Investigating Critical Factors for Implementing Safety Measures in RMG Industry Using ISM-MICMAC

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Abstract

As one of the world's largest and most impactful industries, Ready Made Garments (RMG) sector employs millions of people. However, despite its significant workforce contribution, the industry is also known for its poor safety record, characterized by frequent accidents and fatalities reported at factories. This research utilizes Interpretive Structural Modeling (ISM) and MICMAC techniques to identify twelve critical factors for implementing safety measures in the RMG industry. Categorized as independent, linked, autonomous and dependent variables, these factors were analyzed for their interrelationships and impact levels. The findings offer valuable insight for policymakers and industry leaders, guiding the effective implementation of safety measures in the RMG sector. This research also contributes to ensuring workers well-being and promoting sustainable economic growth.

Keywords
ISM, MICMAC, Critical Factor, Safety Measure, Ready Made Garments Industry (RMG)

1. Introduction

The rapid growth of industries and businesses has resulted in increased workplace accidents and injuries. Among these industries, the ready-made garments (RMG) industry has gained significant attention due to its labour-intensive and hazardous working environment. The implementation of effective safety measures is crucial for ensuring the well-being of workers and possible long-term effects on workers' health need to be investigated (Hamja et al. 2019). The health vulnerabilities of RMG (Ready-Made Garments) workers represent a growing field of investigation that requires enhanced comprehension and the identification of solutions (Kabir et al. 2019). While Accord and Alliance have improved workplace safety, there's still more to do. The challenge is ensuring a smooth transition of their responsibilities to local bodies, requiring transparency, readiness, and strong enforcement (Galib et al. 2019). Ensuring a secure and sustainable working environment is crucial for the reputation and stability of the industrial sector, particularly in Ready-Made Garments (RMG). Unfortunately, recent fire incidents pose a significant obstacle to achieving safety and sustainability in the RMG sector (Hasan et al. 2017). Analytical tools have been utilized very rarely to address safety measures in the RMG sector of Bangladesh. The study is expected to provide insights into the interrelationships among the critical factors and to identify the key drivers of safety measures in the industry. The findings of this research are expected to have significant implications for policymakers, industry stakeholders, and future research.

The objectives of this research are:

- To identify the critical factors that influence the implementation of safety measures in the RMG industry using the Interpretive Structural Modelling (ISM) and (MICMAC) techniques.
- To analyze the interrelationships between these factors and develop a framework that shows the hierarchical structure of these factors.
- To suggest strategies and policies for improving the implementation of safety measures in the RMG industry.

2. Literature Review

The RMG industry plays a significant role in the global economy, employing millions of workers. Despite its importance, this industry is known for its inadequate safety measures, which have resulted in numerous accidents and fatalities. The 2013 Rana Plaza incident in Bangladesh, causing the deaths of over 1,100 garment workers, highlights the dire consequences of inadequate safety standards. However, substantial progress has been made in addressing vulnerabilities in the Bangladesh RMG industry within three years of the tragic event (Barua et al. 2017). A study was conducted that explores the contextual factors and system challenges hindering the establishment of a healthy and safe workplace (Akhter et al. 2019). The Ready-Made Garment (RMG) industry in Bangladesh have been reviewed, highlighting its substantial growth. Despite economic contributions and employment for over 4 million workers, safety issues, including industrial accidents, pose significant challenges. The study evaluates initiatives by the Bangladesh Government and global stakeholders to improve occupational health hazards, focusing on health, safety, and OHS management. Some researchers conducted a direct survey with RMG workers to assess their understanding and acceptance of existing safety practices (Ahmed et al. 2020). In one study, researchers investigated industrial accidents in the RMG sector, identifying causes and proposing safety measures.

The study, conducted in Tangail district, highlighted accident risks in various RMG sections. Through purposive sampling, respondents were interviewed, revealing major causes affecting worker efficiency. Implemented improvement proposals demonstrated a substantial reduction in injury rates, emphasizing the need for effective risk-controlling techniques by management and responsible parties (Parveen et al. 2019). Some researchers address the significant threat of fire risks in the apparel manufacturing industry, particularly relevant in emerging economies like Bangladesh. They propose an integrated multi-criterion decision-making (MCDM) framework to identify and mitigate fire hazards. The study identifies 30 fire risk factors, prioritizing them using the Best Worst Method (BWM) and Weighted Sum Model (WSM) (Siraj et al. 2023). In another study, researchers investigate occupational injuries and fatalities in Bangladesh's readymade garments sector, emphasizing factors such as employer negligence, legal compliance, and building structure. Using a mixed approach, the study employs surveys and interviews, offering a comprehensive understanding (Alama et al. 2020).

3. Methodology

The methodology section will identify and analyze the critical factors for implementing safety measures in the ready-made garments (RMG) industry using ISM-MICMAC technique. This section includes ISM-MICMAC Description, Data Collection and ISM-MICMAC Deployment stages. A brief description on ISM-MICMAC will help the readers to understand the work. Data collection explains the locations of the industries included in this study as well as the data collection technique. The ISM-MICMAC approach will be used in the case intended by ISM-MICMAC deployment. The critical factors for implementing safety measures are identified and analyzed using these stages.

3.1 ISM-MICMAC Description

ISM: It represents the interrelationships between the factors in a hierarchical structure, which is helpful in understanding the complex relationships among the factors. It is done by the five sequential steps. First, the important elements (i.e. variables, factors, or entities) of the system are identified to begin the analysis. Second, the Structural Self-Interaction Matrix (SSIM) is developed that represent the dependency and direction of influence between elements within the system. The third step involves constructing the Initial Reachability Matrix (IRM), which is a binary matrix that signifies the direct relationships among the elements. In the fourth step, the Final Reachability Matrix (FRM) captures the complete reachability relationships by combining direct and indirect influences from the Initial Reachability Matrix (IRM). In the fifth step, level partitioning categorizes elements based on their influence and dependencies to visually represents the hierarchical structure of the system.

MICMAC Analysis: It enhances ISM by quantifying impacts and interdependencies, thereby facilitating a deeper understanding of complex dynamics and the identification of key drivers and clusters for strategic decision-making. Additionally, it differentiates between independent, dependent, and linkage elements. By facilitating an understanding of system structure and interactions, MICMAC facilitates problem-solving and organizational analysis. Therefore, the combination of MICMAC and ISM offers a comprehensive method for analyzing complex systems.

3.2 Data Collection

Data collection is a crucial step in identifying critical factors for implementing safety measures in the RMG sector. A survey was conducted at seven textile factories located in the industrialized districts of Narayanganj, Gazipur, and Savar in Bangladesh. The factories and their location are given in Table 1. The factories were selected based on convenience. The survey was conducted with the help of factory managers and safety officers. The survey questionnaire aimed to gather data from industry experts to identify and assess the importance and interrelationships of critical factors for implementing safety measures in the RMG industry.

Table 1**.** The factories and their location

Factory Name	Locations
RS Composite Ltd	Fatullah, Narayanganj
RS Knit Wear (PVT) ltd	Fatullah, Narayanganj
Montrims Limited	Mouchak Kaliakair, Gazipur
Ratul Group	Ashulia, Savar
LSI Industry Ltd,	Savar
Reliance Trim Park Ltd.	Ashulia, Savar
Abonti Color Tex Ltd	Fatullah, Narayanganj

3.3 ISM-MICMAC Deployment

Five essential steps were implemented during the deployment phase of the ISM methodology. First, the critical factors pertinent to the RMG industry's safety measures were identified. Second, the SSIM was created to illustrate the interdependencies and influences between these elements. Thirdly, the IRM was developed to illustrate the direct relationships between the identified elements. Fourthly, the FRM was created, which incorporated both direct and indirect influences from the IRM to reveal all reachability relationships. Finally, level partitioning was performed to classify the elements according to their influence and dependencies, thereby providing a visual representation of the system's hierarchical structure. In addition, MICMAC analysis was incorporated with ISM, allowing for the quantification of impacts, the identification of key drivers and clusters, and a deeper understanding of the RMG industry's system dynamics. By effectively deploying the ISM methodology and incorporating MICMAC analysis, the critical factors for instituting safety measures in the RMG industry have been identified, paving the way for further analysis and exploration of their interrelationships.

3.3.1 Critical Factor Identification

The critical factors for implementing safety measures in RMG industry were identified with the help of the expert opinion. By surveying the expert panel, fifteen significant factors were initially identified. Then, twelve of them were selected through expert panel brainstorming. The panel of experts eliminated the three factors because they were less relevant to the RMG sector. Table 2 contains the description of the selected factors for implementing safety measures in the RMG industry.

Table 2. Critical factors identified through the expert opinion

Factors	Description
Government regulations and policies	This factor refers to the government-mandated laws and regulations that safeguard workplace safety. Legally enforcing workplace safety rules makes it important. To protect workers in the high-risk RMG industry, strict government rules and policies are needed.
Worker training and awareness	This factor refers to the level of training and awareness that workers have regarding workplace safety. It's crucial because workers need to know how to avoid workplace hazards. Effective safety training may teach people how to perform safely.
Management commitment and leadership	This factor refers to managerial commitment to labour safety and leadership in implementing safety measures. Management has the ability to establish a safety culture in the workplace, making it crucial. Without strong commitment and direction from management, it is less likely that safety measures will be implemented and enforced.
Safety culture and communication	This factor refers to the organization's values, attitudes, and beliefs regarding safety, as well as the communication of those values to employees. A positive safety culture can result in a safer workplace where employees are more likely follow to safe work practices and report hazards and incidents.
Hazard identification and risk assessment	This factor refers to the process of identifying workplace hazards and evaluating the associated risks. It is essential because it aids in the prevention of accidents and incidents by identifying potential dangers and mitigating risks.
Personal protective equipment (PPE)	This factor refers to the use of PPE to safeguard employees from workplace hazards. It is essential because it provides employees with a final line of defence in the event of an accident or incident. Effective use of PPE can significantly reduce the risk of workplace injury or illness.
Machinery and equipment safety	This factor relates to the workplace safety of machinery and equipment. It is crucial because malfunctioning machinery or equipment can result in severe accidents or injuries. Maintenance, inspection, and training on machinery and equipment can aid in preventing accidents and ensuring the safety of personnel.
Emergency preparedness and response	This factor describes the organization's level of preparedness and response in the event of an emergency. It is crucial because emergencies can occur at any time, and the organization must be prepared to respond swiftly and effectively in order to minimize the impact on employees.
Occupational health and hygiene	This factor refers to the extent to which employees are protected from hazards that may cause illness or disease. It is crucial because prolonged exposure to these hazards can result in severe health problems for employees. By ensuring excellent occupational health and hygiene practices, these hazards can be prevented from harming workers.
Employee participation and involvement	This factor describes the level of worker participation and engagement in safety programs and initiatives. It is essential because workers are frequently the greatest source of information about potential workplace hazards. By encouraging and promoting employee participation and involvement in safety programs, hazards can be identified and safety measures can be improved.
Supply chain management and supplier responsibility	This factor refers to the administration of the supply chain and the suppliers' responsibility to ensure workplace safety. It is crucial because suppliers and subcontractors may affect the safety of employees. Effective supply chain management and supplier accountability can contribute to the maintenance of safety standards throughout the supply chain.
Continuous improvement and performance measurement	This factor refers to the continual enhancement and evaluation of safety measures. Organizations can identify opportunities for improvement, manage emerging hazards, and verify the effectiveness of adopted solutions by continuously improving and monitoring safety performance. This method promotes continual learning and workplace safety improvement.

SSIM was built so that the interdependence of the twelve selected elements could be investigated. This matrix is an important analytical tool that may be used to better understand the connections and exchanges that take place between the various components.

3.3.2 Structural Self-Interaction Matrix (SSIM) Development

In this matrix, the rows and columns represent the twelve factors. The cell values indicate the strength and direction of the relationships between each pair of the factors. The notation used in this matrix is given below.

- V: row variable influences corresponding column variable
- A: row variable is influenced by corresponding column variable
- X: row and corresponding column variable influence each other
- O: row and corresponding column variable have no relationship

The Structural Self-Interaction Matrix is demonstrated in Table 3.

Table 3. Structural Self-Interaction Matrix (SSIM)

Variables	**F12**	**F11**	**F10**	**F9**	**F8**	**F7**	**F6**	**F5**	**F4**	**F3**	**F2**
F1	V	V	O	V	O	V	V	V	O	V	V
F2	V	O	A	V	X	V	V	V	V	A	
F3	V	V	X	V	X	V	V	V	V		
F4	V	V	V	V	X	V	V	V			
F5	V	V	X	V	X	V	V				
F6	V	V	X	V	X	V					
F7	V	V	X	V	V						
F8	V	V	V	V							
F9	V	V	X								
F10	V	V									
F11	V										

After analysing the interdependency between the selected factors using the SSIM, the focus is to deploy the IRM to further investigate the relationships within the system.

3.3.3 Initial Reachability Matrix (IRM) Development

IRM deployment requires the construction of a binary matrix that reveals the direct relationships and influences between the identified factors. By comparing the factors pairwise, '1' is assigned if there is a direct influence between two factors, whereas '0' is assigned if there is no direct influence. The IRM is demonstrated in the Table 4.

Table 4. Initial Reachability Matrix (IRM)

Variables	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	1	1	1	0	1	1	1	0	1	0	1	1
F2	0	1	0	1	1	1	1	1	1	0	0	1
F3	0	1	1	1	1	1	1	1	1	1	1	1
F4	0	0	0	1	1	1	1	1	1	1	1	1
F5	0	0	0	0	1	1	1	1	1	1	1	1
F6	0	0	0	0	0	1	1	1	1	1	1	1
F7	0	0	0	0	0	0	1	1	1	1	1	1
F8	0	1	1	1	1	1	0	1	1	1	1	1
F9	0	0	0	0	0	0	0	0	1	1	1	1
F10	0	1	1	0	1	1	1	0	1	1	1	1
F11	0	0	0	0	0	0	0	0	0	0	1	1
F12	0	0	0	0	0	0	0	0	0	0	0	1

After establishing the IRM to capture the direct relationships between factors, the next stage is to implement the FRM to account for both direct and indirect influences within the system.

3.3.4 Final Reachability Matrix (FRM) Development

FRM includes indirect influences into reachability connections from the IRM. To convert the IRM to the FRM, the transitivity rule is applied to determine the indirect links between factors. If there is a direct relationship between factors A and B, and a direct relationship between factors B and C, then there is an indirect relationship between factors A and C.

In the FRM, driving power represents a factor's influence on other factors, whereas dependence power reflects a factor's dependency on other elements. These measures aid in identifying the system's main drivers and dependencies, providing insight into the relative significance and influence of factors. The driving power was computed by adding together the FRM's row entities, whereas the dependence power was computed by adding together the FRM's column entities. The FRM with driving and dependence power is shown in Table 5.

Table 5. Final Reachability Matrix (FRM)

Variables	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	Driving Power
F1	1	1	1	1*	1	1	1	1*	1	1*	1	1	12
F2	0	1	1*	1	1	1	1	1	1	1*	1*	1	11
F3	0	1	1	1	1	1	1	1	1	1	1	1	11
F4	0	1*	1*	1	1	1	1	1	1	1	1	1	11
F5	0	1*	1*	1*	1	1	1	1	1	1	1	1	11
F6	0	1*	1*	1*	1*	1	1	1	1	1	1	1	11
F7	0	1*	1*	1*	1*	1*	1	1	1	1	1	1	11
F8	0	1	1	1	1	1	1*	1	1	1	1	1	11
F9	0	1*	1*	1*	1*	1*	1*	1*	1	1	1	1	11
F10	0	1	1	1*	1	1	1	1*	1	1	1	1	11
F11	0	0	0	0	0	0	0	0	0	0	1	1	2
F12	0	0	0	0	0	0	0	0	0	0	0	1	1

Dependence Power	1	10	10	10	10	10	10	10	10	10	11	12	

With the FRM completed, the focus is now to deploy level partitioning. Level partitioning hierarchically organizes components by influence and dependency for better analysis and decision-making.

3.3.5 Level Partition

After the development of FRM, the factors have been divided into groups to determine their relative significance. From the FRM, the reachability set and antecedent set are initially constructed. In the reachability sets, a specific factor was grouped with other factors that are influenced by it. In contrast, antecedent sets combine a particular factor with other factors that influence that factor. After combining the reachability and antecedent sets, the intersection set was produced. This procedure is followed for each obstacle. Finally, obstacles with similar reachability and intersection sets have been eliminated. Once a factor has been eliminated, it is no longer used.

The iterations are shown in Table 6 - 9. Now, Table 6 shows the iteration-1, with one factor (12) in level 1. Table 7 was generated by eliminating this factor. Only one factor (11) was in level 2 in the 2nd iteration. Table 8 was created by eliminating the factor. Table 8 shows the 3rd iteration, with factor two to factor ten (2, 3, 4, 5, 6, 7, 8, 9, 10) in level 3. Table 9 depicts the final iteration, with one factor (1) in level 4.

Table 6. Level Partitioning (Iterations-1)

Elements (Mi)	Reachability Set, R(Mi)	Antecedent Set, A(Ni)	Intersection Set, R(Mi)∩A(Ni)	Level
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1	1	
2	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
3	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
4	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
5	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
6	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
7	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
8	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
9	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
10	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
11	11, 12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	11	
12	12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	12	1

Table 7. Level Partitioning (Iterations-2)

Elements (Mi)	**Reachability Set, R(Mi)**	**Antecedent Set, A(Ni)**	**Intersection Set, R(Mi)∩A(Ni)**	**Level**
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1	1	
2	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
3	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
4	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
5	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
6	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
7	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
8	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
9	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
10	2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	
11	11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	11	2

Table 8. Level Partitioning (Iterations-3)

Elements (Mi)	**Reachability Set, R(Mi)**	**Antecedent Set, A(Ni)**	**Intersection Set, R(Mi)∩A(Ni)**	**Level**
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	1	1	
2	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
3	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
4	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
5	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
6	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
7	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
8	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
9	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
10	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3

Table 9. Level Partitioning (Iterations-4)

Elements (Mi)	**Reachability Set, R(Mi)**	**Antecedent Set, A(Ni)**	**Intersection Set, R(Mi)∩A(Ni)**	**Level**
1	1	1	1	4

The summary of the iterations is shown in Table 10.

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Table 10. Summary of the iterations

Elements (Mi)	**Reachability Set, R(Mi)**	**Antecedent Set, A(Ni)**	**Intersection Set, R(Mi)∩A(Ni)**	**Level**
1	1	1	1	4
2	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
3	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 1	2, 3, 4, 5, 6, 7, 8, 9, 10	3
4	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
5	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
6	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
7	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
8	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
9	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
10	2, 3, 4, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2, 3, 4, 5, 6, 7, 8, 9, 10	3
11	11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	11	2
12	12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	12	1

The levels of the critical factors are shown in Table 11.

Table 11. Final Level Partitioning

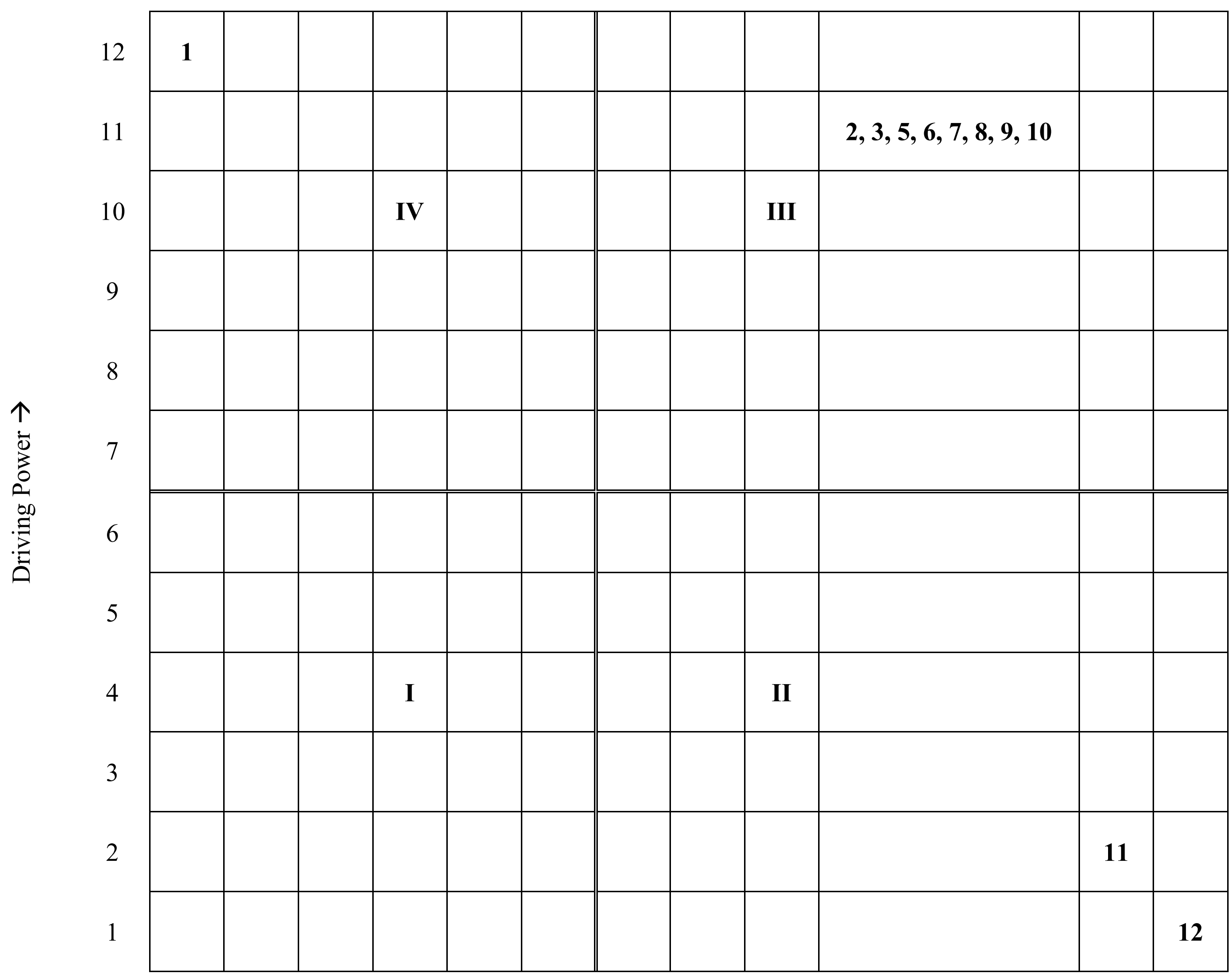
SL No.	**Level**	**Critical Factors**
1	1st	Continuous improvement and performance measurement (Factor-12)
2	2nd	Supply chain management and supplier responsibility (Factor-11)
3	3rd	Worker training and awareness (Factor-2) Management commitment and leadership (Factor-3) Safety culture and communication (Factor-4) Hazard identification and risk assessment (Factor-5) Personal protective equipment (PPE) (Factor-6) Machinery and equipment safety (Factor-7) Emergency preparedness and response (Factor-8) Occupational health and hygiene (Factor-9) Employee participation and involvement (Factor-10)
4	4th	Government regulations and policies (Factor-1)

After ISM analysis is completed, the focus shifts to MICMAC analysis, which further improves our understanding of the system's complex dynamics and interdependencies.

3.3.6 MICMAC Analysis

MICMAC deployment integrates analysis with ISM to enhance understanding, enabling efficient problem-solving, organizational analysis, and strategic decision-making. The MICMAC diagram is a graphical representation of the results of the MICMAC analysis. It consists of four quadrants, each of which represents a different type of factor. The first quadrant (I) represents the autonomous factors, which have a low level of influence and are not influenced by other factors. Our study did not identify any factors as autonomous. The second quadrant (II) represents the dependent factors, which have a high level of influence but are not influenced by other factors. In our study, factors 11 and 12 (Supply chain management and supplier responsibility, Continuous improvement and performance measurement) were identified as dependent factors. The third quadrant (III) represents the linked factors, which have a moderate level of influence and are influenced by other factors. In our study, factors 2 through 10 (Worker training and awareness, Management commitment and leadership, Safety culture and communication, Hazard identification and risk assessment, Personal protective equipment (PPE), Machinery and equipment safety, Emergency preparedness and response, Occupational health and hygiene, Employee participation and involvement) were identified as linked factors, so they would be placed in this quadrant. The fourth quadrant (IV) represents the independent factors, which have a high level of influence and influence other factors. In our study, factor 1 (Government regulations and policies) was identified as an independent factor, so it would be placed in this quadrant. The MICMAC diagram is shown in Figure 1. So, the MICMAC diagram helps to visualize the interrelationships between the different factors and provides insights into how to develop effective strategies for improving workplace safety in the RMG sector.

I - Autonomous Variables
II - Dependent Variables
III - Linkage Variables
IV - Independent Variables



1 2 3 4 5 6 7 8 9 10 11 12

Dependence Power →

Figure 1. MICMAC analysis

4. Discussion

Based on our MICMAC analysis results, it appears that factor 1, "Government regulations and policies," is an independent variable, means it has the most influence on the other factors and is not influenced by any other factors. Factors 2 to 10, on the other hand, are in the linked variable category, meaning they are both influenced by and have an influence on other factors. Finally, factors 11 and 12 are in the dependent variable category, meaning they are mostly influenced by the other factors and do not have as much influence on the system. The result of the MICMAC diagraph is shown by using the Figure 2.

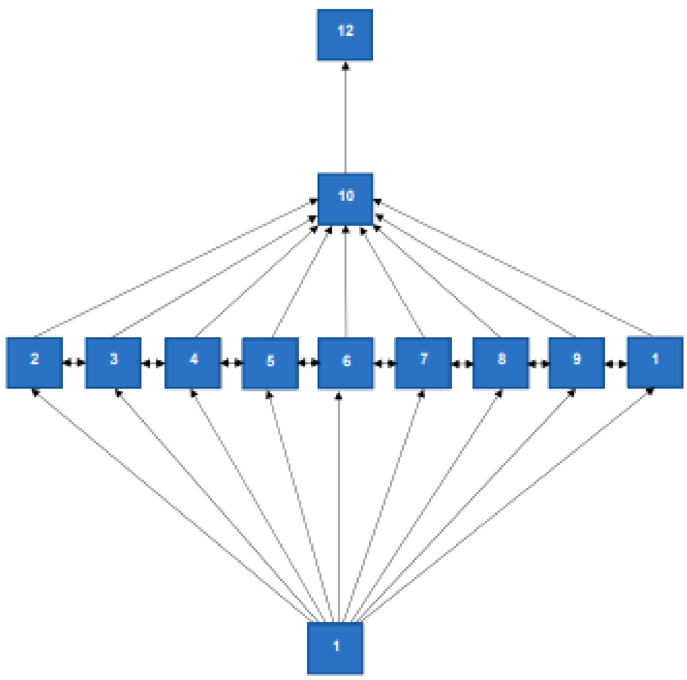


Figure 2. The hierarchical structure of Safety factors

5. Conclusion

This study aimed to investigate critical factors for implementing safety measures in the RMG sector using ISM-MICMAC. The study identified 12 critical factors and analyzed their inter-relationships using the ISM-MICMAC approach. The study found that government regulations and policies were the most critical factor, followed by worker training, safety culture, and risk assessment. The study's findings have several implications for policymakers and industry stakeholders in the RMG sector. The study highlights the importance of developing and enforcing robust regulations and policies to improve safety measures in the sector. Additionally, stakeholders should prioritize investments in training and development programs for workers and create a safety culture within organizations. Risk assessment should also be a priority to identify and mitigate potential hazards in the workplace. The study had several limitations, including its focus on the RMG sector in Bangladesh and the reliance on expert opinions. Future research could explore the perspectives of workers and other stakeholders in the sector and examine the effectiveness of different types of safety measures, such as technology-based solutions. Further research could also explore the impact of external factors, such as the political and economic context, on the implementation of safety measures in the RMG sector.

Conflict of Interest

The author(s) declare no conflict of interest (financial or non-financial).

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