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Examine Barriers of lean manufacturing in Small Scale Water Tank Manufacturing Industry by ISM approach

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Abstract - This thesis aims to "Examine Barriers of Lean Manufacturing in Small Scale Manufacturing Industry by using ISM. "For small businesses, "lean manufacturing" is a very basic instrument that will help them work more simply and create a work environment that will boost prosperity and productivity. The biggest issue affecting small and medium-sized businesses is the lack of awareness about lean manufacturing benefits and lack of financial support when implementing "Lean manufacturing. As a result, barriers to this study are identified with the assistance of professionals from industry and academia, and the recommended procedure is put into practice in the Utkarsh Polyworld Manufacturing industry.

Key Words: Small Scale industry; Lean manufacturing industrial tool and Interpretive Structure Modelling tools.

1.INTRODUCTION

Among the many notable figures that have influenced the development of lean concepts and manufacturing resources are Toyota, Ohno, and Taylor. The most common brand we think of when we talk about lean principles is Toyota.

Lean manufacturing is particularly related to the operational model implemented in the post-war 1950s and 1960s by the Japanese automobile company Toyota called Toyota Production System (TPS), known in the US as "The Toyota Way"(Ohno, Taiichi (1988). Toyota Production System: Beyond Large-Scale Production. CRC Press. ISBN 978-0-915299-14-0).

- Toyota's system was erected on the two pillars of just-in-time inventory management and automated quality control.

The term Lean was coined in 1988 by American businessman John Krafcik in his article "Triumph of the Lean Production System", and defined in 1996 by American researchers James Womack and Daniel Jones to consist of five key principles: "Precisely specify value by specific product, identify the value stream for each product, make value flow without interruptions, let customer pull value from the producer, and pursue perfection."(Womack, James P.; Jones, Daniel T. (2003), Lean Thinking: Banish Waste And Create Wealth In Your Corporation, Simon and Schuster, p. 10, ISBN 9781471111006, archived from the original on October 22, 2021, retrieved October 2, 2020).

Figure 1-Lean Principle

2. Summary of the literature Review

Literature work of this research work has been prepared by the help of guidance from, industry owner and research paper literature survey. The including all the literature structure is shown by below given frame work: -

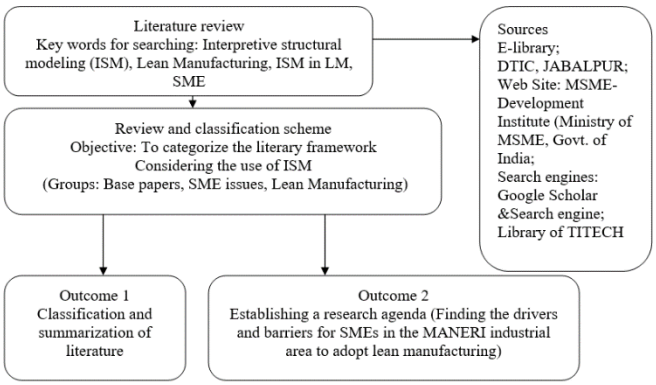

Fig. 2.3Frame Work of Literature

3. Aim of the Research Work

Previous research has demonstrated that "Lean Manufacturing" is implemented in many businesses; nevertheless, neither small-scale nor large-scale Madhya Pradesh "SME's," especially in the Jabalpur area, have adopted this practice. While some research has been done to demonstrate how "Lean Manufacturing" is implemented, more effort has to be done to collaborate among these barriers and develop an orderly model of "Lean Manufacturing" drivers. For SMEs in the Jabalpur region to implement "Lean Manufacturing" successfully, it is crucial to dismantle these barriers' ways of acting. To identify the "driving force of the barriers" (such as those that influence different obstacles) and the "reliant force of the barriers" (such as those that are impacted by others), this examination effort aims to understand the typical communication of these barriers.

4. Problem Statement

Since SMEs support industrialization, job development, and economic growth in MADHYA PRADESH, small industry is crucial to the state. With an industrial GDP of just 19% and a GDP of 11.69 trillion (US$150 billion) in 2022–2023, MADHYA PRADESH must increase its industrialization. The state government of Madhya Pradesh has implemented many initiatives, including MUHKYA MANTRI SWAROJGAR YOJNA, and has received backing from central government programs, to enhance and foster the industry of the state. SME owners in MADHYA PRADESH do not receive technical or marketing assistance from the government side outside of government initiatives. Because of this, SMEs need robust technical approaches linked to sustainable development; one tool for this is lean manufacturing. Small and medium-sized businesses prioritize obtaining and finishing projects; nevertheless, in the interim, they are ill-equipped to anticipate shifting consumer demands and the market. As a result, industries are not growing sustainably. However, SME resistance to change and the use of growth-oriented industrial tools is strong. Therefore, the first step in this research project to address the difficulties mentioned above is to identify the obstacles to lean manufacturing adoption and give SMEs a roadmap for doing so.

SMEs are primarily addressing a small number of challenges with current strategy execution; however, there are issues with every method of implementation. Since SMEs' business visionaries are unable to handle all of the difficulties at once, they require factual and numerical assistance in order to make decisions regarding the priority of issues. Therefore; the problem statement for this research project is the prioritization of obstacles to "lean manufacturing" execution.

To accomplish the goal of this study project, interviews with SME's mostly located in the Maneri, Mandla district. The manufacturers of UTKARSH POLYCOOL water tubes and UTKARSH POLWORLD water tanks have contributed the most effort and assistance.

5. Research Methodology & Structure

The goal of this thesis is to assist the UTKARSH POLYTANK water tank manufacturing sector in prioritizing the barriers based on their relative importance while implementing "Lean Manufacturing". As a result of this research, a study structure is prepared that will enable UTKARSH POLYTANK manufacturing firm to easily identify the barriers in the "Lean Manufacturing" implementation system and simultaneously understand their relative weights. Using relatively straightforward surveys and an incredibly potent device interpretive structural modeling tool, the proposed study design will let the owner of UTKARSH POLYTANK identify the hurdles without interfering with industry operations or requiring a significant financial expenditure.

At a glance, the studies layout can also identify the studies glide chart. Below is a flowchart of the research:

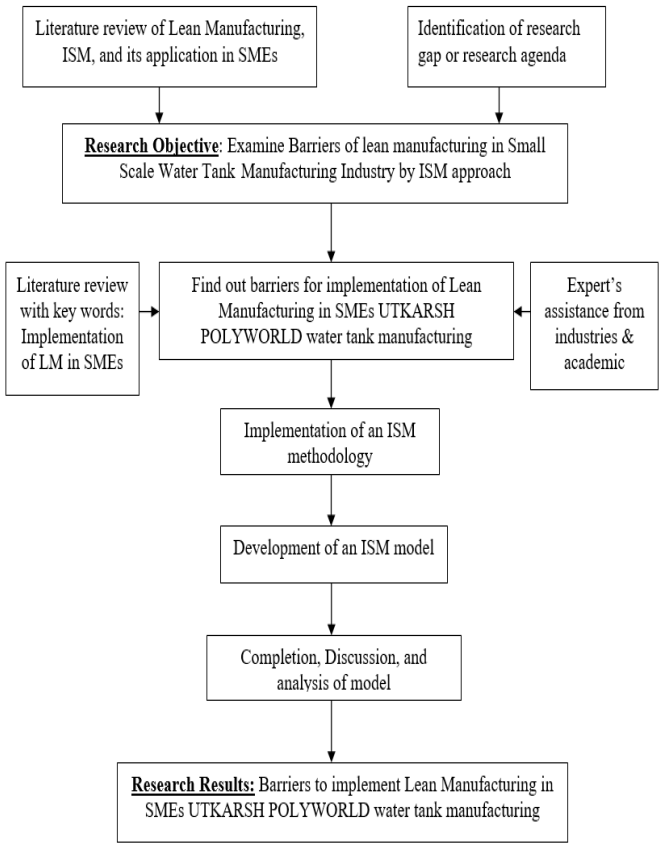

Figure 2- RESEARCH STRUCTURE

6. Barriers to Implement 'Lean Manufacturing' in Small Scale Industry

The literature review focuses on the barriers to the adoption of lean manufacturing, and each barrier was discussed with industry and academic experts at a time that works for them through phone interviews and in-person meetings. Following a discussion with fifteen experts from eight different industries and seven experts from academia, the following primary barriers were chosen to identify the drivers and driven of the SMEs located in the Maneri industrial area.

1. Inadequate communication.

2. Lack of financial support

3. Lack of government support

4. Lack of customer awareness towards green

5. Lack of human resources

6. Lack of new technology, materials, and industrial tools

7. Lack of organization motivation

8. Lack of technical support

9. Lack of top management commitment

10. Lack of employee training

11. Market competition

12. Resistance to adaptable to change

13. Lack of awareness about lean manufacturing benefits

14. Lack of performance measurement system

15. Lack of job security

16. Lack of knowledge of Lean tools

7. Data for finding barriers in the Implementation of "Lean Manufacturing" in Utkarsh Polyworld Water Tank Manufacturer

Numerous meetings and interviews were arranged to carry out this research, including ones with the proprietor of Utkarsh Polyworld Water Tank Manufacturer and academicians who either operate in related fields or have experience in them.

To collect the data for this research work following steps has been taken:

I. Examine the research publications on SMEs and the application of lean manufacturing.

II. Choose the most pertinent research journals and past research researchers' thesis.

III. Sort through all the research papers to identify the pertinent barriers, then discuss them with academic and industry experts.

IV. List all barriers and have a conversation with Utkarsh Polyworld proprietor and academicians from various colleges.

V. The results of this brainstorming session are compiled, and the 16 most appropriate barriers are identified for additional study. Chapter 4.3 provides a description of each of the sixteen barriers.

8. Development of SSIM

An SSIM matrix is constructed once the different barriers have been identified and noted. To do this, a panel of academics and industry professionals was

assembled, and their assessments of the different interactions between the barriers were compiled into an SSIM sheet.

Barrier Number	Barrier Description			Barrier Numbers												
		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	Inadequate communication	A	V	V	A	V	O	A	O	A	A	A	A	O	O	O
2	Lack of financial support	V	V	O	O	V	V	V	X	V	V	V	V	O	X	
3	Lack of government support	A	V	O	V	O	V	V	V	V	X	V	X	O		
4	Lack of customer awareness towards green	A	O	V	O	V	A	A	V	O	A	V	A			
5	Lack of human resources	V	A	V	V	V	O	X	A	V	A	V				
6	Lack of new technology, materials, and industrial tools	X	X	A	A	A	V	X	A	A	V					
7	Lack of organization motivation	A	V	A	X	V	A	V	A	V						
8	Lack of technical support	V	V	V	A	V	V	X	A							
9	Lack of top management commitment	V	V	V	A	A	A	V								
10	Lack of employee training	A	V	X	A	V	V									
11	Market competition	A	A	A	A	A										
12	Resistance to adaptable to change	V	V	A	A											
13	Lack of awareness about lean manufacturing benefits	X	V	V												
14	Lack of performance measurement system	X	V													
15	Lack of job security	X														
16	Lack of knowledge of Lean tools															

Table -1: Structural Self Intersection Matrix (SSIM)

In this above given SSIM four symbols are used V, A, X and O, these symbols notations are given below:

Symbols	Meaning
V	Barrier i will drive to Barrier j;
A	Barrier j will drive to Barrier i;
X	Barrier i and j will drive to each other;
O	Barrier i and j will not drive to each other;

Table -2: VAXO MEANING FOR SSIM

9. Development of IRM

To cultivate the reachability matrix, the symbols of SSIM table 5.1 are transformed into binary numbers '0s' and '1s' in the initial reachability matrix. To produce an initial reachability matrix following 4 steps are following:

- If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.

Entry in SSIM	V
Entry in reachability matrix (i, j)	1
Entry in reachability matrix (j, i)	0

- If the (*i, j*) entry in the SSIM is A, then the (*i, j*) entry in the reachability matrix becomes 0 and the (*j, i*) entry becomes 1.

Entry in SSIM	A
Entry in reachability matrix (i, j)	0
Entry in reachability matrix (j, i)	1

- If the (*i, j*) entry in the SSIM is X, then the (*i, j*) entry in the reachability matrix becomes 1 and the (*j, i*) entry also becomes 1.

Entry in SSIM	X
Entry in reachability matrix (i, j)	1
Entry in reachability matrix (j, i)	1

- If the (*i, j*) entry in the SSIM is O, then the (*i, j*) entry in the reachability matrix becomes 0 and the (*j, i*) entry also becomes 0.

Entry in SSIM	O
Entry in reachability matrix (i, j)	0
Entry in reachability matrix (j, i)	0

After follow the above tables following initial reachability matrix is formed:

Barrier Number	Barrier Number																Driving Power
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	
B1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	4
B2	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	12
B3	0	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	11
B4	0	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	5
B5	1	0	1	1	1	1	0	1	0	1	0	1	1	1	0	1	11
B6	1	0	0	0	0	1	1	0	0	1	1	0	0	0	1	1	7
B7	1	0	1	1	1	0	1	1	0	1	0	1	1	0	1	0	10
B8	1	0	0	0	0	1	0	1	0	1	1	1	0	1	1	1	9
B9	0	1	0	0	1	1	1	1	1	1	0	0	0	1	1	1	10
B10	1	0	0	1	1	1	0	1	0	1	1	1	0	1	1	0	10
B11	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	4
B12	0	0	0	0	0	1	0	0	1	0	1	1	0	0	1	1	6
B13	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	12
B14	0	0	0	0	0	1	1	0	0	1	1	1	0	1	1	1	8
B15	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	1	5
B16	1	0	1	1	0	1	1	0	0	1	1	0	1	1	1	1	11
Dependence Power	8	3	5	6	7	13	9	8	7	11	11	10	5	9	13	10	135

Table -3: Initial Reachability Matrix

10. Level Partition

Each barrier's reachability and antecedent set can be found from the final initial reachability matrix. The reachability set consists of the barriers which have binary number 1, itself, and the other barriers which it may help to achieve, whereas the antecedent set consists of the barriers itself and the other barriers which may come in column and help in achieving it. Thereafter, the common barriers from reachability set and antecedent set are taken and which has minimum number of barriers in reachability set are given "Level-1". The barriers for which the reachability and the intersection sets are have Level-1 will occupy the top level in the ISM hierarchy. The top-level barriers in the hierarchy would not help achieve any other barrier above its own level. Once the top-level element is identified (see Tab. 5.4), it is parted out from the other barriers. Then, the same process is repeated to find out the barriers in the next level. This process is persistent until the level of each barrier is found. These levels help in building the diagraph and the final ISM model.

Criterion Number	Level	BARRIERS NAME	LEVEL OF IMPORTANCE
1	I	Inadequate communication	LESS IMPORTANT
11	I	Market competition	LESS IMPORTANT
4	II	Lack of customer awareness towards green	LESS IMPORTANT
15	II	Lack of job security	LESS IMPORTANT
12	III	Resistance to adaptable to change	LESS IMPORTANT
6	IV	Lack of new technology, materials, and industrial tools	MEDIUM IMPORTANT
14	V	Lack of performance measurement system	MEDIUM IMPORTANT
8	VI	Lack of technical support	MEDIUM IMPORTANT
7	VII	Lack of organization motivation	MEDIUM IMPORTANT
9	VII	Lack of top management commitment	MEDIUM IMPORTANT
10	VII	Lack of employee training	MEDIUM IMPORTANT
3	VIII	Lack of government support	MOST IMPORTANT
5	VIII	Lack of human resources	MOST IMPORTANT
16	VIII	Lack of knowledge of Lean tools	MOST IMPORTANT
2	IX	Lack of financial support	MOST IMPORTANT
13	IX	Lack of awareness about lean manufacturing benefits	MOST IMPORTANT

Table -4: Level Partition Iteration Summary

11. MICMAC ANALYSIS

The above MICMAC analysis is prepared with the help of initial reachability matrix by considering the driving and driven power. From IRM, barrier B1 has driving power 04 and driven power 08 hence barriers B1 come under the "autonomous variables" category.

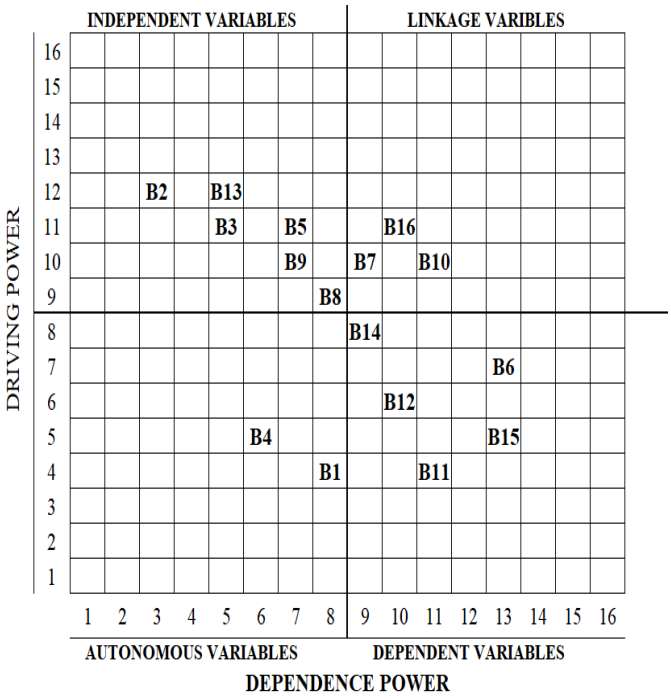

Figure 3- MICMAC ANALYSIS

12. Development of ISM Model

The ISM block diagram is quite helpful since it will quickly indicate the level and weight of the barriers. There are nine levels in this study work's interpretive structural model. The ISM's arrows will direct you from bottom to top. According to the bottom-to-top arrow, the most significant barriers are located at the bottom of the ISM, while the less significant barriers are located at the top. It means barriers importance and weightage will increase from bottom to top. A continuous arrow with heads on both sides indicates how the barriers relate to one another and indicates that they will drive toward one another.

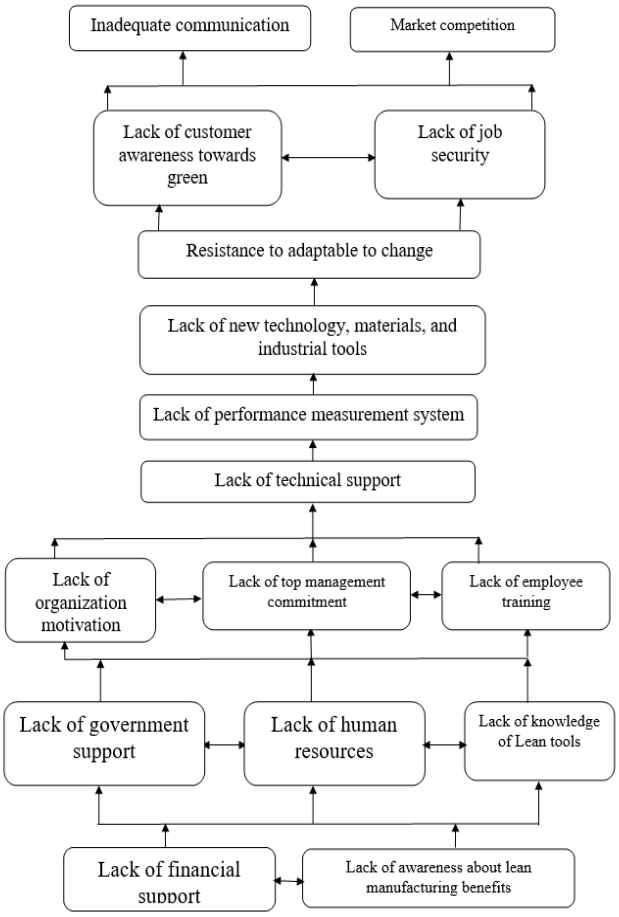

Figure 4- ISM Model

13. RESULTS

The challenge that Utkarsh Polyworld Water Tank Manufacturing and related industries encounter in implementing "LEAN MANUFACTURING" in their organization is the main subject of this thesis study. A brainstorming session and interview were held to gain insight into the work culture and environment of the Utkarsh Polyworld Water Tank manufacturing business to evaluate the factors that drivers and barriers the implementation of "LEAN MANUFACTURING" in small and medium-sized enterprises. In this research work brainstorming and ISM tool are become very useful because this tool provides the following results:

I. A total of sixteen significant barriers were identified, which have an impact on the use of "LEAN MANUFACTURING" in the Utkarsh Polyworld water tank manufacturing industry.

II. The ISM tool gives each barrier's level as well as its priority, weight, and relationship to other barriers.

III. Interpretive Structure modeling diagraph has been providing the importance of all barriers by briefly.

The reachability matrix complete iteration is done in 08 levels. All the fourteen barriers come under in these eight levels. The barriers in the implementation of "social sustainability" have been identified into 08 levels. The eighth level of iteration have three barrier "Lack of importance from top management," "Lack of skilled and experienced persons" and "Lack of managerial capabilities for implementation" it means fourth, twelfth and fourteen barriers are most important in the implementation of "social sustainability" in Utkarsh Polyworld Water Tank manufacturing industry.

The reachability matrix complete iteration is done in 09 levels. All the sixteen barriers come under in these nine levels. The barriers in the implementation of "LEAN MANUFACTURING" have been identified into 09 levels. The nineth level of iteration has one barrier "Lack of financial support" and "Lack of awareness about lean manufacturing benefits"; it means ninth barrier is most important in the implementation of "LEAN MANUFACTURING" in Utkarsh Polyworld Water Tank manufacturing industry.

14. CONCLUSIONS

Table 6.1 provides SMEs with an easy-to-understand roadmap for implementing "LEAN MANUFACTURING" in their organization since they are aware of the drivers and barriers that need to be assessed and prioritized. The ability for industry owners to decide whether to apply the "Lean Manufacturing" technology in their company and to project the associated costs and procedures is another advantage of this research.

ACKNOWLEDGEMENT

We are thankful to the UTKARSH POLYTANK; water tank manufacturer industry is situated at sector-B, Industrial Area Maneri, Mandla (M.P.) for sharing and giving us an opportunity to find out barriers in the implementation of **LEAN MANUFACTURING** methodology.

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