STUDY OF ADOPTION BARRIERS FOR FLEXIBLE MANUFACTURING SYSTEM IN INDUSTRY

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Abstract

Manufacturing companies face a challenge of technological innovation in competitive markets. Rapid changes in technology produce product and process with short product life cycles, short lead times with continuously changing consumer preferences with high the uncertainty that demands enhanced manufacturing flexibility not only for productivity enhancement but for survival too. The higher manufacturing flexibility offers more spare time to feed the customers with a higher product range and variety of options. To dynamic changes and competitive market may be captured through flexibility in manufacturing. This research is focused on the study of the adoption of flexible manufacturing system in industries by studying various barriers for adoption. These study industries which are found for willing to accept modification in present manufacturing system. Mathematical modeling can be developed with the help of Multiple Criteria Decision Making (MCDM) like AHP or TOPSIS can be used by any industry by just finding the value of barriers. Once this is done, Industry can be assessed how they can adopt flexible manufacturing system, which are the most significant barriers for the adoption of FMS. The major outcome of this research is adoption assessment and intensity of barriers for successful implementation of Flexible Manufacturing System. This procedure can be used for both old as well as new industry.

Keywords: *Flexible manufacturing systems, Adoption Barriers.*

In today's market scenario, product life, demand and specification changes very rapidly, also technological advancement, customer's expectation and fierce competition force manufacturer to accommodate these changes in their manufacturing system quickly to remain in market competition Flexible manufacturing system (FMS) has a capability to react to market changes within a shorter time and at less cost.

A flexible manufacturing system (FMS) usually operated by centrally control system generally comprising of a set of processing workstations (usually CNC machine tools) interconnected by an automated material handling system having capability of Automated Storage/Retrieval Systems (ASRS). An AS/RS comprises of Crane, Handling picking and loading, Rack either stationary or movable racks. AS/RS is capable of handling pallets. Flexible Manufacturing Cell (FMC) comprises two or more CNC machines while Flexible Manufacturing System (FMS) have two or more FMC

To combat the above situations, Indian manufacturers are all set to use FMS in a big way to join with the global users. However, they realize that the FMS selection and implementation is costly and time consuming. There are factors that influence the FMS adoption in place of prevailing traditional manufacturing system. Organization must be aware of these factors so that they don't face hardship in FMS selection and implementation. This paper aims to address these issues and provides good time to organization in FMS selection.

Literature review

Nowadays customer demand lower price more customized product more innovative product, make manufacturing system more agile and productive and able to produced customized product and for this FMS is more suitable manufacturing philosophy compare to Job, batch and mass production system. But although above situation still today adoption of FMS is very low, of course first step of FMS i.e. programmable machine tools (CNC machine) is now widely adopted but other components like AGV, Robot, ASRS and CIM is still not adopted in manufacturing system. Present paper is attempted to study various adoption barriers still today for adoption of FMS in industries.

Manufacturing organizations are much influenced by management functioning at strategic, tactical operation level. Manufacturers must pay due attention at its strategic level in selecting a FMS system. Scope for FMS has been established and a four-stage strategic framework for the effective the implementation process has been suggested[1].A unified framework using Analytic Hierarchy Process (AHP) and Data Envelopment Analysis (DEA) is proposed to facilitate decision making during designing and planning stage[3].

The development of intelligent decision support tools to aid the design of flexible manufacturing systems has been proposed[4]. Integration plays an important role in FMS setup. Many researchers have recommended various tools for FMS design, simulation and decision-making support in a defined environment. Simulation and modeling plays a vital role in establishing process without actually running the setup thus provides lot of advantage[5]. Simulation models give maximum information pertaining to facilities, the layout, and their interconnections.

Fuzzy based modeling has been suggested by many researchers in selection of FMS system. Linguistic criteria in FMS selection using fuzzy-set-AHP approach has been proposed[6.] Application of fuzzy sets for the selection criteria framework provides user-friendly features. Many selection criteria have been suggested and grouped viz. like flexibility, cost, productivity, and risk. High capital outlay and moderate risk of a FMS investment must be balanced with benefits such as flexibility and enhanced quality. Selection of FMS based on economic and strategic investment using MCDM framework is also proposed[8.] FMS selection using compromise ranking method in conjunction with Analytic

Hierarchy Process (AHP) has been proposed[9]. Evaluation of alternative FMS for a given industrial application has been carried out using TOPSIS and AHP[10]. Due to globalization and competitive market condition the past two decades, use of FMS as a competitive weapon has increased significantly. [11].(Rakesh Narain R.C. Yadav Jiju Antony, (2004)).

Researchers studied various approach for the implementation for FMS but the real-life scenario, which is very dynamic in nature and requires accurate methodologies and decision support system for FMS adoption. Several researchers suggested different approach for FMS adoption. (e.g., Rezaie and Ostadi 2007, Groover 2003) Groover[16] discussed FMS planning and implementation issue while Rezaie and Ostadi[17] suggested dynamic programming model for FMS implementation and also phased implementation of FMS. Not only FMS but various flexibility also needs great attention for successful FMS adoption. Flexibility is one of the critical dimensions in enhancing the competitiveness of organizations. Sethi and Sethi[18] (1990) defined eleven types of flexibility: product, process, program, production, volume, routing, expansion, operation, machine, material handling and market flexibility. FMS is called flexible because this manufacturing system is capable to manufacture variety and number of products as per market demand.

FMS must be able to cater the need of accomplishing various performance measures such as the average waiting time, the average and maximum lead time, the total production time along with machine utilization. Many researchers have contributed towards selection and implementation of FMS setup. Babbar and Rai [19] insisted that barriers is not technology but its successful implementation is biggest task hence the focus should be on overall effectiveness .Ching and Loh (2003) have raised the issue of good management in successful implementation of FMS.

Methodology

FMS is very versatile but complex system and hence for adoption of FMS is challenging task literature reviews suggest various barriers for successful adoption of FMS. From literature reviews, manufacturing company's survey, academicians and advance manufacturing consultants identified barriers. Raj, Tilak, et al[13] (2010) has identified various barriers for FMS adoption. In these barriers further work is carried out for successful adoption of FMS. These barriers are grouped into seven major categories. To identify intensity of barriers and sub-barriers in the path of adoption of FMSs, total 50 industries are surveyed as pilot survey personally through survey questionnaire and data collected. All sub-barriers are quantified on linear scale as per intensity in path for adoption of FMS and plotted in Tabel-2 to table-7. Also to check reliability, reliability test carried out for data collected through survey questionnaire and found satisfactory as shown in Table 1 value of cronbach's alpha is showing reliability of data. These barriers may be different for different organizations because of their work culture, management's attitude and the type of their product:

Table 1

Construct	No of items	Cronbach Alpha
Behavior barriers	06	0.782
Technical barriers	06	0.859
Operational barriers	06	0.765
Financial barriers	05	0.712
Strategic barriers	06	0.878
Supply chain barrier	04	0.715
Miscellaneous barriers	03	0.706

Table 2

Name of Barriers	Sub-barriers
Behavior barriers	1. fear of failure 2. lack of clear vision 3. employee's resistance 4. non-commitment of top management 5. social implications due to the retrenchment of employees 6. cheap labour

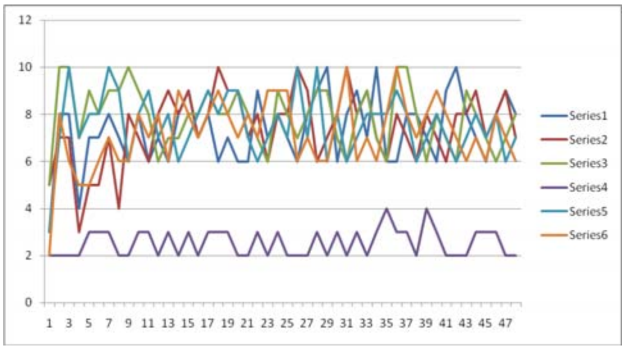


Table 3

Name of Barriers	Sub-barriers
Technical barriers	1. difficulty in the use of high tech-equipments like AGVs, robots, AS/RSs etc. 2. lack of technical knowledge 3. non-availability of trained personnel 4. complex operational techniques of FMSs. 5. technical uncertainty 6. difficulty in the integration of different components of FMSs.

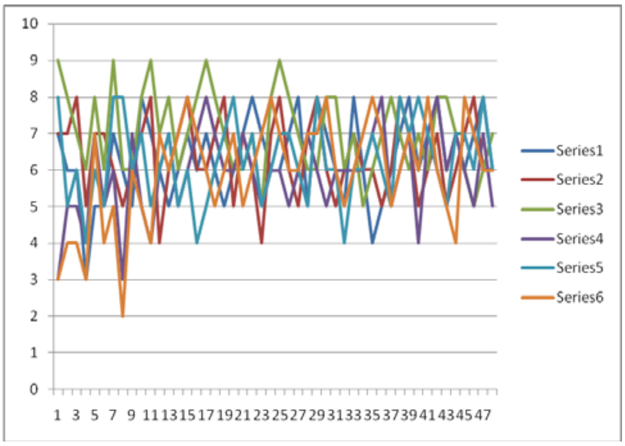


Table 4

Name of Barriers	Sub-barriers
Operational barriers	1. resource failures 2. maintenance failures 3. difficulty in handling the loading problems of FMSs. 4. difficulty in handling the scheduling problems of FMSs. 5. tool management problems 6. layout problems

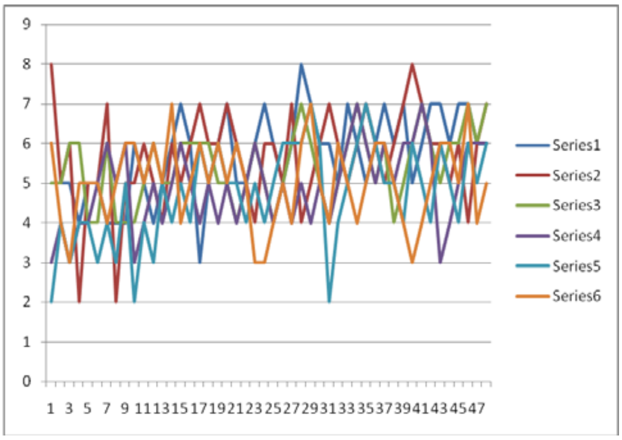


Table 5

Name of Barriers	Sub-barriers
Financial barriers	1. high cost of FMSs 2. non-availability of funds 3. high taxes like sales tax, excise duty etc. 4. poor rate of return over investment 5. long payback period

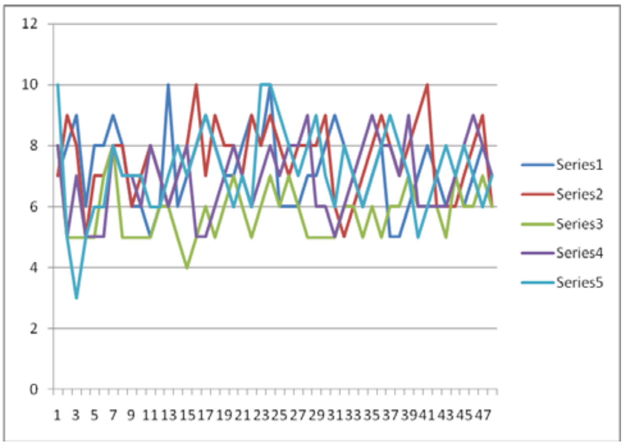


Table 6

Name of Barriers	Sub-barriers
Strategic barriers	1. FMS planning problems 2. low throughput time 3. unfavorable government policies 4. flexibility measurement problems 5. non-availability of good vendors 6. failures to carry out feasibility studies

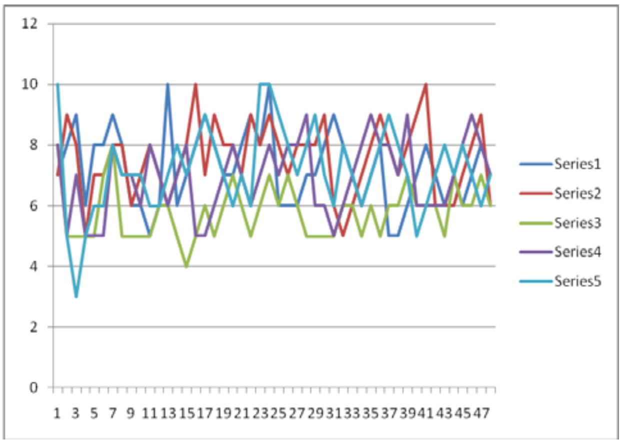


Table 7

Name of Barriers	Sub-barriers
Supply chain barriers	1. vendor selection problems in the supply of high-tech equipment 2. big losses of market share during transition periods 3. lack of supply chain planning and coordination 4. demand uncertainties

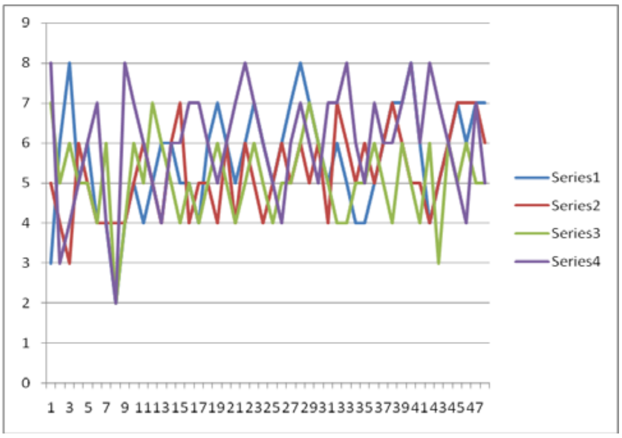
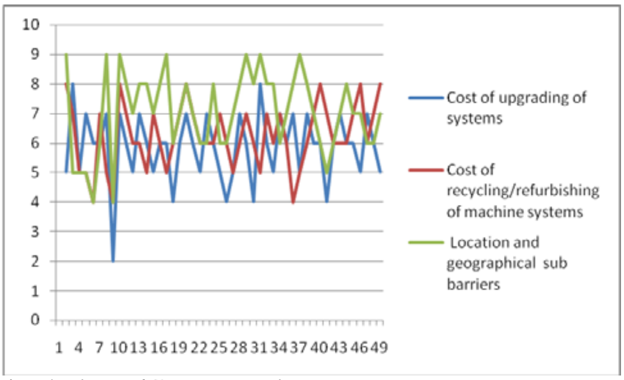


Table 8

Name of Barriers	Sub-barriers
Miscellaneous barriers	1. Cost of upgrading of systems 2. Cost of recycling/refurbishing of machine systems 3. Location and geographical sub barriers



Analysis and Interpretation

From the analysis, it has been observed that financial barriers have the maximum intensity. Next, the major categories of barriers are behavioral, technical and operational. At the technical level, difficulty in the integration of various components of FMSs is an important issue. After identifying various barriers for adoption of FMS. The cost of using flexible manufacturing systems is high and it is one of the factors which needs to be considered when undertaking flexible manufacturing systems adoption project. The cost of obtaining flexible manufacturing systems is a major barrier to the increased uptake of flexible manufacturing systems amongst the industry. In figure 1. Prioritization of barriers is for FMS adoption is shown.

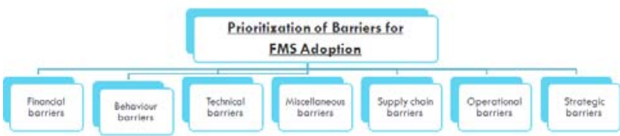


Figure 1

Conclusions

FMS essentially enhances firm's competitiveness thus boost its position in the competitive market. However, the organization may land into trouble by committing common mistakes in adoption of FMS system. The present framework for identification of barriers and sub barriers work will help the organization to make correct decision in adopting FMS system studying intensity of various barriers in a holistic way. It has been observed that financial barriers, behavioral and technical are major barriers to adoption of FMS.

Many a time cost constraint compels the organization to opt for partial flexibility instead of totally flexibility in its shop floor to get benefits of total flexible systems.. However, organization should not consider cost aspect only while deciding for FMS, it should encompass other criteria like behavioral barriers, technical barriers as well for the successful adoption of FMS. The major outcome of this research is adoption assessment and intensity of barriers for successful implementation of Flexible Manufacturing System.

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