Original Research Paper

VOLUME-6 | ISSUE-4 | APRIL - 2017 • ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46

State of the art literature review on Flexible Manufacturing System

Engineering

KEYWORDS: Flexible manufacturing systems, Literature review, Methodology.

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ABSTRACT

In the present market scenario, the customer demand and specification of any product changes very rapidly. It is very important for a manufacturing system to accommodate these changes as quickly as possible to be able to compete in the market. Flexible manufacturing system(FMS) is a manufacturing philosophy based on the concept of effectively controlling of material flow through a network of versatile production station consist of programmable machine tools (CNC machines) using efficient automated material handling system and efficient Automated Storage/Retrieval Systems (ASRS) all are connected with computerized control system.

This research is focused on the review literature on of flexible manufacturing system in industries. A large number of papers in journals, conference and special volumes are publishing research papers concerned on Flexible manufacturing system (FMS). The objective of this paper is to review literature on Flexible manufacturing system (FMS) in last 30 years. Most of the focus was on measurement of flexibility, with few studies illustrating the issues in implementing FMS and using FMS. The reviewed literature was structured using the following categories: year, journal, research methodology, research design, operation research (OR)/mathematical tools and techniques, data analysis technique, industry sector, multi-criteria decision making (MCDM), authors, universities, country, enablers, and barriers These study will become helpful to researcher which are willing to research on FMS

1. Introduction

Manufacturing companies face 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 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 customers with higher product range and variety of options. To dynamic changes and competitive market may be captured through flexibility in manufacturing.

Flexible manufacturing system (FMS) has received considerable attention in the literature over the last several decades. Hence there is literally a huge amount of published literature on FMS. Several studies are devoted to examining the potential benefits of FMS implementation. And the advantages associated with the FMS implementation are numerous. Successful implementation of FMS could generate reduced labor costs, increased flexibility and product variety, productivity improvement, improved responsiveness, and increased machinery utilization (Inman, 1991; Boer and Krabbendam, 1992a, b; Evans and Haddock, 1992; Kaighobadi and Venkatesh, 1994; Maffei and Meredith, 1995).

Literature review works on FMS

Many researchers have conducted intensive research in the area of manufacturing flexibility and earmarked significant factors that are influencing the market viz. Fierce global competition; Changing product life cycle; enhancement in quality requirement; More product customization; rapid-paced advancements in technology and growing options in materials and processes. To achieve success in such an environment, it is not sufficient for manufacturing companies to focus on being competitive in terms of product cost and quality but must also achieve the highest possible performance in an unpredictable environment. Flexible Manufacturing System (FMS) could be the answer to such scenario

Manufacturing organisations adopt Flexible Manufacturing Systems (FMSs) to meet the challenges imposed by today's volatile market standards. But the implementation of FMSs is not an easy job. Various barriers are experienced in real-life cases during its implementation. It is very much necessary to analyse the nature and impact of these barriers so that production managers can think of some strategies to overcome these barriers[1]

The rate of return on investment in FMS is decisive factor for adoption of FMS, hence in early stage the diffusion rate of FMS was slow still 2000 in developed countries like USA, Japan and Europe.[2] Particularly Indian industries also start to implement FMS from early 1990 due to rapid automation in automobile industries and machine tool industries. In research paper Deshmukh and K.Subbarao suggested frame work for adoption of FMS and also discussed various issue related to Indian manufacturing industries for adoption of FMS [3]

D. Ajith et al Examines that the impact of the adoption of Flexible Manufacturing Technology (FMT) on the Malaysian Manufacturing Industry.[4] And find sufficient evidence to conclude that FMT has a direct and moderately significant relationship with price cost margin.

M. Ali et al has analyzed performance of a flexible manufacturing system under different manufacturing strategies. Manufacturing strategies under consideration are manufacturing flexibility, lot size and scheduling of jobs in the system. [5] And the results show that considering different manufacturing strategies decisions in a simultaneous manner can significantly improve the performance of the flexible manufacturing systems.

Yahia Zare Mehrjerdi develop a computer aided decision-making model for flexible manufacturing system (FMS) situations when multiple conflicting objectives are addressed by the management and help decision maker at the level of production scheduling with his model[6]

Zubair, Faizul et al examines the relationship between system performance and machine flexibility[7]

Ozden Bayazit use analytic hierarchy process (AHP) that is a multiple criteria decision-making methodology in evaluating flexible manufacturing systems (FMSs)[8] and suggested 28 factors that were both qualitative and quantitative to assess the FMS implementation. Dixit et al identified various factors which affect the productivity in FMS installation.[9]and concluded that Sometimes manufacturing companies take quick decisions regarding the adaption of new technologies just by following the production system reports of the competitors without taking into account their own capabilities or limitations. In such cases new technologies like FMS prove suicidal.

Robert H. Chenhall examines the role of manufacturing performance measures to evaluate managers' performance for firms pursuing strategies of manufacturing flexibility. Proposes that enhanced performance will be associated with the interaction between manufacturing flexibility and use of manufacturing performance measures.[10]

Injazz Chen et al observe that Employees commitment for the implementation of flexible manufacturing systems is very important [11],they also suggested that there is a significant relationship between educational opportunity and level of employee commitment for successful implementation of FMS.They identified five factor, Job training, job discretion, management support, job security and financial incentives are important factor to employee for successful implementation for FMS.

Dycus, James P has analyzed benefits of FMS. Production processes in the FMS consistently produce high quality parts, when compared to a standalone machining environment. [13]

Godinho Filho, Moacir et al have used Genetic Algorithms (GAs) applied to flexible manufacturing system (FMS) scheduling according to FMS type, types of resource constraints, job description, scheduling problem, measure of performance and solution approach[14]

Uday R. Kulkarni et al proposes a framework of an intelligent system that integrates the neural networks approach and a knowledge-based system to provide decision supporting functions for effective implementation of FMS.[15]

M.G.meharabi et al examine the potential roles and enabling technologies for reconfigurable manufacturing systems (RMS). The results show that two-thirds of respondents stated that FMSs are not living up to their full potential, and well over half reported purchasing FMS with excess capacity[16]

Rakesh Yadava et al observe that company needs to meet its strategic objectives, nor how this flexibility can be achieved. An overview is provided of different types of flexibility, a classification scheme based on the strategic positioning and goals of the firm is provided, and suggestions are made on how these goals may be achieved.[17]

Narayan C. Nayak et al examines the current state of flexibility adoption in manufacturing firms in India, considering the important flexible equipments and indeed, this is the first such attempt. Adoption/implementation includes equipments such as work centre, process centre, support stations, network communications, integration and control. Questionnaire survey methodology is used for status evaluation: not implemented[18]

Narayan C. Nayak et al examine that in a production system is the establishment of appropriate flexibility measures. A firm with higher flexibility is expected to develop a variety of products at low cost, high quality, and with short throughput time. In order to achieve appropriate control over flexibility over time, the best option is to measure and evaluate it in quantitative terms[19]

T. RAJ explain The volatile condition of today's market is forcing the manufacturing managers to adapt the flexible manufacturing systems (FMS) to meet the challenges imposed by international competition, ever changing customer demands, rapid delivery to market and advancement in technology. There are certain enablers, which help in the implementation of FMS or in the transition process from traditional manufacturing systems to FMS.[23]

R. Venkata Rao explain improved compromise ranking method in conjunction with Analytic Hierarchy Process (AHP). The proposed 'FMS Selection Index' (FMS-SI) evaluates and ranks FMSs for a given FMS selection problem.[24] [25]

Research objectives:

Based on the research motivations presented in the above section, the present paper aims to conduct a novel literature review on FMS and provide the current status of the research field by classifying and analyzing the relevant papers extracted from the structured search along different perspectives.

To fulfill the objective of research motive searching answer of following questions are attempted:

What is the present research status in FMS?

What research designs and research methodologies are being used?

Which different data analysis techniques and Mathematical tools are used?

What types of industries are focused and which countries are dominating in FMS research area?

Which decision making methods are employed in FMS research?

What are the key barriers and for FMS adoption?

And finally, what is the future research scope in FMS implementation.

Research methodology description

In order to collect the relevant data on the different manufacturing system which exist. In order to make this process as efficient as possible a search strategy was formulated to aid in the data gathering process. The search strategy was based on identification of the relevant data sources and keywords and focused its attention on gathering information from a wide classification of databases, conference proceedings, books, library and articles from online journals. The search focused on the more recent publications and as such only papers written and published between 1990 and 2016 were considered for the review.

Search strategy used a wide range of keywords such as flexible manufacturing systems, simulation and layouts, and various keyword combinations such as "Flexible Manufacturing System ", "Flexibility" "Barriers for adoption of FMSs", "FMS implementation ", "FMS Simulation and Manufacturing Classification", "simulation", but to name a few. A total of 100 research paper were collected and mendeley desktop application used for analysis and note preparation. After refinement, based on 73 research paper literature review is prepared. The analytic categories derived through literature survey is explain below: Table 1 shows Distribution of reviewed papers by journal on Flexible Manufacturing System (FMS), Figure 1 indicate Distribution of reviewed papers by journal,figure 2 shows article publish by different country, figure 3 shows article publish by yearly, Table 2 shows Distribution of reviewed papers based on research design on Flexible Manufacturing System (FMS).

Table 1.

Distribution of reviewed papers by journal on Flexible Manufacturing System (FMS)

Journal name	No. of papers	percentage
Journal of Manufacturing Technology Management	14	19 %
Integrated Manufacturing Systems	7	9%
International Journal of Operations & Production Management	5	7%
Assembly Automation	3	4%
Global Journal of Flexible Systems Management	3	4%
International Journal of Production Research	3	4%
Procedia Engineering	3	4%
Int. J. Industrial and Systems Engineering	2	3%
Int. J. Services and Operations Management	2	3%

VOLUME-6 | ISSUE-4 | APRIL - 2017 • ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46

International Journal of Agile Management Systems	2	3%
International Journal of Productivity and Performance Management	2	3%
Other	27	37%
Grand total	**73**	**100%**

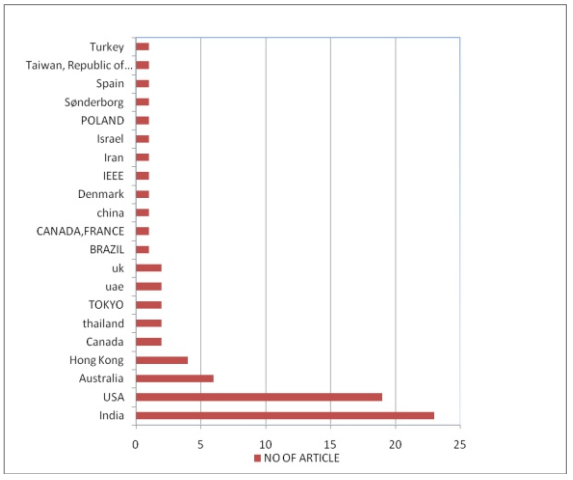


Figure.2 Country vs. article

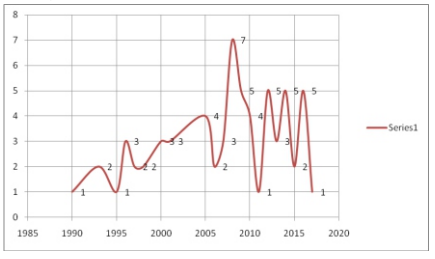


Figure.3 Year wise article

Research conclusion:

The research on FMS has increasingly very rapidly in the past decade. This study tries to enhance the knowledge of the research field by conducting an extensive literature review of 73 articles published on FMS in the last two decade.

The present literature study provides a useful insight as how the research in the field of FMS has shaped up in past twenty years, understanding and implementation of FMS. The literature research as discussed may help other researchers and practitioners to further investigate these issues

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