

CHAPTER 4

UNDERSTANDING THE INTERRELATIONSHIP BETWEEN HCWM BARRIERS

Developing nations like India face inequality in healthcare access due to unbalanced resource allocation, inadequate healthcare structure, and high cost of health services (Ashutosh *et al.*, 2019). Properly disposal of waste generated through health services is challenging, so healthcare waste management is also receiving considerable attention after implementing Biomedical waste management and handling rules in 1998. Per-day waste generation in India varies from 0.5 to 2 kg per bed, and it counts to 0.33 million per year; it is a massive amount of waste to be handled carefully (Patil *et al.*, 2001). More than six lakhs of hospital beds in India, over twenty-three thousand Health Centers, and registered nursing homes. Many hospitals and dispensaries need to be registered. Health centers practice at every corner of urban and semi-urban areas (Swain *et al.*, 2017).

A literature review of papers published in different journals during the previous years and expert opinion was used to identify the barriers. Only peer-reviewed articles have been targeted. Experts found fifteen walls (Table 2.2) relevant and valid (Deshmukh *et al.*, 2017)—a brief discussion of these barriers, as identified from the literature and validated by the experts.

4.1 Identification and definition of barriers:

The Healthcare waste management barriers in Indian hospitals are identified using extensive literature review and expert opinion. Experts from Government and Private hospitals validate the identified barriers. Fifteen barriers were selected for the final study explained. The contextual relationship among barriers was developed using an extensive literature review and expert opinion. As discussed in section 2.2

4.2 Total Interpretative Structure Modeling:

ISM shows a complete system model of attributes or elements, directly and indirectly, related to each other. ISM's basic idea is to use insights generated from the literature review. ISM clarifies the direct and indirect

relationship between barriers more than those considered in isolation. TISM has many advantages over ISM (Jena, 2016). The results of the ISM are shown visually as a hierarchical structure that includes the causal dependent links between the practices and levels in the hierarchy of their influencing power. According to the available literature, ISM is employed with system practices that have a method for accomplishing a common goal and have similar characteristics.

Additionally, the results or hierarchical structure merely show the relationships of hierarchy and causal dependence between the activities. They are slower to interpret these linkages, however. Consequently, the total interpretative structural modeling (TISM) approach was proposed (Sushil, 2012). Each connection explains the hierarchical structure of TISM and includes all of the ISM properties. Additionally, MICMAC analysis is frequently seen as an integral component of the ISM and TISM, which classify practices into four categories: autonomous, linking, driving, and dependent. Because of its capacity to prioritize and describe the causal dependent linkages among the many system attributes, the TISM technique has the edge over other multi-attribute decision-making (MADM) approaches. It is the best strategy for achieving our research goal of identifying and classifying the barriers that support the light of the novelty of TISM combined with MICMAC analysis. Although the ISM can be presented in a varied various article uses, Prasad and Suri's (2011) and Sushil (2012)'s conceptual presentation description of the TISM model applied in this study follows as shown in Figure 4.1

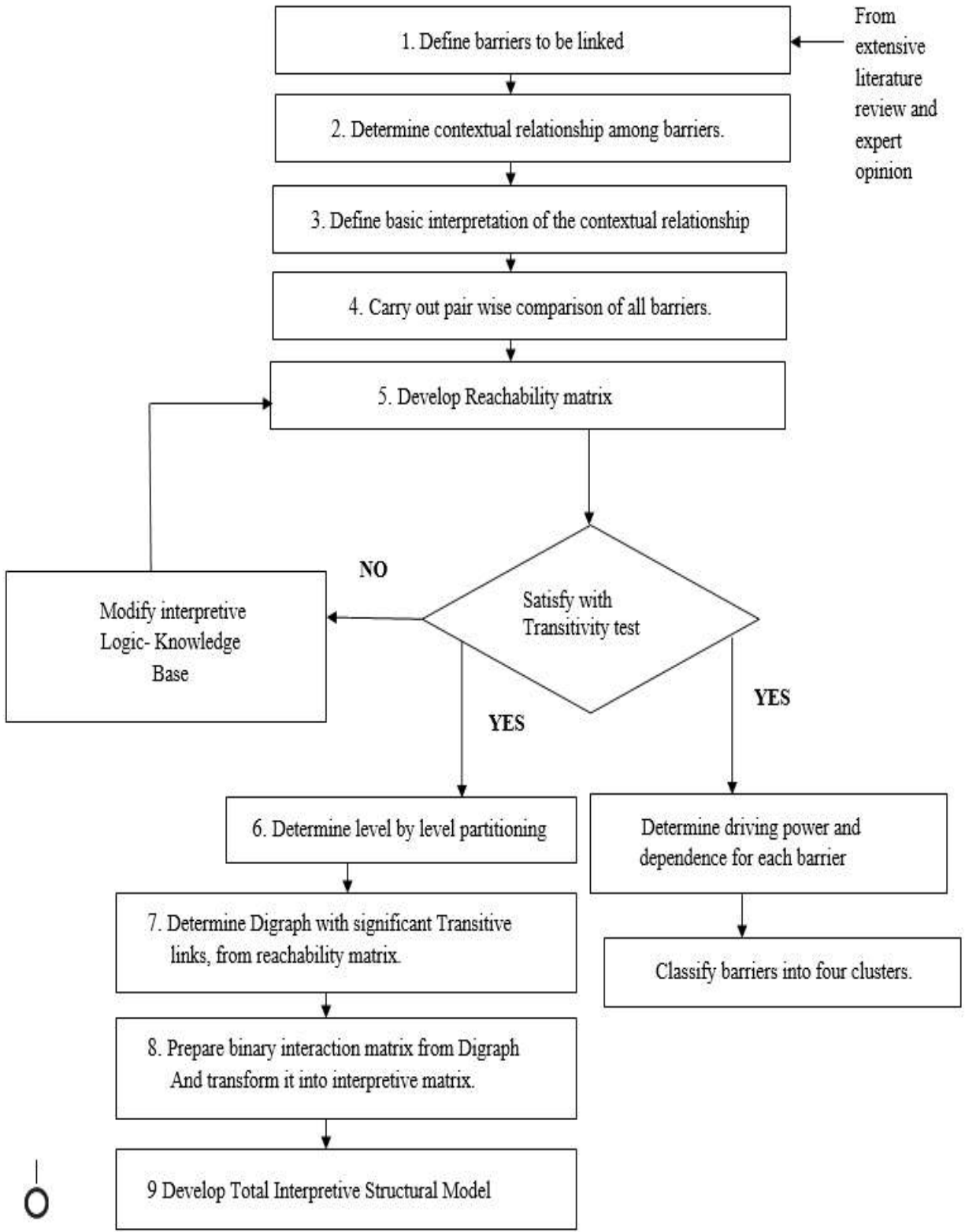


Figure 4.1 Flow Chart for TISM

STEP 1 Development of Structural Self-Interaction Matrix (SSIM): A structured questionnaire was presented to Varanasi city experts to develop a structural self-interaction matrix (SSIM). City solution methodology uses experts’ opinions with the help of discussion and interviews to develop interrelation among the barriers on the structured questionnaire. All the experts agreed on particular relations among the barriers. A total of 7 experts participated, including five experts from Government and two from private hospitals. All the experts have more than ten years of experience in the Healthcare sector. Experts have to choose one value from Y and N, to give the relation between elements i and j; the Structural self-interaction matrix can be formed by using the symbols Y (Yes) and N (No). Where “Y” signifies that the barrier influences other barrier, and “N” signifies that barrier does not have any relationships (Prasad and Suri, 2011; Sushil, 2012). Here is a Total of 15 barriers; SSIM is shown in Table 4.1. This is the final opinion of the experts which we get by considering 70% (Majority) of experts’ opinions either they agree on Y or N.

Table 4.1. Structural Self-Interaction Matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	Y	Y	N	N	Y	N	N	N	N	Y	N	Y	N	N	Y
B2	N	Y	N	N	N	N	N	N	Y	Y	N	N	N	N	Y
B3	N	N	Y	N	N	N	N	N	N	N	N	N	Y	Y	Y
B4	N	N	N	Y	N	Y	N	N	N	N	N	N	Y	Y	Y
B5	N	N	N	N	Y	N	N	N	N	Y	Y	N	N	N	Y
B6	N	N	N	N	N	Y	Y	N	N	N	N	N	Y	Y	N
B7	N	N	N	N	N	N	Y	N	N	N	N	N	Y	Y	Y
B8	Y	N	N	N	N	N	N	Y	N	Y	N	Y	N	N	Y
B9	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	Y

B10	N	N	Y	Y	N	Y	Y	N	Y	Y	Y	N	N	N	Y
B11	N	N	N	N	N	Y	Y	N	N	Y	Y	N	N	N	Y
B12	Y	Y	N	N	Y	N	N	N	N	Y	N	Y	N	N	Y
B13	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N
B14	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N
B15	N	N	N	N	N	Y	Y	N	N	N	N	N	Y	Y	Y

STEP 2 Designing of Reachability Matrix: The reachability matrix will be a binary matrix in which the SSIM matrix's value is converted into 1 and 0 per the rules.

- If Y is the symbol in SSIM, then $(i, j) = 1$
- If N is the symbol in SSIM, then $(i, j) = 0$

The designed Reachability Matrix is shown in Table 4.2 based on the above rule.

Table 4.2 Initial Reachability Matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	1	1	0	0	1	0	0	0	0	1	0	1	0	0	1
B2	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1
B3	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1
B4	0	0	0	1	0	1	0	0	0	0	0	0	1	1	1
B5	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1
B6	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0
B7	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1
B8	1	0	0	0	0	0	0	1	0	1	0	1	0	0	1
B9	0	0	0	0	0	1	1	0	1	1	0	0	0	0	1
B10	0	0	1	1	0	1	1	0	1	1	1	0	0	0	1
B11	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1
B12	1	1	0	0	1	0	0	0	0	1	0	1	0	0	1
B13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
B14	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
B15	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1

STEP 3 Developing the Final Reachability Matrix: The final reachability matrix is obtained after performing the transitivity test. This indicates whether there is some relationship between the two barriers or not. The Final Reachability Matrix is shown in Table 4.3.

Table 4.3 Final Reachability Matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B1	B1	B1	B1	Drive r
												2	3	4	5	
B1	1	1	*1	*1	1	*1	*1	0	*1	1	*1	1	*1	*1	1	14
B2	0	1	*1	*1	0	*1	*1	0	1	1	*1	0	*1	*1	1	11
B3	0	0	1	0	0	*1	*1	0	0	0	0	0	1	1	1	6
B4	0	0	0	1	0	1	*1	0	0	0	0	0	1	1	1	6
B5	0	0	*1	*1	1	*1	*1	0	*1	1	1	0	*1	*1	1	11
B6	0	0	0	0	0	1	1	0	0	0	0	0	1	1	*1	5
B7	0	0	0	0	0	*1	1	0	0	0	0	0	1	1	1	5
B8	1	*1	*1	*1	*1	*1	*1	1	*1	1	*1	1	*1	*1	1	15
B9	0	0	*1	*1	0	1	1	0	1	1	*1	0	*1	*1	1	10
B10	0	0	1	1	0	1	1	0	1	1	1	0	*1	*1	1	10
B11	0	0	*1	*1	0	1	1	0	*1	1	1	0	*1	*1	1	10
B12	1	1	*1	*1	1	*1	*1	0	*1	1	*1	1	*1	*1	1	14
B13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	13
B14	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	13
B15	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	10
Dep ende nce	3	4	9	9	4	13	13	1	8	8	8	3	15	15	13	

Step 4 Level Partitioning: With the help of the Final Reachability Matrix, the reachability set and antecedent sets are found. Level Partition is performed to do the ranking of each barrier. It is an iterative process with the help of the Reachability, Antecedent, and Intersection sets. Different levels are defined for all the barriers, as shown in Table 4.4

Table 4.4 Level Partitioning

First Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B1	1,2,3,4,5,6,7,9,10,11,12 13,14,15	1,8,12	1,12	
B2	2,3,4,6,7,8,9,10,11,13,14,15	1,2,8,12	2	
B3	3,6,7,13,14,15	1,2,3,5,8,9,10,11,12	3	
B4	4,6,7,13,14,15	1,2,3,4,5,8,9,10,11,12	4	
B5	3,4,5,6,7,9,10,11,13,14,15	1,5,8,12	5	
B6	6,7,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12,15	6,7,15	
B7	6,7,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12,15	6,7,15	
B8	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15	8	8	
B9	3,4,6,7,9,10,11,13,14,15	1,2,5,8,9,10,11,12	9,10,11	
B10	3,4,6,7,9,10,11,13,14,15	1,2,5,8,9,10,11,12	9,10,11	
B11	3,4,6,7,9,10,11,13,14,15	1,2,5,8,9,10,11,12	9,10,11	
B12	1,2,3,4,5,6,7,9,10,11,12 ,13,14,15	1,8,12	1,12	
B13	13,14	1,2,3,4,5,6,7,8,9,10,11,12,13, 15	13,14	I
B14	13,14	1,2,3,4,5,6,7,8,9,10,11,12,13, 14,15	13,14	I
B15	6,7,13,14,15	1,2,3,4,5,6,7,8,9,10,11,12,15	6,7,15	

Second Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B1	1,2,3,4,5,6,7,9,10,11,12,15	1,8,12	1,12	
B2	2,3,4,6,7,8,9,10,11,15	1,2,8,12	2	
B3	3,6,7,15	1,2,3,5,8,9,10,11,12	3	
B4	4,6,7,15	1,2,3,4,5,8,9,10,11,12	4	
B5	3,4,5,6,7,9,10,11,15	1,5,8,12	5	
B6	6,7,15	1,2,3,4,5,6,7,8,9,10,11,12,15	6,7,15	II
B7	6,7,15	1,2,3,4,5,6,7,8,9,10,11,12,15	6,7,15	II
B8	1,2,3,4,5,6,7,8,9,10,11,12,15 5	8	8	
B9	3,4,6,7,9,10,11,15	1,2,5,8,9,10,11,12	9,10,11	
B10	3,4,6,7,9,10,11,15	1,2,5,8,9,10,11,12	9,10,11	
B11	3,4,6,7,9,10,11,15	1,2,5,8,9,10,11,12	9,10,11	
B12	1,2,3,4,5,6,7,9,10,11,12,15	1,8,12	1,12	
B15	6,7,15	1,2,3,4,5,6,7,8,9,10,11,12,15	6,7,15	II

Third Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B1	1,2,3,4,5,9,10,11,12	1,8,12	1,12	
B2	2,3,4,8,9,10,11	1,2,8,12	2	

B3	3	1,2,3,5,8,9,10,11,12	3	III
B4	4	1,2,3,4,5,8,9,10,11,12	4	III
B5	3,4,5,9,10,11	1,5,8,12	5	
B8	1,2,3,4,5,8,9,10,11,12	8	8	
B9	3,4,9,10,11	1,2,5,8,9,10,11,12	9,10,11	
B10	3,4,9,10,11	1,2,5,8,9,10,11,12	9,10,11	
B11	3,4,9,10,11	1,2,5,8,9,10,11,12	9,10,11	
B12	1,2,3,4,5,9,10,11,12	1,8,12	1,12	

Fourth Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B1	1,2,5,9,10,11,12	1,8,12	1,12	
B2	2,8,9,10,11	1,2,8,12	2	
B5	5,9,10,11	1,5,8,12	5	
B8	1,2,5,8,9,10,11,12	8	8	
B9	9,10,11	1,2,5,8,9,10,11,12	9,10,11	IV
B10	9,10,11	1,2,5,8,9,10,11,12	9,10,11	IV
B11	9,10,11	1,2,5,8,9,10,11,12	9,10,11	IV
B12	1,2,5,9,10,11,12	1,8,12	1,12	

Fifth Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B1	1,2,5,12	1,8,12	1,12	
B2	2	1,2,8,12	2	V
B5	5	1,5,8,12	5	V
B8	1,2,5,8,12	8	8	
B12	1,2,5,12	1,8,12	1,12	

Sixth Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B1	1,12	1,8,12	1,12	VI
B8	1,8,12	8	8	
B12	1,12	1,8,12	1,12	VI

Seventh Level of Iteration Partitioning

Barrier	Reachability Set	Antecedent Set	Intersection set	Level
B8	1,8,12	8	8	VII

Table 4.5 Level Partitioning of Barriers

Sr. No.	Level	Barriers
1	I	Less implementation of disinfectant techniques No Information about waste quantity
2	II	No separation and Collection center Not Availability of Incineration Plant Less Number of recycling centers
3	III	Less Number of Working Staffs Lack of Bins
4	IV	Less Number of availability of Tools Rigidness with their old thinking Lack of coordination with authorities
5	V	No Proper training and Workshops

		No support from Top Authorities
6	VI	Less Awareness on HCWM Less Priority to HCWM
7	VII	No Support from Government

4.4 Total interpretive structural model:

A TISM-based model is developed from the information of the interpretive matrix and digraph for barriers in HCWM sectors is shown in figure 4.3

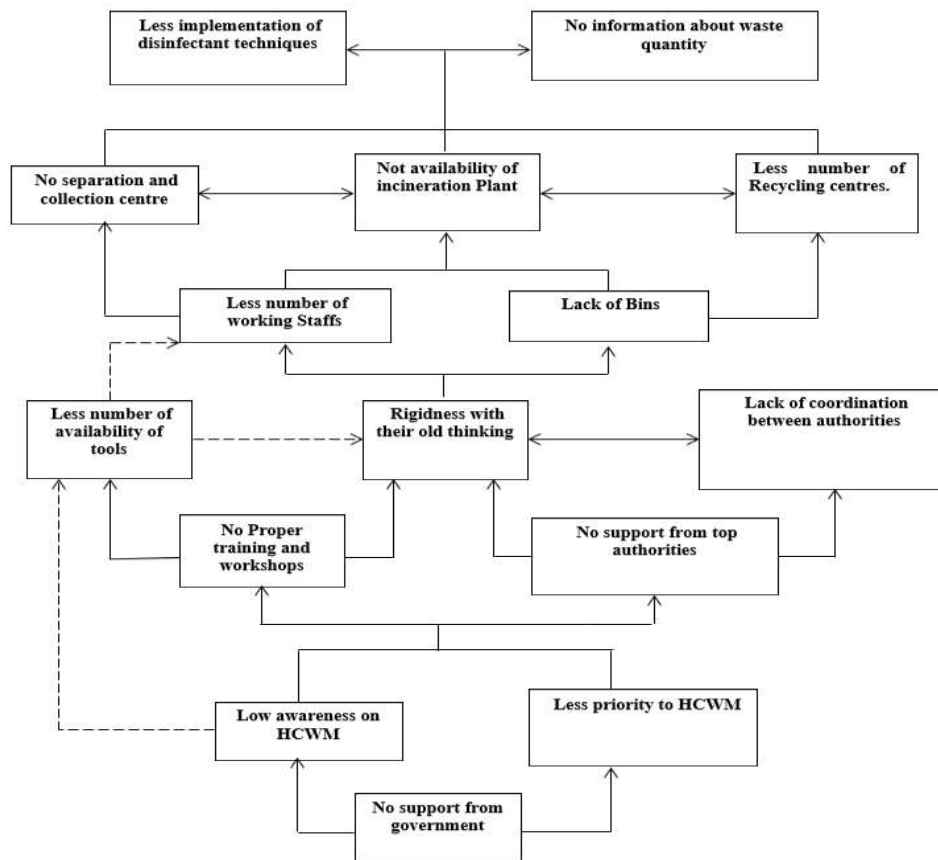


Figure 4.3: TISM MODEL

The factors in the top hierarchy, which are primarily influenced or dependent on other factors, are “Less implementation of disinfectant techniques,” “No information about waste quantity,” “No separation and collection center,” and “Less number of recycling centers.” The independent barriers are at the bottom hierarchy of TISM, which drives all other barriers. The factors in the bottom hierarchy are “Low awareness of HCWM,” “Less priority to HCWM,” and “No support from Government,” which are considered the topmost drivers for driving proper HCWM. These top drivers would help the top authorities make strategic plans to improve HCWM processes.

MICMAC analysis is performed to identify barriers that mainly drive the whole system. In rows, an entry of “1” represents the barrier’s driving power, and “1” in the column represents the barrier’s dependence power. It is shown in table 4.3. It is performed to categorize the barriers into four clusters.

4.5 MICMAC Analysis: Chandramowli *et al.* (2011), Michel Godget and Francois Bourse gave the concept of the MICMAC analysis and are used to cluster the practices of a system into dependent, independent, autonomous, and linkage group practices based on their interdependence relationships.

Driving power is the influencing power of a particular barrier. If the driving power is high, then a particular barrier will influence more barriers and if the dependence power is high, it denotes that the particular barrier will get influenced from a large number of barriers.

Cluster I: Weak driving and dependence power

The barriers under this category neither influence any other barriers nor influenced by other barriers. In the present case, no barriers are in the first cluster; all fifteen barriers are significant for strategic decision-making.

Cluster II: Weak Driving and Strong Dependence on Power

Barriers: Insufficient staff working in HCWM (B3), Unavailability of segregation bins (B4), No

Segregation and Collection center (B6), and Incineration plant, not within the Hospital (B7) have a high dependence and weak driving powers and have been placed at the top level in the model.

Cluster III: Strong driving and dependence on power

In our study, six barriers fell into this cluster, Lack of handling tools and precautions(B9), Reluctance to change and adoption(B10), No coordination between the municipality, Pollution Control Board, and hospital authorities(B11), No Strict implementation of disinfectant techniques(B13), No adequate information regarding waste quantity and compositions(B14) and Lack of Recycling Centers (B15). These linkage barriers are in the model's middle levels in the model.

Cluster IV: Strong driving and weak dependence powers

Total of five barriers fell in cluster IV: Lack of Awareness(B1), Lack of Training(B2), Lack of Top Authority's dedication towards HCWM(B5), Lack of Government Support and Policies(B8), Lesser Prioritization to Waste Management issues in policies of Health Care Units(B12).

The barriers to the healthcare waste management sector identified by us are the leading barriers supported by various studies (Ashutosh *et al.*, 2019, Patil *et al.*, 2001, Swain *et al.*,2017). The barriers to implementing healthcare waste management in India are similar to most other developing nations, also identified by several research (Mbongwe *et al.*, 2008, Khan *et al.*, 2019, Virginia *et al.*, 2016). MICMAC analysis is shown in figure 4.4

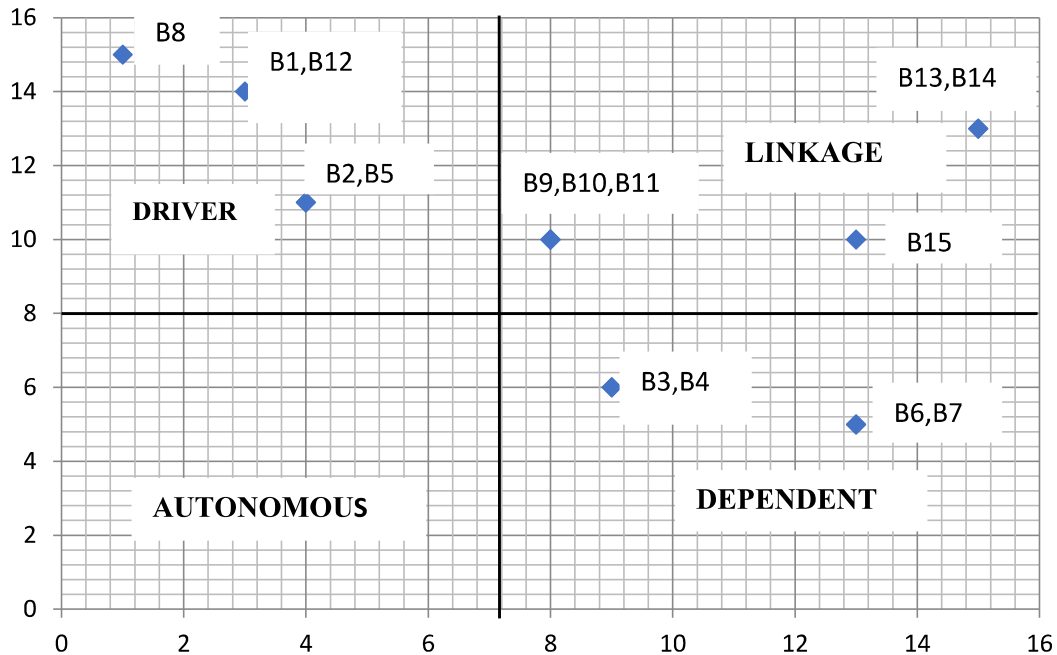


Figure 4.4 MICMAC Analysis

To justify the results obtained from TISM method one more method DEMATEL is used which, classify barriers into cause-and-effect category. More influencing barriers will be under Cause category and less influencing barriers will be under effect category.

4.6 DEMATEL:

The following steps are involved in the DEMATEL methodology to solve the problem.

STEP 1: Design of Direct Relation Matrix-With the help of expert's opinion on the Likert Scale, a Direct relation matrix is formed. The Likert scale varies from 0 to 4. Where 0 is for No influence between barriers, 1 is for Low influence between barriers, 2 is for medium influence between barriers, 3 is for High influence between barriers, and 4 is for Very High influence between barriers.

$$K = \begin{pmatrix} a_{11}a_{12}\dots\dots a_{1n} \\ a_{21}a_{22}\dots\dots a_{2n} \\ \vdots \\ a_{n1}a_{n2}\dots\dots a_{nn} \end{pmatrix} \quad : \quad K = [a_{ij}]_{n*n}$$

Based on the above rule, a direct relation matrix is formed, shown in table 4.6.

Table 4.6 Direct Relation Matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	0	3	2	3	2	3	2	3	4	3	2	4	3	2	1
B2	2	0	2	3	3	4	1	3	4	2	3	2	3	4	4
B3	0	1	0	1	4	2	0	3	1	4	2	2	3	3	1
B4	2	0	0	0	1	3	0	3	4	2	0	4	2	4	1
B5	1	0	4	1	0	2	0	3	3	2	2	3	3	2	1
B6	2	1	4	4	4	0	0	4	1	2	3	4	4	4	1
B7	3	3	3	1	2	2	0	4	1	3	0	4	3	3	3
B8	2	2	3	3	3	4	4	0	4	2	2	3	3	2	3

B9	2	1	3	4	4	3	0	4	0	4	2	4	4	2	3
B10	3	3	4	4	3	3	3	0	4	0	4	4	4	3	3
B11	2	2	3	2	1	3	2	3	1	1	0	2	2	3	3
B12	3	3	3	3	3	3	4	3	3	2	3	0	3	4	2
B13	4	4	4	4	4	4	4	0	4	2	1	3	0	3	1
B14	2	1	3	4	4	2	1	0	2	1	2	3	3	0	2
B15	1	0	0	0	0	1	0	1	0	0	1	2	1	2	0

Step 2: Normalized Relation Matrix- By using the following formulation, Normalized Relation Matrix is formed, which is shown in Table 4.7

$$Y=K/S \quad Y = \text{Normalized Relation Matrix}$$

$$K= \text{Direct Relation Matrix}$$

$$S= \max\left\{ \frac{\max}{1 \leq i \leq n} \left\{ \sum_{j=1}^n |x_{ij}| \right\}, \frac{\max}{1 \leq j \leq n} \left\{ \sum_{i=1}^n |x_{ij}| \right\} \right\}$$

Where $i, j \in \{1, 2, \dots, n\}$

Table 4.7 Normalized Relation Matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	0	0.06	0.04	0.061	0.04	0.06	0.04	0.06	0.08	0.06	0.04	0.08	0.06	0.04	0.02
B2	0.04	0	0.04	0.061	0.06	0.08	0.02	0.06	0.08	0.04	0.06	0.04	0.06	0.08	0.08

B3	0	0.02	0	0.02	0.08	0.04	0	0.06	0.02	0.08	0.04	0.04	0.06	0.06	0.02
B4	0.04	0	0	0	0.02	0.06	0	0.06	0.08	0.04	0	0.08	0.04	0.08	0.02
B5	0.02	0	0.08	0.02	0	0.04	0	0.06	0.06	0.04	0.04	0.06	0.06	0.04	0.02
B6	0.04	0.02	0.08	0.082	0.08	0	0	0.08	0.02	0.04	0.06	0.08	0.08	0.08	0.02
B7	0.06	0.06	0.06	0.02	0.04	0.04	0	0.08	0.02	0.06	0	0.08	0.06	0.06	0.06
B8	0.04	0.04	0.06	0.061	0.06	0.08	0.08	0	0.08	0.04	0.04	0.06	0.06	0.04	0.06
B9	0.04	0.02	0.06	0.082	0.08	0.06	0	0.08	0	0.08	0.04	0.08	0.08	0.04	0.06
B10	0.06	0.06	0.08	0.082	0.06	0.06	0.06	0	0.08	0	0.08	0.08	0.08	0.06	0.06
B11	0.04	0.04	0.06	0.041	0.02	0.06	0.04	0.06	0.02	0.02	0	0.04	0.04	0.06	0.06
B12	0.06	0.06	0.06	0.061	0.06	0.06	0.08	0.06	0.06	0.04	0.06	0	0.06	0.08	0.04
B13	0.08	0.08	0.08	0.082	0.08	0.08	0.08	0.08	0	0.08	0.02	0.06	0	0.06	0.02
B14	0.04	0.02	0.06	0.082	0.08	0.04	0.02	0	0.04	0.02	0.04	0.06	0.06	0	0.04
B15	0.02	0	0	0	0	0.02	0	0.02	0	0	0.02	0.04	0.02	0.04	0

STEP 3: Development of Total Relation matrix: The Total Relation Matrix is formed using the following formulation, which is shown in Table 4.8.

$$T = Y * (I - Y)^{-1}$$

$$T = [t_{ij}]_{n \times n} \text{ Where } i, j = \{1, 2, \dots, n\}$$

Y = Normalized Relation Matrix

I = Identity Matrix

Table 4.8 Total Relation Matrix

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	0.13	0.17	0.22	0.24	0.22	0.25	0.16	0.25	0.23	0.21	0.17	0.28	0.26	0.23	0.16
B2	0.17	0.11	0.22	0.24	0.24	0.26	0.14	0.25	0.23	0.19	0.19	0.24	0.26	0.27	0.21
B3	0.1	0.11	0.14	0.16	0.22	0.18	0.1	0.2	0.14	0.19	0.14	0.19	0.21	0.2	0.12
B4	0.14	0.09	0.14	0.14	0.16	0.2	0.09	0.2	0.19	0.16	0.1	0.23	0.19	0.22	0.12
B5	0.12	0.09	0.22	0.16	0.14	0.18	0.1	0.2	0.17	0.16	0.14	0.21	0.21	0.18	0.12
B6	0.17	0.13	0.26	0.26	0.26	0.19	0.13	0.27	0.17	0.19	0.19	0.28	0.28	0.27	0.15
B7	0.18	0.17	0.23	0.19	0.22	0.22	0.12	0.25	0.17	0.2	0.12	0.27	0.25	0.24	0.19
B8	0.18	0.16	0.25	0.24	0.25	0.27	0.2	0.2	0.23	0.2	0.17	0.27	0.27	0.24	0.2
B9	0.17	0.13	0.24	0.25	0.26	0.24	0.12	0.26	0.15	0.23	0.16	0.27	0.27	0.23	0.19
B10	0.21	0.19	0.29	0.28	0.27	0.27	0.19	0.22	0.25	0.18	0.22	0.31	0.31	0.28	0.21
B11	0.14	0.13	0.2	0.18	0.17	0.21	0.14	0.21	0.14	0.14	0.1	0.2	0.2	0.21	0.17
B12	0.2	0.18	0.26	0.25	0.26	0.26	0.21	0.27	0.22	0.21	0.2	0.22	0.28	0.29	0.19
B13	0.22	0.2	0.28	0.27	0.28	0.28	0.2	0.28	0.17	0.24	0.16	0.28	0.22	0.27	0.16
B14	0.13	0.1	0.19	0.21	0.21	0.18	0.1	0.14	0.15	0.13	0.13	0.21	0.2	0.14	0.13
B15	0.06	0.04	0.06	0.06	0.06	0.08	0.04	0.08	0.05	0.05	0.06	0.1	0.08	0.1	0.04

STEP 4: The sum of Rows and Columns, which is known as the Degree of Influence, is obtained by using the following formula, which is denoted by D_i and R_j respectively, in table 4.9

$$D_i = [\sum_{j=1}^n t_{ij}] \quad \forall j = \{1, 2 \dots n\}$$

$$R_j = [\sum_{i=1}^n t_{ij}] \quad \forall i = \{1, 2 \dots n\}$$

With the help of D_i+R_j and D_i-R_j , cause and effects are easily identified.

Table 4.9 Degree of Influence

	D_i	R_j	D_i+R_j	D_i-R_j	Cause/effect
B1	3.44	2.42	5.87	1.018	cause
B2	3.48	2.1	5.58	1.384	cause
B3	2.64	3.38	6.01	-0.74	effect
B4	2.6	3.3	5.9	-0.7	effect
B5	2.63	3.42	6.05	-0.78	effect
B6	3.48	3.49	6.98	-0.01	effect
B7	3.28	2.21	5.49	1.075	cause
B8	3.63	3.49	7.12	0.132	cause
B9	3.35	2.83	6.18	0.525	cause
B10	4	2.87	6.86	1.128	cause
B11	2.78	2.36	5.14	0.412	cause
B12	3.8	3.79	7.58	0.011	cause
B13	3.75	3.75	7.5	-0.01	effect
B14	2.54	3.56	6.1	-1.02	effect
B15	1.1	2.51	3.61	-1.4	effect

In the DEMATEL analysis, All fifteen barriers are plotted according to D_i+R_j and D_i-R_j values to obtain a causal diagram. Is shown in figure 4.5 suggest that the barriers (**Lack of awareness, lack of training, lack of government support and policies, lack of handling tools and precautions, reluctance to change and adoption, and lack of Coordination between the municipality, pollution control boards, and hospital authorities**) were the leading causes and rest of the barriers are the effects. Without overcoming these

barriers, proper implementation of Health care waste management is not possible.

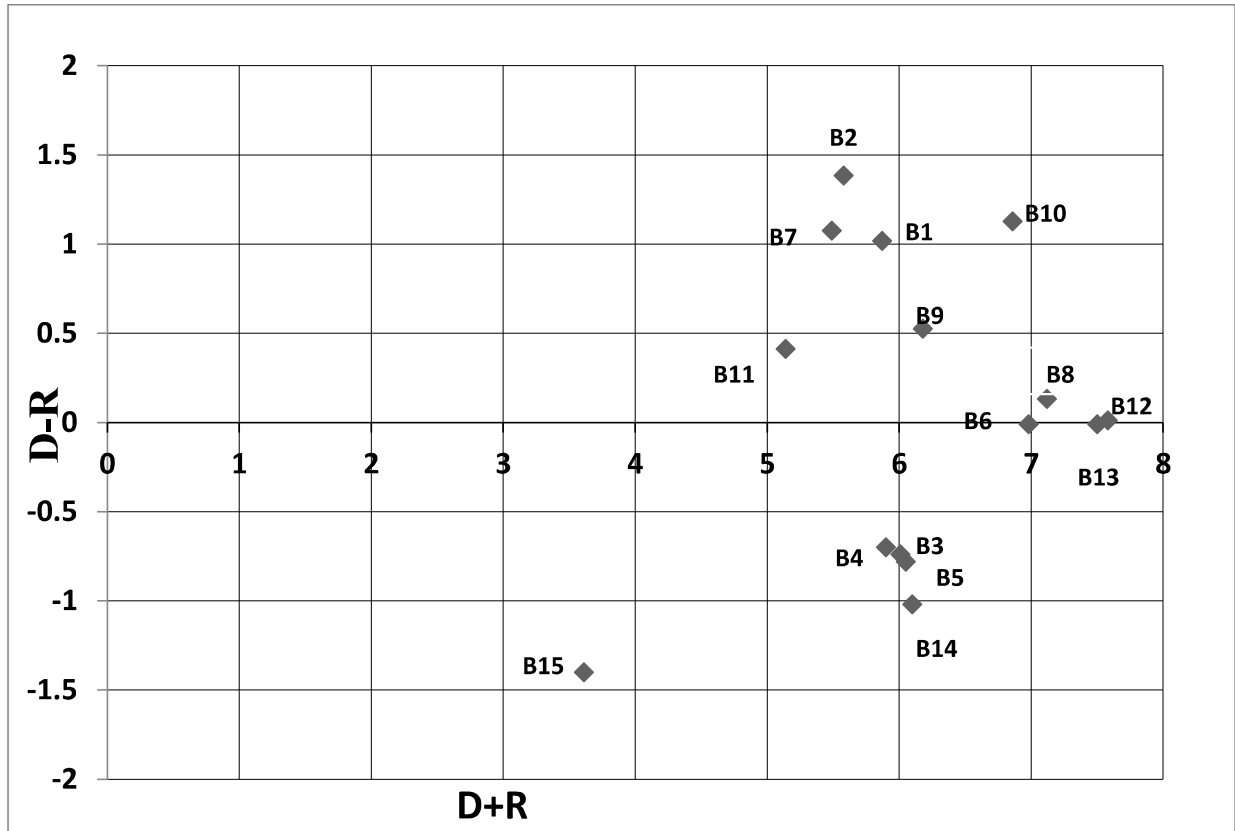


Figure 4.5 Causal Diagram

On comparing the results of TISM and DEMATEL analysis, shown in table 4.10, many similarities were found between the results.

Table 4.10 Comparison of TISM and DEMATEL Analysis

S.N.	TISM	DEMATEL
1	Lack of Awareness (B1)	Lack of Awareness (B1)
2	Lack of Training (B2)	Lack of Training (B2)
3	Lack of Top Authority's dedication towards HCWM(B5)	Incineration plants not within the Hospital (B7)
4	Lack of Government Support and Policies (B8)	Lack of Government Support and Policies (B8)
5	Lesser Prioritization of Waste Management issues in policies of Health Care Units (B12)	Lesser Prioritization of Waste Management issues in policies of Health Care Units (B12)

4.7 Results and Discussions:

In this thesis, an attempt has been made to explore the different healthcare waste management barriers. Few research papers are available on healthcare waste management barriers. Still, no study can conclude the hierarchical relationship between the healthcare waste management sector's barriers and further analysis of these barriers with the help of TISM and DEMATEL analysis. TISM methodology classified barriers into four clusters. The clusters are shown in Figure 4.4. Five barriers were found in the driver category: the main ones driving other barriers. **Out of these five main drivers, we identified two explicitly: Lack of**

Government Support and Policies (B8) and Lack of Top Authorities' dedication towards HCWM (B5). The other three main barriers are Lack of awareness (B1), lack of training (B2), and Lesser Prioritization of Waste Management issues in the policies of Health Care Units (B12).

4.8 Concluding Remark

Presently health care waste management is one of the most complex issues. So, to make the atmosphere less polluted, proper waste management is necessary. During this study, many barriers were identified. These barriers are the main obstacles to the performance of healthcare waste management. Top authorities must be supportive, and there must be some good government policies that promote proper management of healthcare waste. Training and awareness programs must be organized at the hospital level to enhance the knowledge of workers and staff. Healthcare waste management must be on all hospitals' priority lists so that enough employees must be assigned to manage waste correctly.

These barriers have significant implications for people and society, so proper implementation of Health care waste management requires the elimination of these barriers. These barriers must be helpful for the policymakers and the hospital authorities to make beneficial policies for people and society.

4.9 Theoretical and Managerial implications:

This chapter introduces a revolutionary method that visualizes and quantifies the parts of a system inside a logical framework. The ability to comprehend the causal dependent relationships and the relative importance of each component helps the decision-makers. This could aid the decision-maker in formulating policies and planning how best to use their resources.