IDENTIFICATION OF BARRIERS TO FLEXIBLE MANUFACTURING SYSTEM IN AUTOMOBILE INDUSTRY

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Abstract—Continuously changing consumer preferences and technological innovation demands enhanced manufacturing flexibility not only for productivity enhancement but for the survival of manufacturing company. The higher manufacturing flexibility offers the company to feed their customers with the variety of product according to their demand. Flexibility in manufacturing system helps to accommodate dynamic changes and sustain the competitive market. This research is aimed at examining the barriers to the implementation of FMS in the automobile industry. An extensive literature review has been conducted to identify various barriers in the research area of FMS. Identified barriers help automobile industry to adopt flexible manufacturing system by finding most significant barriers.

Keywords—Flexible manufacturing systems, Flexibility, Adoption Barriers, Automobile industry, competitive market

I. INTRODUCTION

With increasing in customer preference for product variety and technological advancements to attain shorter lead-times with higher productivity and quality, there is the need for manufacturing company to accommodate these changes as quickly as possible to sustain in the competitive market. Flexible manufacturing system (FMS) can react to market changes rapidly and at less cost. The automotive industry in India is one of the largest in the world, it accounts for 7.1 percent of the country’s gross domestic product (GDP), following a growth of 2.57 percent over the last year. To accommodate this growth and to maintain in the competitive market, there is the need for the automobile company to adopt flexible manufacturing system. Flexibility in automobile industry helps the company to adopt technological changes and produce goods in huge varieties to fulfill the requirement of the customers.

A flexible manufacturing system (FMS) operated by the central control system comprising of a set of processing workstations (usually CNC machine tools) interconnected by an automated material handling system having the capability of Automated Storage/Retrieval Systems (ASRS). Flexible manufacturing systems (FMS) are advantageous in many ways, they keep high productivity by reducing lead time and wastage. Satisfy customers need by proving the vast variety of products. Decreases overall manufacturing Costs, Keeps low production labor costs and Increases total company revenues.

The optimal design of FMS is a critical issue, and it is a complex problem. The implementation of flexible manufacturing system faces various barriers such as Technical barriers, Operational barriers, financial barriers and Strategic barriers.

Seventeen barriers have been recognized using exhaustive literature review viz. Excessive material handling operations (B1), Poor efficiencies of equipment (B2), Floor layout problem (B3), Deadlock (B4), Tool management decisions(B5), Collisions in automatic guide vehicle (B6), Tool allocation (B7), Machine loading problem (B8), Complexity in Scheduling (B9), Excessive Tool Switching (B10), Design and planning problems (B11), Part type selection problem (B12), Capacity allocation problem (B13), Resource allocation problem (B14), Machine Grouping Problem (B15), High Initial Capital Cost (B16), Tool management decisions(B17).
II. LITERATURE REVIEW

Kouvelis [1] highlight the need for flexible manufacturing system to accommodate dynamic changes and to sustain the competitive market. Flexible manufacturing systems are modern production facilities that are adaptable to different production plans. An FMS includes the material transportation system, the work-piece warehouse, processing equipment and other resources [2]. Adaptation of flexible manufacturing system is a complicated process. Sundaran and Qureshi [3] provided a brief view of problems which are faced in implementation of FMS in any manufacturing industry.

Implementation of FMS faces various barriers such as Technical barriers, Operational barriers, financial barriers, Strategic barriers. Operational barriers include loading problems, scheduling problems, tool management problems and layout problems. Yang et al. [4] addressed layout design problem and highlighted the need for proper layout for increasing the efficiency of the system. They proposed two-step heuristic to solve the layout problem.

Kumar et al. [5] solved machine loading problem with a constraint-based genetic algorithm (CBGA). For tool allocation problem Buyurgan et al. [6] proposed an approach which utilizes the ratio of tool life over tool size (L/S) for tool selection and allocation. Sabuncuglu et al. [7] solved scheduling problem with the help of on-line dispatching algorithm. The algorithm uses various priority schemes and information concerning the load of the system and the status of jobs in the scheduling process. Kim et al. [8] suggest simulation based real-time scheduling. The scheduling mechanism was developed in which the job dispatching rule varies dynamically based on information from discrete event simulation that evaluates a set of candidate rules system.

Technical barriers include poor efficiencies of equipment, Collisions in automatic guide vehicle. Carvalho and Gomes [9] find that the cost of electricity was not regarded as a production cost, and hence the energy efficiencies of equipment are usually not considered in industry. They proposed a new method of evaluating the machines, devices, and equipment involved.

Strategic barriers and financial barriers include design and planning problems, High initial capital cost and unfavorable government policies. Kouvelis [10] reviewed Design and planning problems which helped FMS manager in setting up a highly efficient manufacturing system.

III. IDENTIFICATION OF BARRIERS

The automotive industry in India is one of the largest in the world with an annual production of 23.96 million vehicles in FY (fiscal year) 2015–16, following a growth of 2.57 percent over the last year. The automobile industry accounts for 7.1 percent of the country's gross domestic product (GDP). But due ever-changing customer demand and technological innovation, there is need of flexibility in automobile manufacturing industry to accommodate these dynamic changes. The adaptation of flexible manufacturing system in automobile industry is complex process; it is accompanied by various barriers. Through extensive literature review and expert opinion various barrier are identified and given in the following table:

| S NO. | BARRIERS                          | EXPLANATION                                                                 | REFERENCES          |
|-------|-----------------------------------|-----------------------------------------------------------------------------|---------------------|
| 1     | Excessive material handling       | Increase in material handling operations could lead to increase in overall operational costs. | Jain et al.(2008)   |
|       | operations                        |                                                                             |                     |
| 2     | Poor efficiencies of equipment    | Decrease in efficiency of equipment cause increase in production cost.       | Carvalho et al.(2015) |
|   | Topic                                      | Description                                                                                   | References                                                                 |
|---|--------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 3 | Floor layout problem                       | Floor layout problem is the determination of relative locations for, and the allocation of, available space among a number of workstations. | Ficko et al. (2010), Yang et al. (2005)                                   |
| 4 | Deadlock                                   | A deadlock is a highly undesirable situation in which each of a set of two or more jobs keeps waiting indefinitely for the other jobs in the set to release resources. | Lei et al. (2014)                                                        |
| 5 | Tool management decisions                  | Tool management requirement comes from the high variety and number of cutting tools that are found in automated manufacturing systems. | Konak et al. (2008), Gray et al. (1993)                                   |
| 6 | Collisions in automatic guide vehicle      | Automated Guided Vehicle Systems (AGVSs) are advanced material-handling devices used to transport pieces among the workstations face some traffic problem like collision. | Shirazi et al. (2010)                                                   |
| 7 | Tool allocation Problem                    | Tool allocation problem deals with equipping the machines with proper tools in the tool magazine of limited capacity. | Buyurgan et al. (2004),                                                  |
| 8 | Machine loading problem                    | Machine loading problem deals with the allocation of jobs to various machines under technological constraints to meet certain performance measures. | Shanker and Tzen (1985), Kumar et al. (2006), Srinivas (2004)             |
| 9 | Complexity in Scheduling                  | Scheduling problem include determining the optimal input sequence of parts and an optimal sequence at each machine tool given the current part mix. | Krishnan et al. (2012), Sabuncuoglu and Hommertzheim (1992)              |
| 10| Excessive Tool Switching                   | Tool loading or switching usually consumes time and therefore may delay the planned production. | Konak et al. (2008)                                                     |
11. Design and planning problems  FMS design process is the key to achieving a good and cost-effective design.  Kouvelis et al. (1991), Gang et al. (2016)

12. Part type selection problem  This problem determines the part types to be produced in the FMS out of the total production requirement of the company.  Ozpeynirci et al. (2009)

13. Capacity allocation problem  The machines have limited time, and tool magazine capacities and the tools are available in limited quantities

14. Resource allocation problem  Resource allocation in a Flexible Manufacturing System is assignment of resources to tasks  Shen et al. (2015)

15. Machine Grouping Problem  Grouping of machines should be based on the following:  I. Compatibility of parts minimize  II. Cost of allocating the machines  III. Cost of Inter cell movement  Stecke (1986)

16. High Initial Capital Cost  Setting a flexible manufacturing system requires high investment cost.  Sundarani (2017)

17. Tool management decisions  Tool management decisions include grouping and movement of tools so that the proper tools are at the right machines at the desired times  Buyurgan et al. (2004)

IV. CONCLUSION

FMS enhances firm’s competitiveness and boosts its position in the competitive market. However, the organization may commit common mistakes in adoption of FMS system which lend company into trouble and substantial losses. The present framework for identification of barriers work will help the organization to make the correct decision in the adopting FMS system. Through extensive literature review and expert opinion, it has been observed that High initial capital cost have the maximum impact among various barriers for adoption of FMS. The cost of implementing flexible manufacturing systems is quite high, and it is one of the factors which needs to be considered when undertaking flexible manufacturing systems adoption project. Future scope includes prioritizing these barriers according to their impact on adaptation of flexible manufacturing system in the automobile industry.

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