Social Implications of FMS Implementation: A Study

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ABSTRACT Global, flicking market requirements and modern life trends have put up tremendous challenges to manufacturing industries. FMS helps different organizations to compete with global industries by adapting such system over conventional system. Industries are trying to adapt different methodologies for risk management & protection. Through this paper an small effort has been put to study the social implications of this high technology related manufacturing system on Indian society. Better knowledge of these implications, their driving & dependence power is the most significant for applying FMS in different sectors. Usually industries do not want to adapt this high tech manufacturing system due to some major facts like Unemployment, Lack of skilled workers, high setup cost, structure complexity & many more. So before opting for such technology different social factors must be examined. Those effects which have higher power must need special attention than others. Thus the management can take exact idea in the fields in which they are lagging behind from these implications study in relative factor importance and interconnectivity.

Keywords;- FMS, Social Implication, AGV, Barriers.

I. INTRODUCTION

In today's competitive global market, manufacturers have to modify their operations to ensure a better and faster response to needs of customers. The primary goal of any manufacturing industry is to achieve a high level of productivity and flexibility which can only be done in a computer integrated manufacturing environment. [4] A flexible manufacturing system (FMS) is an integrated computer-controlled configuration in which there is some amount of flexibility that allows the system to react in the case of changes, whether predicted or unpredicted. FMS consists of three main systems.

Today the dynamic production needs and operation are addressed by a FMS system. it comprises of automated machines and MHS with a single control system.[1] This FMS system enable manufacturers to deal with different parts and product designs.

A flexible manufacturing system (FMS) is an integrated computer-controlled configuration in which there is some amount of flexibility that allow

the system to react in the case of changes, whether predicted or unpredicted. FMS consists of three main systems. [4]The work machines which are often automated CNC machines are connected by a material handling system(MHS) to optimize parts. flow and the central control computer which controls material movements and machine flow.[5]

An FMS is modeled as a collection of workstations and automated guided vehicles (AGV). It is designed to increase system utilization and throughput of system and for reducing average work in process inventories and many factors affects both system utilization and throughput of system in this research system utilization and throughput of system has been optimized considering factors, which is discussed in next sections.[2]A complete FMS system should be flexible enough to accept the changing market conditions without human involvement and without any investment. The word „Flexible" explains the flexibility of process, product, machines and

production.[2] Generally manufacturing transformation process are divided into two types

Continuous(oil industry)
Discrete(consumer goods industry)

a) Assembly process (many parts assembled to get product)
b) Non assembly process(like machining, painting etc.)

FMS is capable of processing a variety of parts types simultaneously in different part volume and random order.[1] This feature of this FMS system make it specially applicable for batch production activity‟s. When we are talking about FMS it is useful to also talk about the new generation manufacturing system.[1]This new system is called "Intelligent manufacturing system" IMS which includes use of

- Sensors and controllers
- Designing software"s(CAD,CAM,CAPP)
- CNC,NC,DNC system
- CMM system

II. OBJECTIVE

To identify and rank the various social implications of FMS through literature review:

1. To establish relationship between these social implications through the development of ISM model
2. To identify key social implications of FMS
3. To suggest scope of future research.

On the basis of the literature review 14 social factors of FMS have been identified. In India the effects faced by the industries for implementation of this FMS system are.

SOCIAL IMPLICATIONS:-In India the effects faced by the industries for implementation of this FMS system is-[6][7][15][9]

POSITIVE EFFECTS:-

1. Improved technical skill and education of employees
2. Improvement in salaries/incentives

Improvement in salaries/incentives

3. Long-term committed relationship with vendors

4. Improved quality of product

SOCIAL FACTORS IN IMPLEMENTING FMS[6][7][12]:-

1. High setup cost
2. Long payback period
3. Lack of Government support
4. Trend of labour towards service sector
5. Maintenance of FMS system
6. Employee's resistance
7. Non availability of skilled workers and personnel
8. Failure fear
9. Fear of technology change
10. Planning & control technique of FMS complexity
11. Reliable vendors
12. Reduction of purchase power
13. Commitment to top management
14. Unemployment

Some of the main social factors in implementing FMS are as discussed below:

1. **High Setup cost**:-Implementation of FMS involves a huge investment and a high degree of uncertainty. Avery high capital investment is required for installing the automated set up of the machines and accessories. So, initial high investment is not possible for everyone. Hence high cost of FMS is a main cause for its low level of reception.
2. **Long Payback Period**:-Follow up of quality standards by the quality people in an organization not only improves the quality of the product but also improves in the reputation of the organization. [5]This may lead adequate returns on its investment and will be cooperative in achieving the objectives. By the proper utilization of automation, quality and quantity can be improved up to a great extent in term of accuracy as compare to manual methods.[7] Hence, by FMS implementation payback period of the product is quite long and profit margin reduces.
3. **Supportive policies of the government**:-Due to the highly investment (i.e., initially high cost of FMS technology equipments) and pressure of the labour against automation, government has not made any firm and foolproof policy regarding the development of advanced automation sector in manufacturing. lacking in government resources, suspicious regulations and delay in funding policies

are the barriers in FMS implementation. [2] If the government wants to implement new technology like FMSs, government should make policies which are supportive and helpful to the manufacturing sector in term of loans, taxation, license for export-import of finished and raw material goods, investment in technology and industrial sector development. It will be beneficial to the industry and society

4. **Trend of labour towards service sector:-**This trend has been especially prevalent in the India. However, society and institutes are responsible for this trend. [5]The growth of government employment and growth of private service sector in India has consumed a certain share of the labour market which might otherwise have gone into manufacturing.[16] Due to more money and more freedom peoples are shifting from industries to service sector, i.e., government, insurance, banking, teaching, personal services, legal, sales, etc.
5. **Maintenance of FMS system:-**Maintenance of this FMS system is also a serious issue for proper working of all the equipments, machineries. All the machines , equipments used in FMS system are mostly automotive or computer operative. So for the maintenance of these highly précised equipments one should be highly trained. And also the availability of skilled engineers in India is always a difficult task for proper maintenance of the FMS system.
6. **Employees' resistance in transition to FMS:** Employees' do not want to transit towards the advance technology like FMS in India because they think that they will face the problems like unemployment, retrenchment, harassment and heavily reductions in term of monitory benefits like perks and incentives due to adaptation of these technologies. [5]FMS involves a very high degree of automation which affects the human behavior in the system. Use of FMS not only improves the work environment but also reduces the man power . Hence, existing work force will not be agree for such a transition and may put up great resistance against the implementation of FMS.[2]
7. **Non availability of skilled workers and personnel:-**For proper working of FMS system there is always scarcity of skilled workers specially in countries like India. All this FMS system is mainly computer operative and for proper working employees needs to educate first how to use . [10]so mostly industries avoids this kind of situation where they has to put efforts for the employees. Skilled workers are not easily available everywhere so the management needs to take care of skilled workers every time.[13]
8. **Failure Fear:-**All the industries has always a fear of failure of the FMS system in their mind like whether it will be suitable for us? Or If this FMS system helps in achieving their expectation. [11]Fear may be of any kind like workers issue, machinery failure, market competition, capital investment recovery. These types of fears is now present in the minds of growing industrialists
9. **Fear of technology change:-**No doubt the utilization of FMS will bring revolution in the industries and the society but It will also create fear in the mind of labor force because they may not be technically Trained for the use of new advanced machine tools.[5] They may face the problems like harassment, unemployment, retrenchment and may be outdated and obsolete in term of knowledge and skill after implementation of latest technology.[12]
10. **Planning & control technique of FMS complexity:-** FMS system is quiet a complex system to understand. Its working , controlling, proper planning of machineries is not an easy task with proper optimization of all the recourses. There is always a lot of issues like planning issues, designing issues, operational issues which needs to take care every time. Scheduling and dispatching, Machine loading, Part routing, Tool management each and every step needs proper skilled experience. [16]
11. **Reliable vendors:-**For a developing industry availability of reliable vendors is also a issue in less developed countries. Due to the automation and advanced technology more variety of products are easy to manufacture as per the demand of customers. Competition in more variety of products will be helpful and economical to the society.[5] So the vendors of all type of machineries, raw material, after service is not available everywhere. Mostly industries have to import foreign machineries that is quiet expensive for such small industries. Lack of suppliers and delay in delivery of latest technology equipments are the big barrier in FMS. This may also be a reason of fear in the manufacturing managers and its management .[19]
12. **Reduction of purchase power:** Automation will reduce the purchasing power due to unemployment and high cost of product. Reason being new technology machines will replace the workers and these workers will be unemployed.[2] They will not receive the wages necessary to buy the product brought by automation and market will become saturated with products that people cannot afford to purchase. It will result economic depression.[12]

13. **Commitment to top management:-**Top management important work is to schedule various production operations in the manufacturing system, to take care of the movement of material and tools on the shop floor, for getting updates in real time about any malfunctioning of the machine during operation.[23] depending on the feedback received on the health of the machine, the maintenance schedule is planned by the top managers in the industry.[9] Top management need to clarify all the issues related to workers, machineries, or any other type of issue that may be a hurdle in the FMS implementation.
14. **Unemployment:-**Advance technologies are being developed everyday and their major impact will bring up the revolution in the industry and society. [5] Introduction of new technologies and Automation will reduce the need for human labour. Advancements in technologies can create fear in the mind of human labour which may be a cause of serious problems like unemployment. [12]Due to increased productivity by automation and growing population and due to non-creation of new jobs for human labour, always there is a fear of unemployment in the human labour.[7]

III. METHODOLOGY

Interpretive structural modeling (ISM): ISM is an interactive learning process. In this technique, a set of different directly and indirectly related elements are structured into a comprehensive systematic model. The model so formed portrays the structure of a complex issue or problem in carefully designed pattern implying graphics as well as words. [6]Interpretive structural modeling (ISM) is a well-established methodology for identifying relationships among specific items, which define a problem or an issue. For any complex problem under consideration, a number of factors may be related to an issue or problem. [3] However, the direct and indirect relationships between the factors describe the situation far more accurately than the individual factor taken into isolation. Therefore, ISM develops insights into collective understandings of these relationships. [13]ISM starts with an identification of variables, which are relevant to the problem or issue, and then extends with a group problem solving technique. Then a contextually relevant subordinate relation is chosen.[15] Having decided on the element set and the contextual relation, a structural self-interaction matrix (SSIM) is developed based on pair wise comparison of variables. In the next step, the SSIM is converted into a reachability matrix (RM)and its transitivity is checked. Once transitivity embedding is complete, a matrix model is obtained. Then, the partitioning of the elements and an extraction of the structural model called ISM .[6]

ISM MODEL DEVELOPMENT FOR SOCIAL FACTORS

Steps, used for ISM model development are as follows:

Step 1: Development of Structural Self-Interaction Matrix (SSIM):

ISM methodology suggests the use of the expert opinions based on various management techniques such as brain storming, nominal group technique, etc. in developing the contextual relationship among the variables.[13] For this purpose, experts from the industry and academia should be consulted in identifying the nature of contextual relationship among the factors. These
experts from the industry and academia should be well conversant with the problem under consideration. For analyzing the factors, a contextual relationship of ‘leads to’ or ‘influences’
type must be chosen. This means that one factor influences another factor. On the basis of this, contextual relationship between the identified factors is developed.[8]

In the present research for identifying the contextual relationship among the implications of FMS implementation. These factors are listed by going through various research papers. Based on the contextual relationship among the implications SSIM has been developed. Four symbols have been used to denote the direction of the relationship between the implications.
V- factor i will help to achieve factor j;
A- factor j will help to achieve factor i;
X- factor I and j will help to achieve each other;
O- factors I and j are unrelated

Table-1 Structural Self-Interaction Matrix

IMPLICATION	14	13	12	11	10	9	8	7	6	5	4	3	2
1	A	V	V	V	V	V	V	V	V	V	O	V	X
2	A	V	V	O	V	V	V	V	V	V	V	V	
3	A	A	A	A	O	A	A	A	O	A	X		
4	A	O	A	O	A	A	O	A	A	A			
5	A	A	V	V	X	V	V	O	A				
6	A	X	V	V	V	V	V	A					
7	A	V	V	O	V	V	V						
8	A	O	V	X	A	X							
9	A	A	V	X	A								
10	A	A	V	V									
11	O	A	V										
12	A	A											
13	A												

The table 1 would explain the use of the symbols V,A,X and O in SSIM.

- V is assigned to cell (1,13) denotes that factor 1 affects the factor 13 or it is used for relation from factor 1 to 13.
- A is assigned to cell (1,14) denotes that factor 14 affects the factor 1 or for relation from factor 14 to 1.
- X is assigned to cell (6,13) for bidirectional relation i.e both factor affects each other
- O is assigned to cell (1,4) which indicates that there is no relation between the factors i.e 1 and 4 are unrelated.

Step 2: Development of Reachability Matrix:

The next step in ISM approach is to develop an initial reachability matrix from SSIM. For this, SSIM is converted into the initial reachability matrix by substituting the four symbols (i.e., V, A, X or O) of **SSIM** by 1s or 0s in the initial reachability matrix. The rules for this substitution are as follows:

(a) 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.

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

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

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

Table 2 - Initial Reachability Matrix

IMPLICATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**1**	1	1	0	1	1	1	1	1	1	1	1	1	0
2	1	**1**	1	1	1	1	1	1	1	1	0	1	1	0
3	0	0	**1**	1	0	0	0	0	0	0	0	0	0	0
4	0	0	1	**1**	0	0	0	0	0	0	0	0	0	0
5	0	0	1	1	**1**	0	0	1	1	1	1	1	0	0
6	0	0	0	1	1	**1**	0	1	1	1	1	1	1	0
7	0	0	1	1	0	1	**1**	1	1	1	0	1	1	0
8	0	0	1	0	0	0	0	**1**	1	0	1	1	0	0
9	0	0	1	1	0	0	0	1	**1**	0	1	1	0	0
10	0	0	0	1	1	0	0	1	1	**1**	1	1	0	0
11	0	0	1	0	0	0	0	1	1	0	**1**	1	0	0
12	0	0	1	1	0	0	0	0	0	0	0	**1**	0	0
13	0	0	1	0	1	1	0	0	1	1	1	1	**1**	0
14	1	1	1	1	1	1	1	1	1	1	0	1	1	**1**

Now , the reachability matrix developed from SSIM is checked for transitivity. The transitivity is the basic assumption made in ISM. According to the concept of **transitivity** if social implication A is related to social implication B and the social implication B related to social implication C then the social implication A will be related to the social implication C. The final reachability matrix incorporating transitivity is shown in Table 3 below:

Table-3 Final Reachability Matrix

IMPLICATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	1	1	1*	1	1	1	1	1	1	1	1	1	0
2	1	1	1	1	1	1	1	1	1	1	1*	1	1	0
3	0	0	1	1	0	0	0	0	0	0	0	0	0	0
4	0	0	1	1	0	0	0	0	0	0	0	0	0	0
5	0	0	1	1	1	0	0	1	1	1	1	1	0	0
6	0	0	1*	1	1	1	0	1	1	1	1	1	1	0
7	0	0	1	1	1*	1	1	1	1	1	1*	1	1	0
8	0	0	1	1*	0	0	0	1	1	0	1	1	0	0
9	0	0	1	1	0	0	0	1	1	0	1	1	0	0
10	0	0	1*	1	1	0	0	1	1	1	1	1	0	0
11	0	0	1	1*	0	0	0	1	1	0	1	1	0	0
12	0	0	1	1	0	0	0	0	0	0	0	1	0	0
13	0	0	1	1*	1	1	0	1*	1	1	1	1	1	0
14	1	1	1	1	1	1	1	1	1	1	1*	1	1	1

Note: 1*: Indicates to incorporate transitivity to fill the gap

Step 3: Level Partitions: From the final reachability matrix, for each factor, reachability set and antecedent sets are derived. The reachability set consists of the factor itself and the other factor that it may impact, whereas the antecedent set consists of the factor itself and the other factor that may impact it. [20]Thereafter, the intersection of these sets is derived for all the factors and levels of different factor are determined. The factors for which the reachability and the intersection sets are the same occupy the top level in the ISM hierarchy. This leads to the process of iteration for locating the top level (i.e Ist level) social factor.

The top-level factors are those factors that will not lead the other factors above their own level in the hierarchy. Once the top-level factor is identified, it is removed from consideration. Then, the same process is repeated to find out the factors in the next level. This process is continued until the level of each factor is found. These levels help in building the diagraph and the ISM model.

Table-4 Iteration 1

IMPLICATION	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,14	1,2	
2	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,14	1,2	
3	3,4	1,2,3,4,5,6,7,8,9,10,11,12,13,14	3,4	I
4	3,4	1,2,3,4,5,6,7,8,9,10,11,12,13,14	3,4	I
5	3,4,5,8,9,10,11,12	1,2,5,6,7,10,13,14	5,10	
6	3,4,5,6.8,9,10,11,12,13	1,2,6,7,13,14	6,13	
7	3,4,5,6,7,8,9,10,11,12.13	1,2,7,14	7	
8	3,4,8,9,11,12	1,2,5,6,7,8,9,10,11,13,14	8,9,11	
9	3,4,8,9,11,12	1,2,5,6,7,8,9,10,11,13,14	8,9,11	
10	3,4,5,8,9,10,11,12	1,2,5,6,7,10,13,14	5,10	
11	3,4,8,9,11,12	1,2,5,6,7,8,9,10,11,13,14	8,9,11	
12	3,4,12	1,2,5,6,7,8,9,10,11,12,13,14	12	
13	3,4,5,6,8,9,10,11,12,13	1,2,6,7,13,14	6,13	
14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	14	14	

Table 5- Iteration II				
IMPLICATION	Reachability set	Antecedent set	Intersection set	Level
1	1,2,5,6,7,8,9,10,11,12,13	1,2,14	1,2	
2	1,2,5,6,7,8,9,10,11,12,13	1,2,14	1,2	
5	5,8,9,10,11,12	1,2,5,6,7,10,13,14	5,10	
6	5,6.8,9,10,11,12,13	1,2,6,7,13,14	6,13	
7	5,6,7,8,9,10,11,12,13	1,2,7,14	7	
8	8,9,11,12	1,2,5,6,7,8,9,10,11,13,14	8,9,11	
9	8,9,11,12	1,2,5,6,7,8,9,10,11,13,14	8,9,11	
10	5,8,9,10,11,12	1,2,5,6,7,10,13,14	5,10	
11	8,9,11,12	1,2,5,6,7,8,9,10,11,13,14	8,9,11	
12	12	1,2,5,6,7,8,9,10,11,12,13,14	12	II
13	5,6,8,9,10,11,12,13	1,2,6,7,13,14	6,13	
14	1,2,5,6,7,8,9,10,11,12,13,14	14	14	

Table 6- Iteration-III				
IMPLICATION	Reachability set	Antecedent set	Intersection set	Level
1	1,2,5,6,7,8,9,10,11,13	1,2,14	1,2	
2	1,2,5,6,7,8,9,10,11,13	1,2,14	1,2	
5	5,8,9,10,11	1,2,5,6,7,10,13,14	5,10	
6	5,6,8,9,10,11,13	1,2,6,7,13,14	6,13	
7	5,6,7,8,9,10,11,13	1,2,7,14	7	
8	8,9,11	1,2,5,6,7,8,9,10,11,13,14	8,9,11	III
9	8,9,11	1,2,5,6,7,8,9,10,11,13,14	8,9,11	III
10	5,8,9,10,11	1,2,5,6,7,10,13,14	5,10	
11	8,9,11	1,2,5,6,7,8,9,10,11,13,14	8,9,11	III
13	5,6,8,9,10,11,13	1,2,6,7,13,14	6,13	
14	1,2,5,6,7,8,9,10,11,13,14	14	14	

Table 7– Iteration- IV				
IMPLICATION	Reachability set	Antecedent set	Intersection set	Level
1	1,2,5,6,7,10,13	1,2,14	1,2	
2	1,2,5,6,7,10,13	1,2,14	1,2	
5	5,10	1,2,5,6,7,10,13,14	5,10	IV
6	5,6.10,13	1,2,6,7,13,14	6,13	
7	5,6,7,10	1,2,7,14	7	
10	5,10	1,2,5,6,7,10,13,14	5,10	IV
13	5,6,10,13	1,2,6,7,13,14	6,13	
14	1,2,5,6,7,10,13,14	14	14	

Table 8– Iteration- V				
IMPLICATION	**Reachability set**	**Antecedent set**	**Intersection set**	**Level**
1	1,2,6,7,13	1,2,14	1,2	
2	1,2,6,7,13	1,2,14	1,2	
6	6,13	1,2,6,7,13,14	6,13	V
7	6,7	1,2,7,14	7	
13	6,13	1,2,6,7,13,14	6,13	V
14	1,2,6,7,13,14	14	14	

Table 9- Iteration- VI				
IMPLICATION	**Reachability set**	**Antecedent set**	**Intersection set**	**Level**
1	1,2,7	1,2,14	1,2	
2	1,2,7	1,2,14	1,2	
7	7	1,2,7,14	7	VI
14	1,2,7,14	14	14	

Table 10 -Iteration- VII				
IMPLICATION	**Reachability set**	**Antecedent set**	**Intersection set**	**Level**
1	1,2	1,2,14	1,2	VII
2	1,2	1,2,14	1,2	VII
14	1,2,14	14	14	

Table 11 - Iteration-VIII				
IMPLICATION	**Reachability set**	**Antecedent set**	**Intersection set**	**Level**
14	14	14	14	VIII

Step 4: Conical matrix:

Conical matrix is developed by clustering factors in the same level across the rows and columns of the final reachability matrix. The drive power of a factor is derived by summing up the number of ones in the rows and its dependence power by summing up the number of ones in the columns. Next, drive power and dependence power ranks are calculated by giving highest ranks to the factors that have the maximum number of ones in the rows and columns, respectively.

Table 12- Conical Matrix															
IMPLICATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	**Drive Power**
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	**13**
2	1	1	1	1	1	1	1	1	1	1	**1**	1	1	0	**13**
3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	**2**
4	0	0	1	1	0	0	0	0	0	0	0	0	0	0	**2**
5	0	0	1	1	1	0	0	1	1	1	1	1	0	0	**8**
6	0	0	1	1	1	1	0	1	1	1	1	1	1	0	**10**

7	0	0	1	1	1	1	1	1	1	1	1	1	1	0	**11**
8	0	0	1	1	0	0	0	1	1	0	1	1	0	0	**6**
9	0	0	1	1	0	0	0	1	1	0	1	1	0	0	**6**
10	0	0	1	1	1	0	0	1	1	1	1	1	0	0	**8**
11	0	0	1	1	0	0	0	1	1	0	1	1	0	0	**6**
12	0	0	1	1	0	0	0	0	0	0	0	1	0	0	**3**
13	0	0	1	1	1	1	0	1	1	1	1	1	1	0	**10**
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**14**
Dependence	**3**	**3**	**14**	**14**	**8**	**6**	**4**	**11**	**11**	**8**	**11**	**12**	**6**	**1**	**112**

Step 5: Development of Diagraph:-

A digraph has been made on the bases of levels of each factor (social implication) as identified through different iteration in the above steps. A final digraph (Figure 14) has been developed by removing the indirect links. In this digraph, the top level social implication is placed at the top of the digraph and second level social implication is placed at second position and so on up to final level.

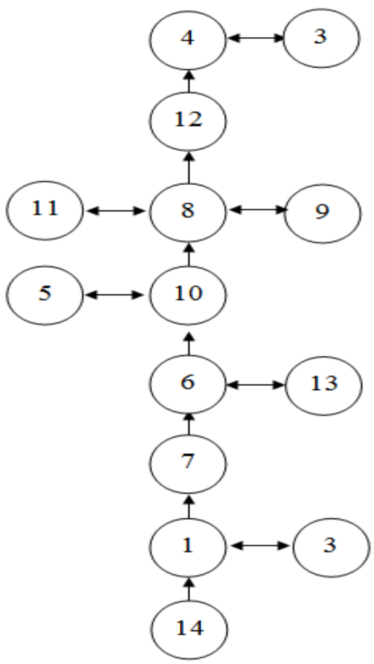

Figure 14-Diagraph showing hierarchy of level for factors

Step 6: ISM Model:

Digraph is converted into an ISM model by replacing nodes of the factors with statements.

Step 7: Checking of Conceptual Inconsistency:

Finally, if there is any conceptual inconsistency in the ISM model then it is checked and replaced by incorporating the transitivity in the model.

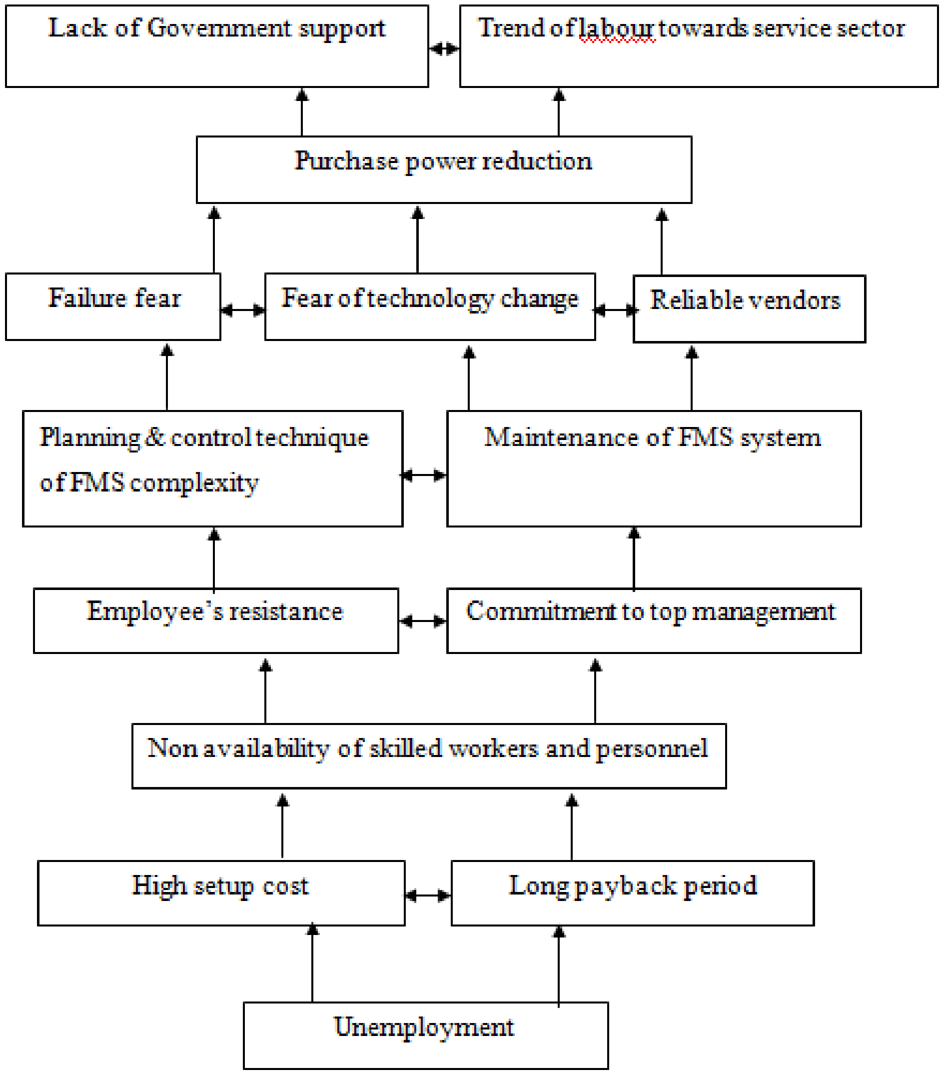

Figure 15-ISM Model depicting different levels of factors

MICMAC analysis:

Matrix d'Impacts croises-multiplication applique' an classment (Cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC [5]. MICMAC analysis is done with the help of driving power and dependence power. In table 12 the driving power and dependence power of each factor have been shown. This driving and dependence calculations have been used in the MICMAC analysis to classify these factors into four groups of Autonomous, Dependent, Linkage, and Independent factor. The driving power-Dependence power diagram has been constructed which is shown in figure 16.

- **Cluster I** (Autonomous social factor): Social factors having weak driver power and weak dependence power and lies in the first quadrant as shown in figure 16. No factor has been found as autonomous factor.
- **Cluster II** (Dependent social factor): Social factors having weak driver power and strong dependence power and lies in the second quadrant as shown in figure 16.

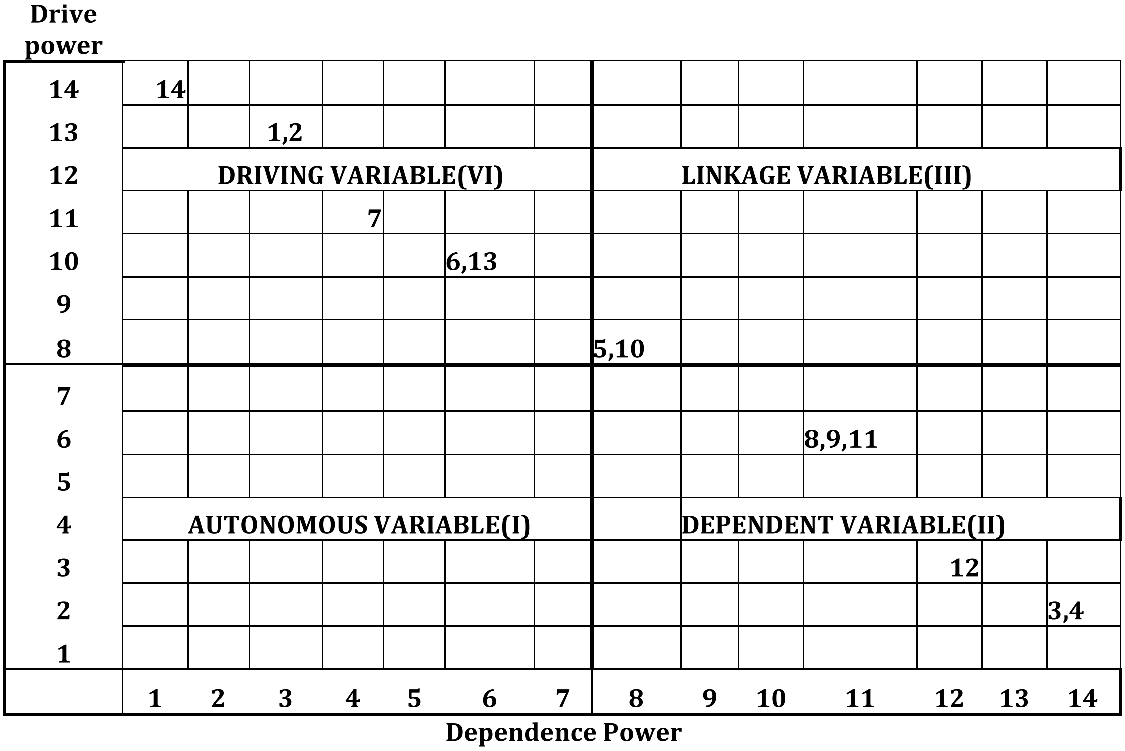

Figure 16- Clusters of factors of FMS Implementation

- **Cluster III** (Linkage social factor): Social factors having strong drive power as well as strong dependence power and lies in third quadrant as shown in figure 16. Two factors has been identified as linkage social factor.
- **Cluster IV** (Independent social factor): Social factors having strong driver power and weak dependence power and lies in the fourth quadrant as shown in figure 16.

III. RESULT & DISCUSSION

The focus of the manufacturing industries is to adopt upcoming systems and methodologies but is afraid because of the risks associated in their adaption. The main goal of this study is to find out the various social factors of FMS implementation which may affect the advance manufacturing system so that management may successfully deal with them. An ISM model is presented for analyzing the interaction among various social factors. The management and manufacturing managers can take the inspiration from these social implications in understanding their relative importance and interdependencies. Based on the different cluster (shown in Figure 16) driver power and dependence power shows their virtual importance and interdependency among the social factors as discussed below:

- There is no social implication in the autonomous cluster that can be disengaged from the entire system it means that the management should concentrate to all the recognized social factors. These autonomous social implications are weak drivers and weak dependence and do not have much impact on the FMS.
- The second cluster is of dependent factors like Trend of labour towards service sector, Lack of Government support, Fear of technology change, Failure fear, Reliable vendors, Reduction of purchase power. In this cluster, identified social implications have least drive power and most dependence power; form the top most position in the ISM hierarchy. Manufacturing managers should keep these social implications in mind while taking decisions regarding implementation of FMS.
- The next cluster is of the linkage social factors which are strong in driving power and high dependencies. Social factors like Maintenance of FMS system, Planning & control technique of FMS complexity. The management should take care of these social factors while implementing FMSs in

industry. These social factors are influenced by medium level social factors and make impact on other social factors in the ISM model.

- The last cluster is of independent social factors like High setup cost, Long payback period, Employee's resistance, Commitment to top management and most important Unemployment. These are the key social factors and have strongest drive power to affect other social factors. They need up most care to deal with them.

IV. CONCLUSION

- The contribution of this is to propose an integrated framework for social implications of FMS by using ISM approach. The framework will guide the managers to understand and manage implications related to FMS implementation in a country like India. The awareness of these factors and their driving and dependence power is important for implications because management can now think upon on those factors which are of more strategic orientation in these type of developing countries. The analysis shows social implications whose impact is most important on social life in India is Unemployment, High setup cost and Long payback period caused due to the implementation of FMS.
- According to the ISM approach in these implications, most significant social implication due to implementation of FMS is 'unemployment' which is at rank number one. It has been found at the bottom level in the ISM model as a key social factor of FMS. It is most important social issue in country like India where population is more as compared to other developed countries.
- Along with of identification of such factors this report has also presented an approach to categorize these factors. This would help the managers to estimate the effect and then they can develop suitable solution to counter them. In India generally conventional manufacturing system are used because of cheap labour availability. Along with this high initial cost related to machineries, skilled workers, lack of government support are also the hurdles in this FMS system adaption.
- In India workers itself does not want to adapt this high tech system because of employees retrenchment, trend towards service sector, maintenance, system planning & complexity. Therefore before opting for the advanced manufacturing technology systems like FMS, different social aspects must be examined. Social implications with higher power must require special
- attention as compared to the other. The management and manufacturing managers can take the idea from these social implications in understanding their relative importance and interdependencies.
- The management should develop proper strategies for tackling the major negative implications of FMS. The management should initiate the proper training programs and policies for their employees' which may be helpful in adopting latest technologies. The workers may also be trained through rotation in inter department for enhancing their knowledge. In this way, workers will feel motivated and the unemployment will also be controlled. The positive thinking of management is must towards the society and their employees. These policies of the management can reduce the retrenchment, unemployment and thus, disputing issues among workers and staff.

V. LIMITATIONS AND SCOPE FOR FUTURE WORK

In this thesis report 14 social factors were identified but there may be much more factors which also cause of not adaption of this FMS system. Also sub factors of these factors may be identified that can help in understanding the main cause of FMS system resistance up to a much extent. The factors identified are according to literature survey but there may be some other factors which are not covered here.
At present, an ISM model is not validated. It maybe corroborated and tested by using structural equation modeling (SEM). SEM can statistically authenticate a developed model but it does not result into initial model. This initial model is provided by ISM approach. Hence, it becomes fascinating to equate ISM and SEM techniques.

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