Analysis of barriers for implementation of Industry 4.0 in Indian SMEs

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Abstract

The purpose of this study is to understand the various barriers faced by the Indian SMEs, in integrating the modern technology of Industry 4.0. From vast literature review, a list of challenges has been identified in various fields of SMEs like, smart production, logistics, sustainable supply chain etc. After interviewing with industry experts and conducting a survey, the inputs for barriers were identified and ranked using ISM for understanding the criticality and contextual relationship among them. While many SMEs are trying to cope up with the emerging technology, most SMEs in India lack the basic operational ability in terms of IT technology, real time monitoring of the processes, inter-connectivity of different domains of supply chain along with other challenges. Overcoming these challenges is very crucial for Indian SMEs, in moving towards the I4.0. Businesses improve their future plans by considering these challenges and devising a strategy to overcome it. Also, the dependability of different barriers on each other, which is quantified using MICMAC analysis, is a step forward in understanding these barriers better.

Keywords: Indian SME, Industry 4.0, barriers, Interpretive Structural Modelling, MICMAC analysis

1 Introduction

Small and medium enterprises or SMEs are considered as the backbone of Indian economy. There are about 6.3 crores MSMEs (Micro, Small and Medium Enterprises) in India, which is a result of 18.5% YoY growth from 2019 to 2020. Through its trade, both national and international, Indian MSMEs contributes to around 29% of India's GDP (India Brand Equity Foundation Report, 2021). There is no need to say that this growth also leads to growth in employment. According to Confederation of Indian Industry Report (2019), MSMEs gives employment to around 120 million people, 80% of which is rural based.

The 4th Industrial revolution or Industry 4.0 (I4.0) intend to make the industries smarter, using new and advanced technologies like Industrial Internet of Things (IoT), cloud based computing, smart manufacturing and logistics, etc. (Bag et.al., 2020; Sahi et al., 2020; Khanzode et al., 2021). I4.0 has the ability to improve speed and productivity along with many other advantages like real time monitoring (Plastino & Purdy, 2018; Calatayud et al., 2019), automation (Dash et al., 2019; Radanliev et al., 2019; Bag et al., 2020), improvement in logistics (Da Xu et al., 2014; Calatayud et al., 2019; Bag et al., 2020), cost reduction (Plastino & Purdy, 2018; Bag et al., 2020), optimised resource utilization (Plastino & Purdy, 2018; Bag et al., 2020; Kumar et al., 2020 ; Khanzode et al., 2021) etc., by using advanced technologies like Internet of Things (IoT) to gather and communicate information, and Artificial Intelligence (AI) for advanced analysis.

There is a need for the SMEs to collect and analyse data in an automated manner, to make faster, accurate and intelligent decisions, and to handle the unstable fluctuations of demand and supply in the market (Min, 2010; Calatayud et.al., 2019). Also, the SMEs need to be more cost efficient and data centric in making decisions (Singh, 2011; Tripathy et al., 2016; Bayraktar et

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al., 2009), where I4.0 can play a crucial role. As mentioned above, there are so many advantages for I4.0 but its adoption by SMEs is not that easy. There are many hurdles in adopting and implementing I4.0 by SMEs. However there is limited studies on the barriers for I4.0 in Indian SMEs is available in literature. This provides an opportunity to the researchers to explore the challenges faced by Indian SMEs in adopting I4.0 technologies.

Deriving from the above discussion, it is implied that there is a need for the Indian SMEs to adapt I4.0 to improve the productivity and operational capability along with other benefits. For the purpose of this study, we have considered only SMEs as Micro scale industries have less turnover (Rs. 5 Cr.), which decreases the feasibility for I4.0 drastically. Implementing these advanced technologies won't be easy and there will be many barriers to this, which is the focus of this study. Hence, the key objectives of this study are as follows:

- Identify the major barriers for implementing Industry 4.0 in Indian SMEs
- Analyse and develop a relationship between these barriers using Interpretive structural modelling (ISM).
- Categorise the barriers based on driver and dependence power using MICMAC analysis.

Literature Review

The study has been done on three aspects, Indian SMEs and their need, Industry 4.0 and the potential barriers for I4.0 in SMEs. The understanding of both the SMEs and the I4.0 is necessary before we make an attempt to integrate both the domains.

Indian SMEs and the current scenario

SMEs have found to be more oriented towards personalised services rather than being data oriented and seldom consider factors like cost, time and distance factors (Thakkar et.al., 2012). To manage the uncertainties of demand and supply in the market, SMEs needs to be intelligent, fast and accurate (Singh, 2011). And to meet these requirements, SMEs should to improve their IT infrastructure and adapt more advanced technologies. But since the SMEs operate very differently from other larger firms, it becomes difficult to analyse the effect of use of IT in SMEs (Singh, 2011; Tripathy et al., 2016; Bayraktar et al., 2009). Thakkar et.al. (2012) also explained that SMEs lack in SC integration and have poor infrastructure for logistics. Information is required from inventory, production line, logistics, warehouse etc. and the data needs to be collected in an automated manner, in order to make quick and accurate decisions (Min, 2010; Calatayud et.al., 2019). In a data driven world, the SMEs need to adapt smart technologies like smart logistics, smart manufacturing better collaboration between different members to be able to survive the competition (Witkowski, 2017; Thakkar et. al., 2012; Singh, 2011; Tripathy et. al., 2016; Bayraktar et. al., 2009)

Industry 4.0

The 4th industrial revolution is quite different from the previous three revolutions which were driven by steam and water power in first industrial revolution, machinery in second revolution and semiconductors and computers in the third industrial revolution. The 4th Industrial revolution creates a very different approach on how we interact with each other. With internet of things and internet of system coming into play, everything is becoming smart. Factories and machineries are all connected via internet and automation is taking the upper hand (Marr, 2018). According to Bag et al. (2020), I 4.0 will encourage smooth flow of information by creating a connection between organizations internally and with external stakeholders too. It is also found that I4.0 will encourage smart logistics and manufacturing.

Barriers of I4.0 in SME

A list of 11 barriers has been identified from vast literature review and expert opinion. The detailed explanation for these 11 barriers has been provided in Table 1.

Table 1 List of Barriers

S No	Barriers	Description	References
1	Govt. regulations and Support	Lack of govt. directions and guideline for Industry 4.0. Also there are no set policies to support the implementation of I4.0	Bag et.al., 2020; Khanzode et.al., 2021;Kumar et.al,. 2020; Luthra & Mangla, 2018
2	Human capital , training of workforce for I4.0	Need to create a human workforce who are capable of understanding and operating I4.0 technologies. Requirement of continuous training	Bag et.al., 2020; Kumar et.al,. 2020
3	IT infrastructure, Cyber security and Data Privacy	An advanced IT infrastructure is required along with focus on cyber security and Data privacy for all the stakeholders	Bag et.al., 2020; Khanzode et.al., 2021; Kumar et.al., 2020; Luthra & Mangla, 2018; Suresh et.al., 2018; Radanliev et.al., 2019
4	Knowledge, awareness and Top management support	Lack of awareness among SMEs, and those who are aware, lack proper knowledge of I4.0. The top management are also reluctant in adapting I4.0 for various reasons	Khanzode et.al., 2021; Kumar et.al., 2020; Plastino & Purdy, 2018; Suresh et al., 2018; Luthra & Mangla, 2018
5	Financial Support	A good capital investment is required for the installation of equipment, machinery and infrastructure required for I4.0, which is a big challenge, especially for SMEs	Khanzode et.al., 2021; Kumar et.al., 2020; Luthra & Mangla, 2018
6	New HR Practices	I4.0 encourages decentralization of authority. Hence new HR policies and practices are required to accommodate these changes	Khanzode et.al., 2021; Plastino & Purdy, 2018; Suresh et al., 2018
7	Lack of coordination	Coordination between different members of SMEs is very crucial for better communication and integration in terms of software and hardware to create a smooth flow of information and data	Gupta et al., 2020; Kumar et.al., 2020; Luthra & Mangla, 2018
8	Fear of unemployment	Introduction of these advanced technology will bring automation into the picture, which may lead to unemployment for the labour, especially for those who are unable to cope up with the emerging technology	Kumar et.al., 2020, Gupta et al., 2018
9	Poor R&D on I4.0	Every organization in Indian SME operates in a different way and hence the use and adaptability of I4.0 will be different. Hence, there is a need to do more research on I4.0 and how every organization can adapt these emerging technology in their firms	Kumar et.al., 2020; Luthra & Mangla, 2018

10	Poor Data Quality	I4.0 is majorly data driven. Thus, the quality of data and information is very crucial to make accurate and precise decisions	Luthra & Mangla, 2018; Yuan et.al., 2001; Duan et.al., 2005
11	Global Standards and Protocol	There is a need for adopting global standards and protocols for data sharing. This will create a uniformity in operating policies and improve understanding and coordination among all the members of SMEs	Luthra & Mangla, 2018; Yuan et.al., 2001; Duan et.al., 2005; Da Xu et.al., 2014

2 Methods

Research Methodology

First, a vast literature review has been done to understand the I4.0 standards and its impact on the SMEs, based on which the research gap was identified. The clear research gap identified is lack of studies in this context specifically to the India. Considering the limitations of the author and the existing studies done, the research objective was set. Once this was done, a list of barriers was derived from these literatures which can be found in Table-1. Furthermore, ISM or Interpretive structural modelling was used to derive a relation between these barriers and MICMAC analysis was done to sort these barriers in different categories. Based on these analysis, a diagraph is formed which helps us to identify the barrier or challenge which needs to be handled first so that it will help in tackling the other barriers.

ISM Methodology

Interpretive structural modelling (ISM) was first proposed by J. Warfield in 1974, as a method to derive relations between different elements. Using human judgement, and identification of relations between different elements, this model is able to transform poorly constructed model into a well-defined structural model. This new represents the relations in a well-defined pattern including a graphical representation (Raj et al., 2008; Singh et al., 2008; Luthra et al., 2011; Jayant & Azhar et al., 2014; Gupta et al., 2017).

ISM has been used in analysing mutual relations in many studies and relations. The relations between the challenges of Indian logistics was analysed by Gupta et al. (2017) using ISM and again in 2019 for the study of barriers in implementation of e-governance (Gupta et al., 2019). A study of challenges to implement green supply chain management in Indian automobile industries was studied using ISM by Luthra et al. (2011).

Analysis and Discussion

ISM Analysis

Step 1: SSIM Matrix

The relation between different attributes have been established by the judgement and opinion of SME experts and working professionals. The inputs for this study has been taken from 5 experts from manufacturing and online retail sector. The experts have rich experience of working in SMEs and dealing with technological operations at Indian SMEs. The relations are denoted by symbols, which are explained below (Warfield, 1974) as shown in Table 2:

V – Barrier i will lead to barrier j

A – Barrier j will lead to barrier i

X – Barrier i and j will lead to each other

O – Barrier i and j are unrelated

It is required to fill only half of the matrix as the relation of the other half can be interpreted (if cell (i,j) has a relation of ‘V’, then it is implied that cell (j,i) will have a relation of ‘A’).

Table 2 SSIM Marrix

Barrier No.	Challenges	11	10	9	8	7	6	5	4	3	2	1
1	**Govt. regulations and Support**	X	V	A	V	V	V	V	X	V	O	
2	**Human capital , training of workforce for I4.0**	A	V	A	V	V	X	A	X	X		
3	**IT infrastructure, Cyber security and Data Privacy**	A	X	A	O	V	X	A	A			
4	**Knowledge, awareness and Top management support**	X	V	X	V	V	V	V				
5	**Financial Support**	O	V	X	V	O	O					
6	**New HR Practices**	X	V	A	X	V						
7	**Lack of coordination**	A	V	A	O							
8	**Fear of unemployment**	O	O	A								
9	**R&D on I4.0**	X	V									
10	**Data Quality**	A										
11	**Global Standards and Protocol**											

Step 2: Reachability Matrix:

The SSIM is now converted to reachability matrix by substituting the symbols (V,A,X,O) with 1 and 0, by following certain rules described below (Table 3):

- If the cell (i,j) is V then replace it with 1;If the cell (j,i) is V then replace it with 0;
- If the cell (i,j) is A then replace it with 0;If the cell (j,i) is A then replace it with 1;
- If the cell (i,j) is X then replace it with 1; If the cell (j,i) is X then replace it with 1;
- If the cell (i,j) is O then replace it with 0; If the cell (j,i) is O then replace it with 0;

Table 3 Reachability Matrix

Barrier No.	Challenges	1	2	3	4	5	6	7	8	9	10	11	Driving Power
1	**Govt. regulations and Support**	1	0	1	1	1	1	1	1	0	1	1	**9**
2	**Human capital , training of workforce for I4.0**	0	1	1	1	0	1	1	1	0	1	0	**7**
3	**IT infrastructure, Cyber security and Data Privacy**	0	1	1	0	0	1	1	0	0	1	0	**5**

4	**Knowledge, awareness and Top management support**	1	1	1	1	1	1	1	1	1	1	1	**11**
5	**Financial Support**	0	1	1	0	1	0	0	1	1	1	0	**6**
6	**New HR Practices**	0	1	1	0	0	1	1	1	0	1	1	**7**
7	**Lack of coordination**	0	0	0	0	0	0	1	0	0	1	0	**2**
8	**Fear of unemployment**	0	0	0	0	0	1	0	1	0	0	0	**2**
9	**Poor R&D on I4.0**	1	1	1	1	1	1	1	1	1	1	1	**11**
10	**Poor Data Quality**	0	0	1	0	0	0	0	0	0	1	0	**2**
11	**Global Standards and Protocol**	1	1	1	1	0	1	1	0	1	1	1	**9**
	Dependence Power	**4**	**7**	**9**	**5**	**4**	**8**	**8**	**7**	**4**	**10**	**5**	**71**

Step 3: Final Reachability Matrix

We now check for transitivity and replace the transitive cell with a "1*". If barrier A is related to barrier B, and barrier B is related to barrier C, then it is implied that barrier A is related to barrier C (Table 4).

Table 4 Final reachability matrix - transitivity removed

Barrier No.	Challenges	1	2	3	4	5	6	7	8	9	10	11	Driving Power
1	**Govt. regulations and Support**	1	1*	1	1	1	1	1	1	1*	1	1	**11**
2	**Human capital , training of workforce for I4.0**	0	1	1	1	0	1	1	1	0	1	0	**7**
3	**IT infrastructure, Cyber security and Data Privacy**	0	1	1	0	0	1	1	0	0	1	0	**5**
4	**Knowledge, awareness and Top management support**	1	1	1	1	1	1	1	1	1	1	1	**11**
5	**Financial Support**	0	1	1	0	1	0	0	1	1	1	0	**6**
6	**New HR Practices**	1*	1	1	1*	0	1	1	1	1*	1	1	**10**
7	**Lack of coordination**	0	0	0	0	0	0	1	0	0	1	0	**2**
8	**Fear of unemployment**	0	0	0	0	0	1	0	1	0	0	0	**2**
9	**Poor R&D on I4.0**	1	1	1	1	1	1	1	1	1	1	1	**11**
10	**Poor Data Quality**	0	0	1	0	0	0	0	0	0	1	0	**2**
11	**Global Standards and Protocol**	1	1	1	1	1*	1	1	1*	1	1	1	**11**
	Dependence Power	**5**	**8**	**9**	**6**	**5**	**8**	**8**	**8**	**6**	**10**	**5**	**78**

Step 4: Intersection Set

From the final reachability matrix, reachability set and antecedent set for each attribute is derived. Reachability set contains the attribute itself and the attributes which it will help in achieving. The antecedent set consist the attribute itself and the attributes which will help achieving it. In other words the reachability set consists of all the attributes which has 1 along the row, and the antecedent set consists of all the attributes which has 1 along the column. From these two sets, an intersection set is derived which consists of the attributes present in both the reachability and antecedent sets. The attribute(s) which has the same reachability and antecedent set, is considered as level-1 attribute(s) i.e. they occupy the top most level in the ISM model (Table 5). Once the top most level is identified, the attribute is not considered for the remaining calculations and it is separated from the remaining variables. The same process is implemented to the remaining variables to find out the attributes in the next level. This process is repeated until all the variables or barriers are allocated to a level (Table 6-11). These levels will help in developing the diagraph (Figure 1).

Table 5 Intersection set

Barrier No.	Reachability Set	Antecedent Set	Intersection Set
1	1,2,3,4,5,6,7,8,9,10,11	1,4,6,9,11	1,4,6,9,11
2	2,3,4,6,7,8,10	1,2,3,4,5,6,9,11	2,3,4,6
3	2,3,6,7,10	1,2,3,4,5,6,9,10,11	2,3,6,10
4	1,2,3,4,5,6,7,8,9,10,11	1,2,4,6,9,11	1,2,4,6,9,11
5	2,3,5,8,9,10	1,4,5,9,11	5,9
6	1,2,3,4,6,7,8,9,10,11	1,2,3,4,6,8,9,11	1,2,3,4,6,8,9,11
7	7,10	1,2,3,4,6,7,9,11	7
8	6,8	1,2,4,5,6,8,9,11	6,8
9	1,2,3,4,5,6,7,8,9,10,11	1,4,5,6,9,11	1,4,5,6,9,11
10	3,10	1,2,3,4,5,6,7,9,10,11	3,10
11	1,2,3,4,5,6,7,8,9,10,11	1,4,6,9,11	1,4,6,9,11

Table 6 Level Partitioning - Iteration - 1

Iteration - 1				
Barrier No.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Partition Levels**
1	1,2,3,4,5,6,7,8,9,10,11	1,4,6,9,11	1,4,6,9,11	
2	2,3,4,6,7,8,10	1,2,3,4,5,6,9,11	2,3,4,6	
3	2,3,6,7,10	1,2,3,4,5,6,9,10,11	2,3,6,10	
4	1,2,3,4,5,6,7,8,9,10,11	1,2,4,6,9,11	1,2,4,6,9,11	

5	2,3,5,8,9,10	1,4,5,9,11	5,9	
6	1,2,3,4,6,7,8,9,10,11	1,2,3,4,6,8,9,11	1,2,3,4,6,8,9,11	
7	7,10	1,2,3,4,6,7,9,11	7	
8	6,8	1,2,4,5,6,8,9,11	6,8	Level1
9	1,2,3,4,5,6,7,8,9,10,11	1,4,5,6,9,11	1,4,5,6,9,11	
10	3,10	1,2,3,4,5,6,7,9,10,11	3,10	Level1
11	1,2,3,4,5,6,7,8,9,10,11	1,4,6,9,11	1,4,6,9,11	

Table 7 Level Partitioning - Iteration - 2

Iteration - 2				
Barrier No.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Partition Levels**
1	1,2,3,4,5,6,7,9,11	1,4,6,9,11	1,4,6,9,11	
2	2,3,4,6,7	1,2,3,4,5,6,9,11	2,3,4,6	
3	2,3,6,7	1,2,3,4,5,6,9,11	2,3,6	
4	1,2,3,4,5,6,7,9,11	1,2,4,6,9,11	1,2,4,6,9,11	
5	2,3,5,9	1,4,5,9,11	5,9	
6	1,2,3,4,6,7,9,11	1,2,3,4,6,9,11	1,2,3,4,6,9,11	
7	7	1,2,3,4,6,7,9,11	7	Level2
9	1,2,3,4,5,6,7,9,11	1,4,5,6,9,11	1,4,5,6,9,11	
11	1,2,3,4,5,6,7,9,11	1,4,6,9,11	1,4,6,9,11	

Table 8 Level Partitioning - Iteration - 3

Iteration - 3				
Barrier No.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Partition Levels**
1	1,2,3,4,5,6,9,11	1,4,6,9,11	1,4,6,9,11	
2	2,3,4,6	1,2,3,4,5,6,9,11	2,3,4,6	Level3
3	2,3,6	1,2,3,4,5,6,9,11	2,3,6	Level3
4	1,2,3,4,5,6,9,11	1,2,4,6,9,11	1,2,4,6,9,11	
5	2,3,5,9	1,4,5,9,11	5,9	
6	1,2,3,4,6,9,11	1,2,3,4,6,9,11	1,2,3,4,6,9,11	Level3
9	1,2,3,4,5,6,9,11	1,4,5,6,9,11	1,4,5,6,9,11	
11	1,2,3,4,5,6,9,11	1,4,6,9,11	1,4,6,9,11	

Table 9 Level Partitioning - Iteration - 4

Iteration - 4				
Barrier No.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Partition Levels**
1	1,4,5,9,11	1,4,9,11	1,4,9,11	
4	1,4,5,9,11	1,4,9,11	1,4,9,11	
5	5,9	1,4,5,9,11	5,9	Level4
9	1,4,5,9,11	1,4,5,9,11	1,4,5,9,11	Level4
11	1,4,5,9,11	1,4,9,11	1,4,9,11	

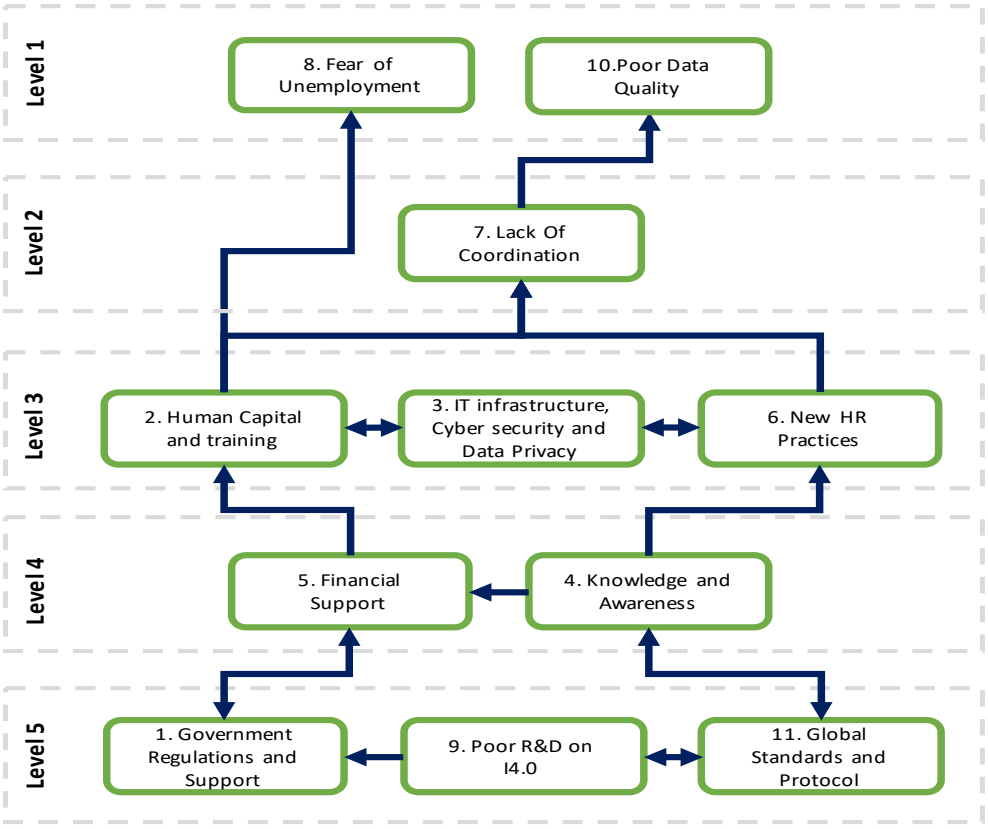
Table 10 Level Partitioning - Iteration - 5

Iteration - 5				
Barrier No.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Partition Levels**
1	1,4,11	1,4,11	1,4,11	Level5
4	1,4,11	1,4,11	1,4,11	Level5
11	1,4,11	1,4,11	1,4,11	Level5

Table 11 Final Partition Level

Barrier No.	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Partition Level**
1	1,2,3,4,5,6,7,8,9,10,11	1,4,6,9,11	1,4,6,9,11	**Level - 5**
2	2,3,4,6,7,8,10	1,2,3,4,5,6,9,11	2,3,4,6	**Level - 3**
3	2,3,6,7,10	1,2,3,4,5,6,9,10,11	2,3,6,10	**Level - 3**
4	1,2,3,4,5,6,7,8,9,10,11	1,2,4,6,9,11	1,2,4,6,9,11	**Level - 4**
5	2,3,5,8,9,10	1,4,5,9,11	5,9	**Level - 4**
6	1,2,3,4,6,7,8,9,10,11	1,2,3,4,6,8,9,11	1,2,3,4,6,8,9,11	**Level - 3**
7	7,10	1,2,3,4,6,7,9,11	7	**Level - 2**
8	6,8	1,2,4,5,6,8,9,11	6,8	**Level - 1**
9	1,2,3,4,5,6,7,8,9,10,11	1,4,5,6,9,11	1,4,5,6,9,11	**Level - 5**
10	3,10	1,2,3,4,5,6,7,9,10,11	3,10	**Level - 1**
11	1,2,3,4,5,6,7,8,9,10,11	1,4,6,9,11	1,4,6,9,11	**Level - 5**

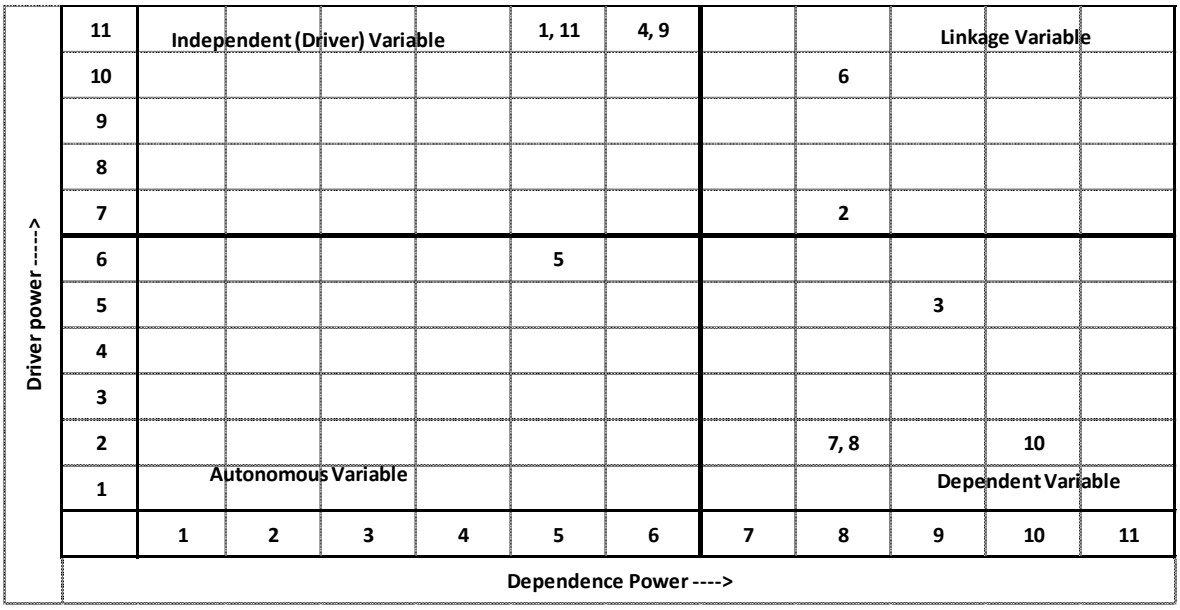
Figure 1 Diagraph



MICMAC Analysis

MICMAC analysis is a technique to analyse the driver and dependence power of different attributes or variables. It helps to identify the key variables which affects the system in different ways.

Figure 2 Graph - MICMAC Analysis



As per the driver and dependence power, the variables are classified among 4 categories, described below on the basis of figure 2:

1. Autonomous Variables: Variables with low driver and low dependence power falls in this category. They are relatively disconnected from the system and have few links with other variables. Barrier 5 Is found to be autonomous variable.

2. Independent (driver) Variables: The variables in this category have high driver power and low dependence power. They are also known as “key enablers”. Barriers 1,4,9,and 11 barriers are coming to be independent variable

3. Linkage Variables: These variables have high driver and high dependence power, and are considered unstable in nature as they have large number of linkages and any action on them will affect others. They also have a feedback effect on themselves. Barriers 2 and 6 are identified as linkage barriers

4. Dependent Variables: These variables have low driver power and high dependence power and are majorly dependent on other variables. Barriers 3,7,8 and 10 are found to be dependent variables.

Discussion

It is certain that there are many advantages of I4.0 and also that it is being adopted by many industries across the world. But, implementing them in SMEs in the Indian market is a difficult task. According to the ISM analysis and the diagraph hence derived, the lower level barriers (Level-5) are the most important barriers, which needs immediate attention.

Poor R&D, government regulations and adapting global standards are found to be the barriers which should be dealt on an immediate basis. R&D is definitely required to get a better understanding of I4.0 for both the SMEs and the govt. If the SMEs and the govt. are not aware about how I4.0 works, its advantages and its future implications, it becomes difficult for them to put effort and investment towards this revolution. Once, adequate knowledge is attained, govt. support is very much required to make I4.0 scalable and sustainable in Indian SMEs for the future growth. There has to be better, robust policies which support the I4.0 in the Indian market. These polices must consider the global standards and protocols, so that integration with other firms, both national and international, becomes easier and smooth. The firms also needs to understand the importance of global standards, and how it will make the integration easier and smoother with other firms. As per the MICMAC analysis, these barriers are also the driver variables or the key enablers, which will drive other variables. In simple terms, if the SMEs are

able to overcome these challenges, it will become easier for them to overcome the other challenges too.

Financial support can improve if we have a robust government regulations and policies. More investment can expected if government supports the 4th Industrial revolution. With better financial support, the SMEs can focus on getting better infrastructure to support I4.0 like IT equipment, machinery and skilled human resource who are capable of working with these advanced technologies. The financial support is also found as autonomous barrier which has low driving and low dependence power. It implies if the companies show interest in adoption and implementation of I4.0 technologies, this barrier can become less significant. However, it is very much important for SMEs to create awareness and enhance knowledge of their employees and stakeholders about I4.0 implications. Once the SMEs have gained knowledge about the global standards and have supporting infrastructure, the HR will be able to make new policies which will be supporting I4.0 and will promote other aspects also, like data security, improved coordination, and training and development of new and existing workforce.

The barriers such as human capital and training; IT infrastructure, cyber security and Data privacy and New HR practices are found to be at third level of diagraph. SMEs need to make their manpower ready to adopt latest technologies and need to hire some experts for training and monitoring. SMEs need to understand benefits from I4.0 benefits and invest in human and systems to make them future ready. In India, lack of infrastructure is common barrier which needs to be rectified. SMEs need to develop adequate IT infrastructure (both hardware and software) for better business operations and maintain data privacy and cyber security. SMEs need to devise new HR policies so that the employees also feel motivated to adopt the technological change. Human capital and training and New HR strategies are found to be linkage barriers from MICMAC analysis, which implies HR revised strategies for trainings will assist manpower readiness for handling technological advancements. The manpower readiness will drive only successful implementation of I4.0 in SMEs. IT infrastructure is found to be dependent barrier with high dependence power and low driving power. The government support and SMEs commitment towards improvement of existing IT infrastructure is very crucial to make drastic changes in the systems.

The top 2 layers of the diagraph, derived from the ISM analysis are lack of coordination, poor data quality and fear of unemployment. These are also the dependent variables as per the MICMAC analysis as they have high dependence power and very low driver power. Once the lower layer of barriers are dealt with, and SMEs have good knowledge, infrastructure, human resources and willingness towards I4.0, it will help in better coordination among different members of the SMEs and also among the organization. This coordination will improve the quality of the data which will be used for further analysis. I4.0 is completely data driven and hence, improved quality of data will lead to a better system.

There is a big challenge that there will be loss of jobs as automation will come into the picture. But if traditional job roles are going to perish, new job requirements will emerge. There will always be requirement for people who will be able to operate new equipment, people who understands how the system works. The employees and workers need to understand this fact that they have to change, learn and improve themselves in order to fit in the new roles and training and development provided by the SMEs will play a crucial role in this.

There is no doubt that 4th Industrial revolution will disrupt the status-quo of not only the SMEs but the entire sector. And it's only a matter of time that SMEs will start adapting these technologies. But what the SMEs need to focus now is how efficiently they change and adapt to I4.0.

Implications of the study

The study will be very beneficial for SME's industry professionals, practitioners and researchers. It will help them to identify the most crucial barriers in implementing Industry 4.0 and can understand the contextual relationships among identified barriers. The least crucial

barriers can be ignored and the policies and strategies can be devised for the quick rectification of the more complex and crucial barriers. Moreover, The MICMAC analysis can help SME's to locate each barrier on the basis of their dependence and influence on other barriers. The study can assist industry professionals to find out appropriate solutions for the challenges in adopting and implementing Industry 4.0.

4 Conclusion and Future Scope

The 4th industrial revolution is the future of the world, which will be driven by data. The firms need to adapt and implement these technology or they will be left behind by the firm who will implement and invest in I4.0. Hence, there is a dire need to understand I4.0 and study different aspects of it. The advantages of this revolution is endless and in every domain of SMEs. The top management needs to acknowledge this and make an attempt to implement I4.0 in their firms.

Additionally, there is still a lot of scope for this study as to how the SMEs can implement I4.0, what will be a roadmap and glide goals for the SMEs. Different strategies are needed to be developed for different firms, as the Indian SMEs are very diverse. There needs to be a more intensive study on the ways by which these challenges will be tackled and the objective of implementing I4.0 in the Indian SMEs will be achieved. Also, there can be studies considering circular economy and sustainable development.

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