluate it, and develop an action to assist someone with a specific task or learn from a process by merging these connected devices with the help of automated systems (Jain 2021). This technology has a wide range of applications and benefits in the RMG industry, including gaining a better grasp of the requirements of the clients, optimizing product assortment, customized satisfaction, improving the design, pattern, and shape, and having more insights into continuous innovation, among other things (Jain 2021). The IoT ecosystem has several important components (Masum et al. 2020), which are shown in Table 1.

Table 1. Fourteen Elements of IoT

No.	IoT Components	References
1	Sensors	(Marques et al. 2016)
2	Actuators	(Masum et al. 2020)
3	System Security	(The Basic Elements of IoT n.d.)
4	Central Control hardware	(The Basic Elements of IoT n.d.)
5	Technology and Governance Standards	(Marques et al. 2016)
6	Intelligent Insights and Standards	(Masum et al. 2020)
7	Network Interconnection	(IoT Ecosystem: Top 7 Components n.d.),
8	Gateway	(IoT Ecosystem: Top 7 Components n.d.)
9	Services	(Marques et al. 2016)
10	Semantic	(Marques et al. 2016)
11	The Cloud	(IoT Ecosystem: Top 7 Components n.d.), (The Basic Elements of IoT n.d.)
12	Data Analytics	(Masum et al. 2020)
13	User Interface	(The Basic Elements of IoT n.d.), (Gubbi et al. 2013)
14	Users	(IoT Ecosystem: Top 7 Components n.d.)

In the traditional garment production line, all the production records are maintained manually by using paper documents. It is tough to oversee a large factory, which is at the same time, complex and exhaustive. The IoT-based data monitoring can provide real-time visibility of the process and operations. It can also aid in the rapid detection of machine defects and the extension of machine life. The complexity and dynamic nature of information systems converging have prompted industrial enterprises to invest in smart manufacturing (Wang et al. 2015). IoT is a new technology that has the potential to change the way manufacturing industries operate and function (Manavalan & Jayakrishna 2019). However, it is easier to track if IoT is implemented in the whole factory, from raw materials input to production output through dedicated devices, software, and cloud systems.

Another aspect of IoT is the automatic flaw detection of textile products. For instance, Cognex, an American machine maker, produces machinery and software in this area (Saha 2018). This technology can also be used to measure a worker's efficiency, strengths, and flaws. Automatic color balancing, automatic sewing machines, digital printing, and floor area management are just a few examples (Saha 2018). The IoT opens a lot of scope to the RMG (Saha 2018; Fatiya 2017). The vast volume of cloud data, client internet searches, and the accessible and quick availability of the latest designs- all aid in research and development tailored to the needs of the customer (Segura 2018). The adoption of the IoT provides several advantages in the garment sales business and product development. The key benefit is that it makes handling large amounts of data easier. It aids in a greater grasp of the garment markets and customers by better handling large data. It is possible to make better and faster decisions with a deeper grasp of the market and the client. Even when an industry is trying to offer a new product, it can better forecast customer reaction and improve the product's utility (Barhanpurkar & Barhanpurkar 2019). The IoT can also drastically change the RMG industry's productivity by enhancing the production monitoring system. However, in an emerging economy like Bangladesh, very few industries have tried to adopt an IoT-based production system.

There were several recent studies that tried to explore the implementation of various components of Industry 4.0. However, to date, no research has tried to analyze the components of IoT for their implementation in the RMG industry or any other industry in emerging economies. This study, thereby, tried to address this research gap by using an integrated multi-criteria decision-making (MCDM) framework combining the fuzzy analytical hierarchy process (FAHP), and the preference ranking organization method for enrichment evaluations (PROMETHEE II) methods.

1.1 Objectives

Organizations in Bangladesh, particularly those in the RMG sector, frequently lack the capital funds to integrate IoT aspects, which can be costly. As a result, RMG industries in developing countries such as Bangladesh must aim to incorporate IoT aspects gradually rather than all the components at once. To do so, industry managers must first prioritize or rank the IoT components depending on their importance and relevance, then adopt the component that appears at the forefront, gradually working their way down to the bottom. Therefore, this study was conducted to achieve the following goals.

- Identification of the evaluation criteria to assess the components of IoT from the literature review.
- Using the FAHP approach to calculate the weights of the identified evaluation criteria based on expert feedback.
- Ranking the components of IoT based on their implementation potential, using the PROMETHEE II technique, utilizing the obtained criteria weight.
- Lastly, discussing the study's research implications and recommendations for future research.

2. Literature Review

IoT is currently being used in a variety of industries to make products, services, and operations smarter, including automotive, healthcare, manufacturing, residential, and high-tech electronics (Miorandi et al. 2012). By researching prior relevant literature, some essential criteria for evaluating the aspects of IoT for implementation have been found in this study. 14 IoT elements for implementation in the RMG industry have been identified based on a literature review and from different sites, and several related research publications were examined to determine ten significant evaluation criteria for IoT aspects, which are included in Table 2 below.

Table 2. Criteria identified for the assessment of the IoT component

No.	Criteria	Reference
1	Energy Savings (Sustainability)	Eskerod et al. 2019
2	Technological availability	Masum et al. 2020
3	Top Management's interest	El-Hamed et al. 2021
4	Technical Richness/Skill	El-Hamed et al. 2021
5	Financial Readiness	Bhuiyan et al. 2020
6	Team Readiness	El-Hamed et al. 2021
7	Organizational Strategy	Masum et al. 2020
8	Training of Technology (ToT)	Rumi et al. 2020
9	Mindset for Technology adoption	Bhuiyan et al. 2020
10	Computer and IT Knowledge	Moktadir et al. 2018

In this study, FAHP has been employed to calculate the criteria weights, which were then used as inputs to the PROMETHEE II method to achieve the final ranking of IoT elements. The analytic hierarchy process (AHP) is a prominent MCDM technique that uses pair-wise comparisons. Because of the unpredictability and ambiguity of human judgment, the conventional AHP technique has some flaws (Calabrese et al. 2019). To compensate for these flaws, fuzzy sets theory is frequently used with AHP. There are several types of Fuzzy AHP scales, such as monotonic, triangular, trapezoidal, and so on. In this study, the Fuzzy triangular scale is used to find out the weights of the evaluation criteria. Fuzzy triangular numbers (TFNs) are better suited for this purpose since it allows easy representation and manipulation of linguistic variables (Bari et al. 2022a; Bari et al. 2022b). Fuzzy AHP has been widely used in strategic decision-making and analysis of complex socioeconomic systems (Moktadir et al. 2018).

PROMETHEE II is an improved version of the PROMETHEE method. In comparison to PROMETHEE I, which could only provide a partial rating of the alternatives, PROMETHEE II can provide a complete ranking (Anojkumar et al. 2014). PROMETHEE II is the most widely used version since it allows a decision-maker to find a fully ranked vector of possibilities. PROMETHEE II is frequently used in conjunction with other approaches such as AHP or FAHP to improve analytical performance (Isa et al. 2021). Tong et al. (2020) developed a performance evaluation framework for maintenance vendors in the petrochemical industries using an expanded fuzzy PROMETHEE II technique. Isa et al. (2021) used a hybrid AHP-PROMETHEE II method to select and prioritize suppliers for a railroad construction project.

3. Methods

This study investigates the ranking of industry 4.0 elements to help the decision-makers to decide which element they need to implement first when the available resource is constrained. After the identification of the evaluation criteria, two MCDM tools, FAHP and PROMETHEE II, have been used to obtain the final ranking of the elements. Hence, FAHP, and PROMETHEE II methods have been briefly discussed below in the next two subsections.

3.1 Fuzzy Analytical Hierarchy Process (FAHP)

In this study, the triangular fuzzy membership function, or the Triangular Fuzzy Number (TFN) has been utilized. Because of its' easier linguistic evaluations, it is more popular in Fuzzy MCDM studies (Karmaker et al. 2022). A TFN is denoted as ã = (l, m, u), where l, m, and u are the lower bound, most likely value and upper bound of the fuzzy number ã, respectively, and l ≤ m ≤ u. A TFN is shown in Eq. 1:

$$\mu_{\tilde{a}}(x) = \begin{cases} 0, x < 1 \ or \ x > u \\ x-l/\ m-l,\ l \leq x \leq m \\ u-x/\ u-m,\ m \leq x \leq u \end{cases} \tag{1}$$

The step-by-step procedure of FAHP (Bari et al. 2022b) is given below:

Step 1. The problem is structured hierarchically.

Step 2. A square (n x n) dimensional comparison matrix is formed between the criteria. Components on the diagonal of the matrix take the value 1, where row number = column number (i=j). The linguistic pair-wise comparison of criteria is then transformed into TFNs, ã = (l, m, u). The linguistic scale used in this research, along with the corresponding TFNs and reciprocal of TFNs is shown in Table 3 (Anojkumar et al. 2014).

Table 3. Conversion scale of a fuzzy triangular number

The scale of Relative Importance			
Importance Intensity	**Linguistic scale for the importance**	**TFN (l, m, u)**	**Reciprocal of TFN (1/u, 1/m, 1/l)**
1	Equal Importance	(1,1,1)	(1,1,1)
3	Moderate Importance	(2,3,4)	(1/4, 1/3, 1/2)
5	Strong Importance	(4,5,6)	(1/6, 1/5, 1/4)
7	Very Strong Importance	(6,7,8)	(1/8, 1/7, 1/6)
9	Extreme Importance	(9,9,9)	(1/9, 1/9, 1/9)
2	Intermediate Values	(1,2,3)	(1/3, 1/2, 1)
4		(3,4,5)	(1/5, 1/4, 1/3)
6		(5,6,7)	(1/7, 1/6, 1/5)
8		(7,8,9)	(1/9, 1/8, 1/7)

Step 3. Based on the information of pair-wise comparison as in Eq. 2, the fuzzy positive reciprocal matrix can be formed as:

$$\tilde{A}_{nxn} = \begin{pmatrix} \tilde{a}_{11} \ldots & \ldots \tilde{a}_{n1} \\ . \quad . & . \\ . \quad . & . \end{pmatrix} \quad a_{ii} = 1,\ a_{ji} = 1/a_{ij},\ a_{ij} \neq 0 \tag{2}$$

Eq. 2 indicates if i^{th} row, j^{th} column component (a_{ij}) of the comparison matrix takes x value, then j^{th} row i^{th} column

(a_{ji}) component of the matrix will take 1/x value.
Step 4. Fuzzy weights of each criterion are obtained using Eq. 3.

$$\tilde{w_i} = \tilde{r}_i \times (\tilde{r}_1 + \tilde{r}_2 + \cdots + \tilde{r}_n)^{-1} \quad (3)$$

The fuzzy geometric mean value of each criterion can be obtained from Eq. 4.

$$\tilde{r}_i = (\tilde{a}_{i1} \times \tilde{a}_{i2} \times \cdots \times \tilde{a}_{in})^{1/n} \quad (4)$$

Where $\tilde{w_i}$ _denotes the fuzzy weight and $\tilde{r}_i$ denote the fuzzy geometric mean value of a criterion.

Step 5. The weights of each criterion are defuzzifieded. Center of Area, COA (Eq. 5) is used for weights defuzzification. Weights are normalized to get a more precise output.

$$\text{COA, } W_i = (l_i + m_i + u_i)/3 \quad (5)$$

Where W_i denotes the defuzzified fuzzy weight of a criterion.

3.2 Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE II)

To implement PROMETHEE II, two types of information are required on each criterion: the weight and the preference function. Weight determines the importance of each criterion, which has been done by using FAHP in this research. The preference function translates the evaluations obtained for the alternatives. Six different types of preference functions are commonly used in PROMETHEE II. However, significant differences have not been found among the performances of these functions in the previous literature (Abdullah et al. 2019). This study has utilized a preference function named the 'V-shape criterion' since many previous studies on PROMETHEE II have picked it over others (Ozsahin et al. 2017; Wu et al. 2020; Tushar et al. 2022).

The step-by-step procedure of the PROMETHEE II method is as below (Bari et al. 2022a):

Step 1. The preference function is determined for each criterion to translate the difference between the evaluations obtained by two alternatives into a preference degree ranging from 0 to 1.

Step 2. Deviations are determined based on pair-wise comparisons, as shown in Eq. 6.

$$d_j(a,b) = g_j(a) - g_j(b) \quad (6)$$

Where $d_j(a,b)$ = denotes the difference between the evaluations of a and b on each criterion.

Step 3. The preference function is applied as shown in Eq. 7.

$$P_j(a,b) = F_j[\, d_j(a,b)\,];\ j = 1, \ldots, k \quad (7)$$

Where $p_j(a,b)$ denotes the preference of alternative a with respect to alternative b on each criterion, as a function of $d_j(a,b)$.

Step 4. The overall or global preference index is calculated using Eq. 8.

$$\pi(a,b) = \text{the } \sum_{j=1}^{k} Pj\,(a,b) * Wj\,;\ \forall\, a, b \in A \quad (8)$$

where $\pi(a, b)$ is defined as a weighted sum of $P_j(a, b)$, w_j is the weight according to the decision maker's preference as the relative importance of the j^{th} criterion, and A is the set of all available alternatives.

Step 5. Outranking flows are calculated using Eq. 9 and Eq. 10.

$$\phi+(a) = \frac{1}{n-1} \sum_{x \in A}^{k} \pi(a, x) \quad (9)$$

$$\phi^-(a) = \frac{1}{n-1} \sum_{x \in A}^{k} \pi(x, a) \quad (10)$$

Where $\phi+(a)$ and $\phi-(a)$ represent the positive and negative outranking flow for each alternative, respectively, and n is the total number of all available alternatives.

Step 6. Net outranking flow $\phi(a)$ is then determined using Eq. 11.

$$\phi(a) = \phi+(a) - \phi-(a) \quad (11)$$

Step 7. Ranking of all considered alternatives is obtained depending on the values of $\phi(a)$. The higher value of $\phi(a)$ implies a better ranking of the alternative.

4. Data Analysis and Calculation

Purposive sampling has been used in this research to select the experts to provide feedback during different stages of this research (Debnath et al. 2023; Palit et al. 2022; Akhter et al. 2022). Fifteen experts working in various RMG industries were chosen to provide feedback. The selection criteria for the experts included more than 5 years of work experience in the RMG sector, a deep understanding of Industry 4.0 components, especially about IoT, willingness to provide feedback, and so on. A summary of the experts' profiles is provided in Table 4.

Table 4. Summary profile of the experts

Experts who participated in the study and provided feedback			
Total number of experts (N=15)	Experience	N	Percentage
	5 to 9 years	8	53.33%
	10 to 15 years	4	26.67%
	> 15 years	3	20%

A questionnaire has been made using Google Forms and sent to the experts via email to conduct this survey. They weigh the criteria based on the following point system:

10 points – Very Strong; 7 points – Strong; 4 Points – Moderate; 1 Point- Very Poor

The average has been taken against every individual criterion. If there is any fraction or number between the point, then it is downgraded or upgraded to the nearest integer (e.g., if the average of an individual response is 6.6, then it is upgraded to the nearest integer 7). Thus, in this way, the criteria have been rated, which is shown in Table 5.

Table 5. Criteria rating value obtained from feedback

Criteria	Energy Savings (Sustainability)	Technological availability	Top Management's interest	Technical Richness/Skill	Financial Readiness	Team Readiness	Organizational Strategy	Training of Technology (IoT)	Mindset for Technology Adoption	Computer and IT Knowledge
Sensors	10	7	10	10	10	10	1	10	7	10
Actuators										10
System Security	5	1	7	10	1	7	3	10	1	10
Central Control Hardware	10	1	3	10	7	3	1	3	10	10
Technology and Governance Standards	10	7	5	1	7	10	7	1	1	10
Intelligent Insights and Actions	1	1	7	10	5	1	3	3	3	10
Network Interconnection	1	1	7	1	7	1	1	10	1	1
Gateway	5	1	1	7	7	1	1	5	7	1
Services	1	1	7	7	7	3	7	7	7	5
Semantic	1	1	1	10	7	3	1	5	1	10
The Cloud	1	1	7	1	5	3	7	10	10	7
Data Analytics	1	1	3	10	10	5	1	5	7	10
User Interface	3	7	7	7	10	10	10	10	10	7
Users	5	1	3	5	7	10	7	7	10	3

A pair-wise comparison matrix was also formed using the feedback of those students. That matrix is shown in Table 6.

Table 6. Pair-wise comparison matrix based on expert feedback

Criteria	Energy Savings (Sustainability)	Technological availability	Top Management's interest	Technical Richness/Skill	Financial Readiness	Team Readiness	Organizational Strategy	Training of Technology	Mindset for Technology Adoption	Computer and IT Knowledge
Energy Savings (Sustainability)	1	2	5	2	1/3	5	5	3	5	1
workers safety	1/2	1	3	4	1/4	3	4	3	6	2
Top Management Involvement and Commitment	1/5	1/3	1	1/5	1/5	1/5	5	2	1	5
Technical Richness/Skill	1/2	1/4	5	1	1/4	5	4	1	4	2
Financial Readiness	3	4	5	4	1	2	3	3	1	3
Team Readiness	1/5	1/3	5	1/5	1/2	1	3	1/3	1	1/3
Organizational Strategy	1/5	1/4	1/5	1/4	1/3	1/3	1	1/5	1/3	1/5
Training of Technology	1/3	1/3	1/2	1	1/3	3	5	1	2	1/2
Mindset for Technology Adoption	1/5	1/6	1	1/4	1	1	3	1/2	1	1
Computer and IT Knowledge	1	1/2	1/5	1/2	1/3	3	5	2	1	1

From the metrics above, Criteria Index and Criteria Ratio have been calculated. CR tends to 0.1. Hence, it can be assumed that the metrics are consistent. Values shown in Table 4, are transformed into TFN following the conversion scale given in Table 2. After that, the fuzzy pair-wise comparison matrix was used to derive the geometric mean of each criterion. The fuzzy geometric mean, fuzzy weights, and defuzzified weights of the criterion are shown in Table 7. If the sum of the defuzzified weights is higher than one, the weights are normalized to improve accuracy.

Table 7. Fuzzy Geometric mean, Fuzzy weights, defuzzified weights, and normalized defuzzified weights of the criteria by using the FAHP

Criteria	**Fuzzy Geometric mean value, $\tilde{r}i$**	**Fuzzy Weights, $\tilde{\tilde{w}}i$**	**Defuzzified Weights (Wi)**	**Normalized Defuzzified Weights**
Energy Savings (Sustainability)	1.625,2.187,2.734	0.172,0.177,0.176	0.17	0.17
Technological availability	1.473,2.011,2.646	0.156,0.162,0.17	0.16	0.16
Top management's interest	0.771,0.696,0.856	0.081,0.056,0.055	0.06	0.06
Technical Richness/Skill	1.067,1.38,1.769	0.113,0.111,0.114	0.11	0.11
Financial Readiness	1.888,2.578,3.207	0.199,0.208,0.206	0.20	0.20
Team Readiness	0.509,0.638,0.846	0.054,0.052,0.054	0.05	0.05
Organizational Strategy	0.23,0.257,0.374	0.024,0.021,0.024	0.02	0.02
Training of Technology	0.699,0.982,1.162	0.074,0.079,0.075	0.08	0.08
Mindset for Technology Adoption	0.51,0.758,0.818	0.054,0.061,0.052	0.06	0.06
Computer and IT Knowledge	0.699,0.896,1.162	0.074,0.072,0.075	0.07	0.07
		Sum	1.00	1.00

Defuzzified Criteria weights obtained using FAHP, as shown in Table 6, are then used as inputs to the PROMETHEE II method to obtain the ranking of the IoT elements. Table 8 shows the evaluation matrix that has been used for the final ranking using PROMETHEE II.

Table 8. Evaluation matrix to be used for analysis by PROMETHEE II

Criteria	Energy Savings (Sustainability)	Technological availability	Top Management's interest	Technical Richness/Skill	Financial Readiness	Team Readiness	Organizational Strategy	Training of Technology (ToT)	Mindset for Technology Adoption	Computer and IT Knowledge
Sensors	10	7	10	10	10	10	1	10	7	10
Actuators	7	5	1	1	7	7	1	5	3	1
System Security	5	1	7	10	1	7	3	10	1	10
Central Control Hardware	10	1	3	10	7	3	1	3	10	10
Technology and Governance Standards	10	7	5	1	7	10	7	1	1	10
Intelligent Insights and Actions	1	1	7	10	5	1	3	3	3	10
Network Interconnection	1	1	7	1	7	1	1	10	1	1
Gateway	5	1	1	7	7	1	1	5	7	1
Services	1	1	7	7	7	3	7	7	7	5
Semantic	1	1	1	10	7	3	1	5	1	10
The Cloud	1	1	7	1	5	3	7	10	10	7
Data Analytics	1	1	3	10	10	5	1	5	7	10
User Interface	3	7	7	7	10	10	10	10	10	7
Users	5	1	3	5	7	10	7	7	10	3
Max(Xij), Min(Xij)	10,1	7,1	10,1	10,1	10,1	10,1	10,1	10,5	10,1	10,1

Finally, the complete final ranking of the IoT elements is obtained by using the PROMETHEE II method, which is presented in Table 9. The final ranking of the elements is based on the obtained value of the Net Outranking Flow $\phi(a)$.

Table 9. Final ranking of the IoT elements using PROMETHEE II

Aggregated Preference Function	**Leaving Flow, $\phi+$**	**Entering Flow, ϕ^-**	**Net Outranking Flow, $\phi(a)$**	**Rank**
Sensors	0.5	0.0513	0.446	1
System Security	0.67	0.2342	0.434	2
Users	0.37	0.198	0.173	3
Central Control Hardware	0.28	0.168	0.108	4
User Interface	0.19	0.1148	0.074	5
Technology and Governance Standards	0.3	0.2325	0.067	6
Data Analytics	0.14	0.1939	-0.055	7
Services	0.11	0.2406	-0.135	8
Semantic	0.12	0.2703	-0.148	9
Actuators	0.17	0.3229	-0.152	10
Gateway	0.09	0.2769	-0.185	11
The Cloud	0.11	0.2988	-0.193	12
Intelligent Insights and Actions	0.11	0.3147	-0.205	13
Network Interconnection	0.11	0.3405	-0.231	14

5. Result and Discussion

In this study, Table 7 and Figure 1 reveals that among all the criteria, 'Financial Readiness' is the most important, accounting for 20% of the overall weight. As a result, the most essential evaluation factor is 'Financial Readiness,' on which Bangladesh's RMG companies should focus more to support the proper deployment of IoT features. This is followed by 'Energy Savings (Sustainability)' and 'Workers Safety,' which account for 17% and 16% of the total weights, respectively. 'Organizational Strategy,' on the other hand, was deemed to be the least important criterion, receiving only 2% of the weight.

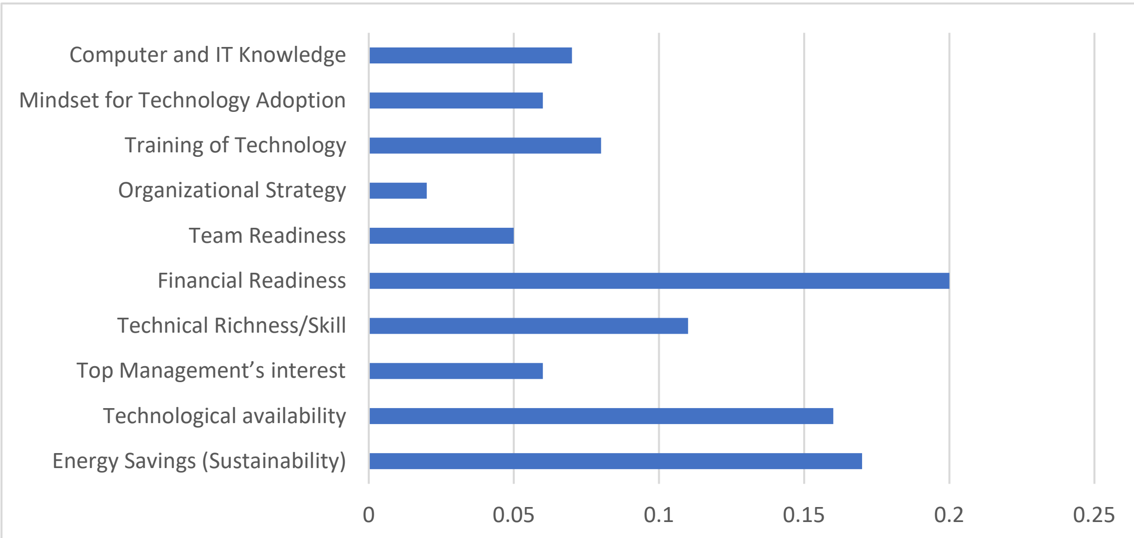

Figure 1. Rank of the evaluation criteria based on their normalized defuzzified weights

After that, Table 9 shows the total ranking of IoT elements produced by using the PROMETHEE II approach. Table 8 shows that 'Sensors' is the most significant aspect of IoT, and 'System Security' is the second most important element of IoT, both of which must be deployed in Bangladesh's RMG businesses as soon as possible. 'Network Interconnection', on the other hand, has been rated as the least significant factor of IoT in terms of operational priority.

Since all industries are moving toward technological improvement, Bangladesh's RMG sectors should also follow suit. Manufacturing costs and delivery times must be reduced to compete with other industries both inside and outside the country. As a result, IoT deployment in the RMG industry would be a wise decision. Due to cost constraints, it is difficult to integrate all parts of IoT at the same time in Bangladesh's RMG businesses. However, industries would benefit to a greater extent if they implemented the IoT features sequentially, according to the ranking provided in Table 8.

6. Managerial and Policy Implications

The suggested study can assist managers and decision-makers in the RMG industry, as well as other related industrial sectors in developing nations, in building the essential foundation for implementing IoT. This study will give industrial decision-makers and practitioners the tools they need to assess the impact of the various elements of IoT in a developing economy. Furthermore, this research can assist industrial decision-makers in understanding the need to assess and rating IoT features before moving forward with implementation, especially when resources are limited. This research can assist policymakers in understanding the importance of the evaluation criteria and priority ranking of the elements of IoT, which will aid them in developing strategies to facilitate the deployment of industry 4.0 in RMG and other related industries.

This study can also contribute to the overall development of the country's economy. RMG businesses in Bangladesh provide a significant source of income. If these industries are digitalized, manufacturing costs will be decreased, and delivery times will be shortened, allowing the country to earn more foreign currency than ever.

7. Conclusion and Future Research

The analysis in this study was done using an integrated FAHP-PROMETHEE II framework. For the deployment of IoT in the RMG industries of developing nations like Bangladesh, the FAHP results show that 'financial readiness' is the most essential evaluation criterion, while 'organizational strategy' is the least important. The findings show how each criterion is weighted, giving decision-makers insight into which criteria they should prioritize for effective IoT deployment. From the final ranking obtained from using PROMETHEE II, the 'Sensors' appears to be the most significant component of IoT, while the 'Network Interconnection' is the least important component from an implementation priority standpoint. When decision-makers resources are limited, these findings advise which aspect of IoT they should deploy first. Implementing all the features of IoT in a developing country's business might be quite costly. As a result, for such industries, this research can provide invaluable insights.

In the future, this research could be expanded in several ways. Only the parameters linked to the RMG industries of emerging nations like Bangladesh were examined in this study. Hence, this research can be expanded in the future to include various other industries from countries with other economic standings. Moreover, including a larger number of experts may improve the accuracy of similar studies by reducing subjective bias, which is an important insight for future researchers. Furthermore, this study did not investigate the barriers and drivers of IoT implementation, which could be an interesting research idea to investigate in the future.

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