EVALUATING EFFICACY OF CRITICAL FACTORS INFLUENCING FLEXIBLE MANUFACTURING SYSTEMS

***Dr. A. K. Madan, **Rahul Garg**

**Associate Professor, Delhi Technological University*
***Student, Delhi Technological University, Delhi India*

ABSTRACT

Flexible Manufacturing System (FMS) is a manufacturing system in which there is some amount of flexibility that allows the system to react in case of changes, whether predicted or unpredicted. The scope of this research includes identification of various variable of FMS on which the productivity and performance of the system depends. Two methods namely questionnaire method and Interpretive Structural Modelling technique are used to calculate the relative importance of these variables and their dependency on each other. The data used to rank these factors are obtained from survey of faculty members and industry professionals. Contextual relationship among these variables has been set after carrying out brainstorming sessions.

Keywords: *Dependability, Driver Power, Scheduling, Ergonomics, ISM, SSIM*

1. INTRODUCTION

Flexible Manufacturing is a structure identified in many commercial companies since the 90's.
The versatility of a manufacturing system is an essential attribute to be considered while developing and working the same. The freedom being made, quick reaction to unidentified industry changes and loss of cost of products or services has become the key factor for keeping the proportion of the marketplace. A significant task for many producers, therefore, is to achieve versatility in addition to accomplishing efficiency and quality (Cordero, 1997). Basically flexible manufacturing looks for to make a product that is what the customer at right time, reducing all non value added actions in the development (Womack & Jackson, 1994).
The use of Versatile Manufacturing systems is improving day by day and sectors are trying to recognize and find out the factors which are most important in terms of improving efficiency.

1.1 IDENTIFICATION OF FACTORS

Variables affecting Flexible Manufacturing systems in Industry Sector and establishing dependency of other variables had been carried out using brainstorming techniques between various experts and surveys conducted. As a result 10 key factors were identified to be most important listed as follows -

1. Raw Material Quality
2. Human Resource Quality
3. Effective Scheduling and reduction in waiting time.
4. Use of new more efficient technology
5. Proper Floor Space utilization
6. Effective Visual Control
7. Safety and Ergonomics
8. Defect Minimization
9. Customer involvement in quality program
10. Value Addition

2. METHODOLOGY

To achieve the objectives of this research work a questionnaire-based survey and an ISM approach have been used

.2.1 QUESTIONNAIRE-BASED SURVEY

A Questionnaire based survey is the first step towards implementing ISM technique. The results of this method are based on survey conducted on 300 individuals in the field of academia and industry.

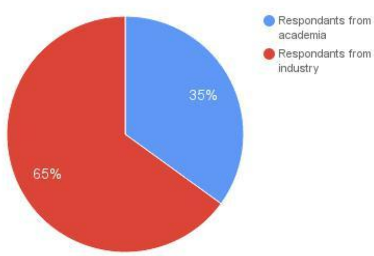

Fig.1 Respondents from Industries and Academia considered for study

The factors were rated from 1 to 10 to depict importance of the respective factor, 1 being “very low” and 10 being “very high”.

Mean of rating given to each factor was calculated and respective rank was given.

Variable	**Mean rating**
Raw Material Quality	8.124
Human Resource Quality	7.536
Effective Scheduling and reduction in waiting time	8.216
Use of new more efficient technology	6.932
Proper floor space utilization	6.235
Effective Visual Control	8.734
Safety and Ergonomics	6.110
Defect Minimization	7.636
Customer involvement in quality control	7.390
Value Addition	7.445

Table 1. Mean Score of Variables

Variable	Rank
Effective Visual Control	1
Effective Scheduling and reduction in waiting time	2
Raw Material Quality	3
Defect Minimization	4
Human Resource Quality	5
Value Addition	6
Customer involvement in quality control	7
Use of new more efficient technology	8
Proper floor space utilization	9
Safety and Ergonomics	10

Table 2. Rank of variables based on mean score

2.2 INTERPRETATIVE STRUCTURAL MODELLING(ISM)

ISM is an entertaining learning procedure. In this strategy, a extensive methodical design is established to represent the framework of a complicated issue or condition in a properly designed design indicating design as well as words (Sage, 1977; Warfield, 1974). ISM is a well-established strategy for determining connections among specific items, which determine a issue or a issue (Jharkharia and Shankar, 2005). It is described as an activity targeted at supporting the human being to better understand what he/she considers and to acknowledge clearly what he/she does not know.

The Various Steps involved in ISM methodology are as follows-

1. The variables identified in the previous section are listed.
2. Contextual relationships between the variables are examined
3. Pair wise relationship among variable are determined by developing a structural self interaction Matrix (SSIM)
4. Based on final SSIM dependence of variables on other variables and driver power of variables is calculated.

2.3 STRUCTURAL SELF INTERACTION MATRIX(SSIM)

Four signs have been used to indicate the route of the connection between the factors (i and j):

V- Varying i will help to accomplish varying j;
A- varying j will help to accomplish varying i;
B-X- varying i and j will help to accomplish each other;
C-O- Varying i and j are irrelevant.

The SSIM has been modified into a binary matrix, known as the preliminary reachability matrix by replacing the signs V, A, X, and O by 0 and 1 implementing following rules:

• If (i, j) value in the SSIM is V, (i, j) value in the reachability matrix will be 1 and (j, i) value will be 0

• If (i, j) value in the SSIM is A, (i, j) value in the reachability matrix will be 0 and (j, i) value will be 1

• If (i, j) value in the SSIM is X, (i, j) value in the reachability matrix will be 1 and (j, i) value will also be 1

• If (i, j) value in the SSIM is O, (i, j) value in the reachability matrix will be 0 and (j, i) value will also be 0.

Variables	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**
1	V	O	A	V	V	A	X	V	V
2	A	V	V	X	V	A	O	V	
3	V	X	V	A	A	O	X		
4	V	A	A	V	X	V			
5	O	V	V	X	A				
6	A	A	V	V					
7	V	X	A						
8	V	V							
9	A								
10									

Table 3.Structural self Interaction Matrix

Variables	1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	0	1	1	0	0	1
2	0	1	1	0	0	1	1	1	1	0
3	0	0	1	1	0	0	0	1	1	1
4	1	0	1	1	1	1	1	0	0	1
5	1	1	0	0	1	0	1	1	1	0
6	0	0	1	1	1	1	1	1	1	1
7	0	1	1	0	1	0	1	0	1	1
8	1	0	0	1	0	0	1	1	1	1
9	0	0	1	1	0	0	1	0	1	0
10	0	1	0	0	0	0	0	0	1	1

Table 3. Initial reachability Matrix

(IJIASE) 2017, Vol. No. 3, Jan-Dec **e-ISSN: 2454-9258, p-ISSN: 2454-809X**

Variables	1	2	3	4	5	6	7	8	9	10	Driver power
1	1	1	1	1	0	1	1	0	0	1	7
2	0	1	1	0	0	1	1	1	1	0	6
3	0	0	1	1	0	0	0	1	1	1	5
4	1	0	1	1	1	1	1	0	0	1	7
5	1	1	0	0	1	0	1	1	1	0	6
6	0	0	1	1	1	1	1	1	1	1	7
7	0	1	1	0	1	0	1	0	1	1	6
8	1	0	0	1	0	0	1	1	1	1	6
9	0	0	1	1	0	0	1	0	1	0	4
10	0	1	0	0	0	0	0	0	1	1	3
Dependence	4	5	7	6	4	4	8	5	8	7	

3. OBSERVATIONS

1. Effective Visual Control and Effective Scheduling, Reduction in waiting time were observed to be the most important factors affecting Productivity of Flexible Manufacturing Systems according to questionnaire survey.

2. Effective Visual Control, Defect Minimization and, Value addition were observed to have the highest Driver Power.

3. Customer Involvement in Quality Control and Proper floor space utilization were observed to have the highest dependability.

4. CONCLUSION

This article has presented a discussion on flexibility in manufacturing systems. Important issues for consideration in flexible supply chains have been highlighted. The application of flexible manufacturing system technologies can improve the ability of some general manufacturing environments to meet the needs of customers. Maintenance requirements are ubiquitous within the supply chain for any manufacturing environment. Flexible manufacturing environments cannot exist in environments that have view maintenance as a low priority. Efficient maintenance scheduling is an important tool for any manufacturing environment. If properly understood and applied, good maintenance practices can greatly enhance the performance of any manufacturing supply chain and facilitate the creation of genuine flexible manufacturing systems.

5. SCOPE FOR FUTURE WORK

- The number of factors considered for research work could be increased considerably
- Other Soft computing techniques can be used these factors and carry out necessary tasks.
- Other areas affected by these variables could be studies and hence can be improved significantly.

6. REFERENCES

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