

Identification of Manufacturing Flexibility in SMEs- Program, Labour and Machine Flexibilities

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Abstract— Manufacturing flexibility, the ability to produce a variety of products in the quantities that customers demand while maintaining high performance is a critical dimension of value chain flexibility. It is strategically important for enhancing competitive position and winning customer orders. This work deals with the identification of manufacturing flexibility in SMEs in the parameters of Program Labour and Machine. In today's changeable market, uncertainties play vital role. Uncertainties comes with respect to customer demand and competition. To overcome on this, we used the term named as Manufacturing Flexibility. In today's era of globalization, SMEs should possess the ability of quick change over and delivered the service that should be required. Hence it is important to define manufacturing flexibilities in industries so we can find the right approach for increasing the production. The statistical software used for reliability and validation of data obtained from questionnaire. In addition to this, statistical results indicate the compatibility between different dimension of manufacturing flexibility. By using Cronbach's Alpha, the overall flexibility of the system is found to be 0.60 to 0.70.

Keywords—*Manufacturing Flexibility, Program, Machine, Labour.*

I. INTRODUCTION

In 20th century the market is growing very rapidly, all the industries are doing experimentation to increase their profit. Profit can be increase by proper planning of production in SMEs. According to H. Vasudevan and A. Kumar [5] SMEs have a vital role to play in developing and developed countries' economies. More attention has been focused on small and medium sized enterprises in India over the past ten years, and this is one of the reasons why knowledge management in small and medium sized enterprises is not much explored. In today's changeable market uncertainties plays a vital role. It acts as one of the most important characteristics. This uncertainties comes with respect to customer demands and competition. To overcome on such

uncertainties many industries use the concept name as Manufacturing Flexibility. Manufacturing Flexibility is the ability of the manufacturing industries to face any kind of uncertainties. S. Kumar, A. Goyal, A. Singhal [3] define Manufacturing Flexibility as ability of the manufacturing system to develop and select alternatives for a particular manufacturing situation. In 21st century due to Global Competition and rapid introduction towards new product, variation in product demand, the market value got increases. Hence to be in competition and to survive SMEs must utilized the flexibility in their daily work which will results in high quality product at lowest cost and ready to give rapid response to customer's needs and changeable market demands. Due to which Manufacturing Flexibility plays important role to get the maximum productions with minimum supply.

A. Sethi and S. Sethi [1] attempt the survey on flexibilities in manufacturing system that has been accumulated from past 10 to 20 years. Also, they examined the interrelationships among the several flexibilities. They discussed and reported the various empirical studies and analytical models dealing with flexibilities. R. Parker and A. Wirth [2] studied and formulated the manufacturing flexibility measures and relationship between them by introducing a framework to facilitate the development of flexibility measures. They validate the measures of flexibility types. S. Kumar, A. Goyal and A. Singhal [3] tried to attempt to understand the different flexibility parameters and their effect on the performance on production. They found that beyond the certain level of manufacturing flexibility system performance starts deteriorating. R. Garg and V. Kumar [4] investigated in the importance of the flexibility parameter in the process of manufacturing planning and control system development during the 20th century. They come with the idea of factors effecting production planning and manufacturing strategy. Also

objectives and design steps of production planning and control. They mentioned the flexibility types and different flexible systems and their growth in today’s environment. H. Vasudevan and A. Chawan [5] explored different insights on knowledge management in the Indian manufacturing small and medium scale enterprises (SMEs). They also suggested few managerial implications for owner of SMEs for the effective use of knowledge management in their organizations. W. Terkaj, T. Talio and A. Valente [6] highlighted the relevance of the problem both at industrial and academic level in manufacturing flexibility. They reviewed the state of art of the literature on manufacturing flexibility by a conceptual framework to support flexibility formalizing process. The overall Literature study helps us to identify the flexibility parameters regarding time management, cost saving, improve products Quality and rate of production in the manufacturing process.

The main aim of this paper is to identify the manufacturing flexibility in small and medium scale enterprises (SMEs). There are various parameters that influences the manufacturing flexibility namely, Machine, Process, Operations, Product, Routine, Volume, Production, Expansion, Material Handling, Program, Market, Automation, New Design, Delivery, Labour, etc. But, in this study we are more focused on the following three flexibilities mentioned as Machine, Program and Labour Flexibilities. As these three are one of the most effective flexibilities which has great impact on the output and efficiency of the manufacturing system. According to A. Sethi and S. Sethi [1] machine flexibility is referring to various types of operations that the particular machine can perform without requiring an excessive effort in switching from one operation to another. Machine flexibility requires considerable attention on part management. Program flexibility which was state by A. Sethi and S. Sethi [1] is the ability of system to run virtually untended for a long enough period. It depends on process and routing flexibilities and operates on sensors and computer controls for detection and handling of production. S. Kumar, A. Goyal, A. Singhal [3] define labour flexibility as the multitasking ability of the labour/ workers/ human resources. It varies from skills of resources from various influencing factors. They suggest the proper definitions and its measures related to program, labour and machine flexibilities [see TABLE 1] by proper studying and analyzing the manufacturing requirements.

TABLE 1. DEFINITIONS OF FLEXIBILITY TYPES AND THEIR RESPECTIVE MEASURES

Flexibility type	Definition	Measures
Program Flexibility	System’s Ability to unattended operation for long period of time.	Period for which MS could be operated
Labour Flexibility	Multitasking ability of labour/ Operator/ Human	Average number of tasks that human resources can performed

Machine Flexibility	Ability of machine to perform various range of operations	Average of different number of operations performed on machine
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II. DATA COLLECTION

As our purpose is to identify the manufacturing flexibilities in small and medium sized enterprises (SMEs), we made a standard Questionnaire [see TABLE 2] that contain the questions related to the three parameters namely Program, Labour and Machine flexibilities. This questionnaire was addressed from the ground level of the organization work to the top level management either to the worker or the above position consultants by the mode of direct and indirect communication. It was not possible to contact Manager/Supervisor of each company to complete the questionnaire. Hence our targeted resources were Workers and above position Employers which works under the SMEs. The Likert scale method is used to complete the survey research. We used **5-point Likert Scale**.

Thane- Belapur Road, Rabale MIDC, Turbhe MIDC and their surrounded node is our targeted region as it contains number of small and medium sized enterprises (SMEs). For these research electronics, machinery, process, services, technology and small workshop are considered. We sent 60 mailed attached questionnaires to the respective industries out of which we received 3 correct replies and we got 53 questionnaires by doing direct visit to the respective Enterprises. We skip 4 Questionnaires as it was incomplete or improper. So, we select 52 questionnaires for our final analysis.

TABLE 2. STANDARD QUESTIONNAIRE

1	Program flexibility	1	2	3	4	5
a)	Ability of the system to run for long enough time					
b)	Manufacturing performance will be high when increase in program flexibility					
c)	Program flexibility is expected to increase throughput by facilitating the organization					
d)	Compactivity of program is less to attend high performance					
e)	Program flexibility reduces set-up time by means of reduction in throughput time					
2	Labour flexibility	1	2	3	4	5
a)	Workers are capable to work on more than one machine at a time					
b)	Ability of workers to operate various machines is high					
c)	Workers can be easily transferred between different departments					
d)	When change in demand skilled worker availability is no issue					

e)	A typical worker can use many different tools effectively					
3	Machine flexibility	1	2	3	4	5
a)	Machine set-up can be done quickly					
b)	Total number of operations that machine can perform is high					
c)	Machinery is designed to accommodate quick changeover					
d)	Machine tools can change quickly					
e)	Machine frequently become outdated when new operations are required					

III. DATA ANALYSIS

Carmines and Zeller [7] reported that reliability concerns the extent to which an experiment, test or any measuring procedure yields the same result. Internal consistency analysis was carried out to measure reliability of the items under each critical factor using Cronbach’s Alpha. The overall Cronbach’s alpha is found to be ranged from 0.60 to 0.70. This states that the item/variables of the performance measure were reliable, and the results are shown in Table 3.

Table 3. CRONBACH’S ALPHA AND OTHER PARAMETERS

Factor	No. of Items	Mean	Standard Deviation	Cronbach’s Alpha	Factor Loading	Communality	Eigen Values
Program Flexibility	5	3.852	0.938	0.554	0.593	0.600	1
Labour Flexibility	5	3.850	1.125	0.565	0.585	0.646	1.004
Machine Flexibility	5	3.702	1.070	0.202	0.409	0.691	1

Every parameter has a construct validity of its measure that is designed to measure. To determine construct validity, there are three methods used namely Multi method analysis, Factor analysis and correlation analysis. Here we choose Factor analysis method to evaluate construct validity. The values of factor loading [see Table 3] represented in items are almost more than 0.40 which indicates Manufacturing Flexibilities has the construct validity. To determine strength of relationship correlation matrix is used, which measures the sampling adequacy. The number of factors to be extracted in each analysis was determined by the Eigen values which are more than or equal to 1. (see Fig.1) Scree plot is used in Principal Components analysis. Factor analysis is visually assesses which

components or factors account for most of the variability in the data. The ideal pattern of scree plot is a steep curve followed by a bend and then flat horizontal line. (See Fig.2)

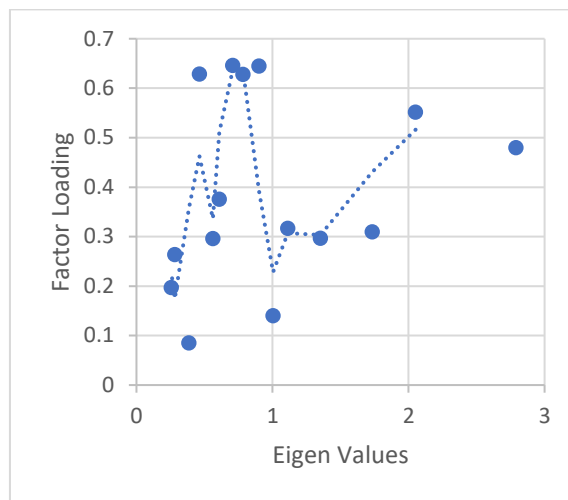


Fig.1 Scatter plot of Factor Loading vs. Eigen Values

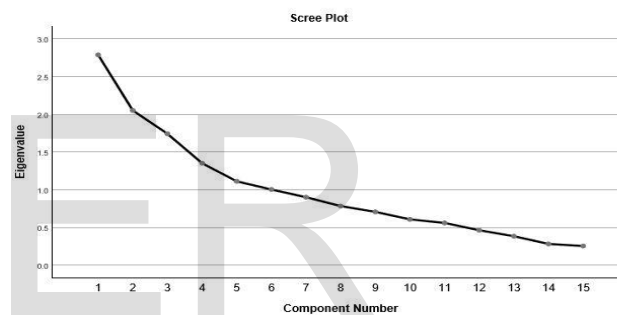


Fig. 2 Scree plot of Eigen Values vs. Component Number

IV. RESULTS AND CONCLUSION

Manufacturing industries in the world wide are investing in flexibility to overcome and adopt the uncertainties. Manufacturing flexibility allows firms to quickly put into use of new technologies, fulfill customer’s demands and deal with legislative and social climates. Manufacturing flexibility can provide a competitive advantage if there is proper fit between different variables which affects the performance of firms. In last 15 years, significant advance research has been made on manufacturing flexibilities. However, further studies are necessary to more fully explain the complex nature of manufacturing flexibility. Therefore, it proves that implanting Manufacturing Flexibility in SMEs will gives more impact on the productivity.

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