International Journal of Engineering Sciences Paradigms and Researches (IJESPR)
Vol. 48, Special Issue, (TAME-2019, April 4-5, 2019)
(An Indexed, Referred and Impact Factor Journal approved by UGC- Journal No. 42581)
ISSN (Online): 2319-6564
www.ijesonline.com

HIERARCHY MODEL TO MEASURE PERFORMANCE OF ROUTING IN FMS

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Abstract

Flexible manufacturing is a system which allows manufacturing system to perform under highly adapted production needs. The problems such as uncertainty in inventories requirements and market-response time to match-up with the customer needs, response and satisfaction to adjust as per the trends in the market can be achieved by flexible manufacturing system. Routing is an important component and plays a major role in any manufacturing system. Selection of optimum Route can reduce the total cost and improve efficiency of the entire system. Designing of the route of machines can be analyzed same domain of industries based on automated system or conventional system. Selection of best route of machines for particular set of products or particular section of industry is a very important activity because it depends upon a lot of criterions and each criterion has different level of impact on routing. So, here the core attributes of routing system in conventional and FMS environment is identified through exhaustive literature survey. . Automated and conventional routing systems are compared. These attributes are further classified into different categories. A model is developed which can be utilized in different situations to compare the different alternatives of routing system.

Keywords: FMS, Routing, Attributes, layout

1. INTRODUCTION

1.1 1.1 Flexible Manufacturing System

In this period of globalization, manufacturers are adapting quickly to counter the crucial threats of swelling in market needs and corporate lifestyle. Hence, in current circumstances, Industries which are reacting rapidly to showcase variation with more intensity will have great abilities in creating items with high degree of satisfaction of the end user's needs. Now the attributes which are of importance to the producer are flexibility, quality, efficient delivery and consumer satisfaction as compared to the cost. Hence, to achieve these elements producing ventures are receiving most recent methods like automation, robotics and PPC (production planning and control), undertaking asset arranging ERP (Entrepreneur Resource development).Flexible manufacturing system is additionally one of the techniques which are frequently utilized by these firms to accomplish their objectives.

Flexible manufacturing is a strategy which permits production system to perform under highly customized manufacturing requirements. The issues, for example, minimum inventories and market-response time to strike into clients needs, reaction and fulfilment to alter according to the trends in market

1.2 Routing in the Production System

Routing may be defined as the selection of path for material movement as per the process plan and loading so as to achieve minimum material handling and waiting time. Routing is sequential order of all the operations done from the raw material to finished product. In routing, techniques like route card, worksheet, and route sheets were used manually.

Designing and operating different routing layout that can promptly and efficiently adjust to the requirements of ever-changing technology and customer demands is becoming increasingly vital to the success of manufacturing companies. With the realities of reduced product life cycle and lead times as well as increased variety of products and random customer demands, manufacturers are realizing that operating a single routing system or

route can no longer be profitable. This is because production efficiency entails that plant layout should quickly adapt from a route to another without equipment replacement, extensive retooling, and re-arrangement of resources. In production system there is always certain possibility of machine or system failure. The effects of machine or system failures, demand uncertainties, and concurrent routing are difficult to cast. So, lot of knowledge and attention is required at the time of framing the routes for the production system.

Main Route .....
Alternate Route ———————

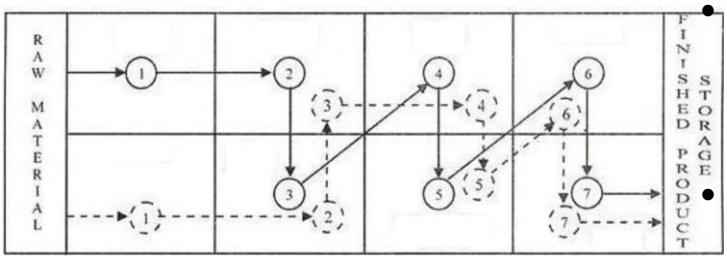

Fig1.1 Example of Routing in Production System

Routing is done in case of machine failure or in order to optimize the certain attributes in Production system. Figure 1.1 Shows an example of a certain class of product having which could have alternate route. Alternate machine could be used in situation of failure in machinery.

Routing of machines and materials can be done by two ways

- Conventional routing methods
- Automatic routing methods in FMS

1.2 1.3 Factors Determining Design of Routing

The inability to get manufacturing processes right leads to delays, inflexibility, inefficiency, excess inventory, high costs, etc. But modifying an ineffective layout is quite expensive; hence there is a need to design a functional plant layout
Right from the start. so, some factors to be considered while designing of route are given below:

- Room for future adjustments and expansion– at the onset, route should be designed so as to be easily changed or expanded in line with ever-changing needs of manufacturing. This will ensure that flexibility is attained in the facility in order to reduce the set up time required in the manufacturing of different products and also attain the required throughput.
- Maximum flexibility - good route should be easily modified in order to match up with the ever-changing demands
- Throughput – Routing should be done to assist the manufacturing to attain its production output at the shortest possible time, in order to ensure customer satisfaction.
- Efficient utilization of space – this entails the provision of sufficient space around the machines and the traffic lanes, as well as ensuring that adequate spaces are made available for storage points within the industry.
- Ease of Communication – routing should be done in such a way to communication and easy flow of information among the various labours and concerned staff.
- Safety – as the importance of safety in all human endeavours should not be overemphasized, a good route should be designed to function efficiently and ensure that accidents and its causes are reduced to the barest minimum.
- Maximum accessibility: the repairs and maintenance sections should be made readily accessible. This implies that equipment and machines must not be placed against the walls in order to ensure that maintenance and servicing operations are easily undertaken.

2. 2. LITERATURE REVIEW

Flexible manufacturing is a broad area in advanced manufacturing system so researchers have keen interest in this field. Routing is very important activity in flexible manufacturing system and a lot of work has been already done on this.

2.1 2.1 Literature Review Regarding FMS

R. Venkata Rao (2008) In this paper the author demonstrates a logical method to assess alternate flexible manufacturing system for a given firm. The strategy depends on a combined multiple attribute decision making method using TOPSIS and AHP methods together. A flexible

manufacturing system appropriateness index is suggested that assesses and positions flexible manufacturing system for a given firm.

Pandey R.et al. (2016) evaluated the execution of Flexible manufacturing system in the industries. Flexible manufacturing system (FMS) utilizes numerically controlled machine tools, robots, machine driven material dealing with frameworks and programmed examination and self-diagnosis into one manufacturing system. One among the major problems with these production system that have an impact on the effectiveness of the production system is that the planning of parts types .In this paper, author have tried to conquer the effects of uncertainties like machine breakdowns, deadlocks.

Kaushal .et al (2016) featured the benefits, faults, use of FMS and furthermore diagram of different parts of FMS. The fundamental of FMS is to improve inspiration all through the assembling procedure for accomplishing higher efficiency and best nature of item. Adaptable assembling framework comprise of an incorporated arrangement of modernized numerically controlled (CNC) machine instrument, mechanized material dealing with framework working under the controlled PC, workstation, stockpiling and so on

Bakhtiar Ostadi (2018) In this paper the author has discussed general preventive maintenance model for the components of a system, which improves the reliability of the components as it is when it's freshly manufactured. Such model was used to optimize the maintenance cost. In this paper, maintenance characteristics of a typical flexible manufacturing system (FMS) have been determined. These characteristics can be used to understand and protect the unexpected chances of failures.

2.2 2.2 Literature Review Regarding Routing Layout

Mahmoud A. Younis (1992) The problem of dynamic part routing in an automated manufacturing system is described. The system has workstations which is having potential of performing a number of different operations on a batch of parts. In view of the unreliability of machines the production control system should be able to manage the production and Schedule, given the random pattern for repair of machine failure. A three-level hierarchical control structure is suggested and simulated, using stochastic generation of events and part movements. The attained outcomes indicate that a manufacturing profile derived under the developed controller is feasible.

Parames Chutima (1998) As per the paper "routing flexibility provides the ability of FMS to efficiently encounter traffic problems caused by machine breakdown, excessive workload, etc". The advantages of imposing routing flexibility can be fully obtained by a competent part routing rule. In this study, Fuzzy Analytical Hierarchy Process (Fuzzy AHP) is applied to form part routing rules from the attributes of alternate machines: workload on machine buffer, processing time, and the probability that the part being routed to the alternate machine can be processed before the machine fails.

Amine Drira et.al (2007) Routing problems are found in several types of manufacturing systems. Typically, routing problems are related to the location of facilities (e.g., machines, departments) in a plant. Routing is known to have a significant impact upon manufacturing costs, work in process, lead times and productivity. A good placement of machines contributes to the overall efficiency of operations. Different factors which are needed to be considered for effective routing are min handling cost, pick-up & drop off locations, minimum backtracking & bypassing etc

2.3 3. OBJECTIVES OF PRESENT RESEARCH

- Study of comparison between conventional routing layout and automatic routing layout in FMS.
- Identification of Attributes for comparison of conventional routing layout and automatic routing layout in FMS.
- Formulation of Hierarchy Model based on the Identified Attributes for comparison of conventional routing layout and automatic routing layout.
- To find the implications of this research.

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4. IDENTIFICATION AND DISCUSSION OF ATTRIBUTES

A number of key factors or attributes have been used for structuring and evaluating of Routing of machines and facilities in the production system. These attributes have noticeable impacts on the outputs of the manufacturing system. So, after an ample amount of literature review following

attributes are recognized. These attributes are further divided into sub-attributes.

4.1 Identification of Attributes of Routing Layout\

Amongst all the attributes collected from the literature few are selected. Some identified attributes and their corresponding sub-attributes are shown in the table 4.1 given below.

Table 4.1: List of attributes and sub-attributes

S. No	Attributes	References
1)	Flexibility ● Routing flexibility ● Expansion flexibility	R.Venkata Rao(2008) Browne et al(1984) son and park(1987)
2)	Productivity ● Material handling productivity ● Labour productivity	Mahmoud A.Younis(1992)
3)	Inventory ● Buffer ● Alternate machine ● work-in-process inventory	Parames et al(1998)
4)	Flow Rate of Parts to Workstation ● Minimum handling ● Pick-up & drop off locations ● Min Backtracking & Bypassing	Mahmoud A.Younis (1992) Amine Drira(2007)
5)	Cost ● Initial ● Operating ● other	Giovanni Azzone (2007)

2.4

2.5 4.2 Discussion Regarding Identified Attributes

Flexibility is the ability to transport different components between various processing stations over multiple paths economically and effectively (R.Venkata Rao,2008).The Nature of flexibility which provides facility to process a given set of part types with several routes is known as routing flexibility. But economy and efficiency of the system must be considered along with the routing flexibility. The potential of system to grow and expand easily whenever it is needed is known as expansion flexibility.

Productivity can be defined as reduction in wastage of resources like men, material machine, and time, capital with less and less input resources. Productivity can be stated as the relation between output and one or all inputs. Productivity can further be divided into two categories: Material handling productivity and labour productivity. Material handling productivity denotes the ease with which material handling can be done. Utilisation of labours effectively in the routing system and material handling gives the measure of labour productivity.

Buffer inventory, also called buffer stock or safety stock, is a factor of safety for supply in excess of forecast demand. Buffer inventory is utilized to reduce the incidence or severity of stock-out situations in sales and thus provide better customer service. Work in process (WIP), work in progress (WIP), goods in process, or in-process inventory are a company's moderately finished goods waiting for completion and eventual sale or the value of these items. These buffer stock are either assembled or kept aside for further processing in a queue or a buffer storage.

The flow rate of material and work piece in the production system should balance production rates of the work piece. Minimum material must be capable of transporting & handling large volume of products with good speed. It is important to find the location from which parts enter and leave facilities, called Pick-up and Drop-off (P/D) points. Although they can potentially be located at various places but several researchers restricted their possible position to reduce the complexity. An example is given in Fig.4.1. Pick-up & drop off locations should be restricted so as to minimize complexity & enhance better material flow.

Fig 4.1. Example of P/D points of a machine with a usual shape

Backtracking and bypassing (see Fig.4.2) are two particular movements that can occur in routing system, which impact the flow of the products and impact productivity and other attributes of the production system. Backtracking is the movement of a part, from one work station or machine to another preceding station

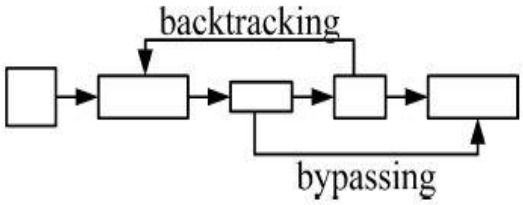

Fig 4.2 Backtracking and Bypassing

Cost is the combination of variable and the fixed cost. Variable costs are generally the operating costs of associated with shifting of the machines & changing of schedules for production. Variable cost includes the cost of power, lubricants and maintenance. Other costs are associated with salary and other expenses provided to the human labour and cost associated with sudden failures and breakages.

3. 5. HIERARCHY MODEL DEVELOPMENT

In using AHP technique to decision problem, first step is to prepare an AHP model. Goal of our model is to compare conventional and automatic routing layout in FMS layout. Author has placed this goal at top of the model structure. The hierarchy structure expanded from more general criteria in the second level to sub-criteria in the third level and it has the alternates at the bottom or the fourth level. The general criteria level includes major five attributes: Flexibility, Productivity, Inventory, Flow rate of Parts to workstation and cost.

Author has identified sub-attributes for these attributes: routing flexibility, labour flexibility, Material handling, productivity, Labour productivity, Buffer, Alternate machines, Work-in-process inventory (WIP), Minimum handling, Pick-up & drop off locations, Min Backtracking & Bypassing, Initial cost, operating cost and other costs. Routing flexibility, labour flexibility are sub-attributes of flexibility. Material handling productivity, Labour productivity are sub-attributes of productivity. Buffers, Alternate machines, Work-in-process inventory (WIP) are sub-attributes of inventory. Minimum handling, Pick-up & drop off locations, Min Backtracking & Bypassing are sub-attributes of Flow rate of Parts to workstation. Initial cost, operating cost and other costs are sub-attributes of cost. Finally the decision makers have selected two alternates (Conventional routing layout and automatic routing layout in FMS), which finds a place in the bottom of the model. Figure 5.1 shows the model representation of selecting best alternate in routing in production system.

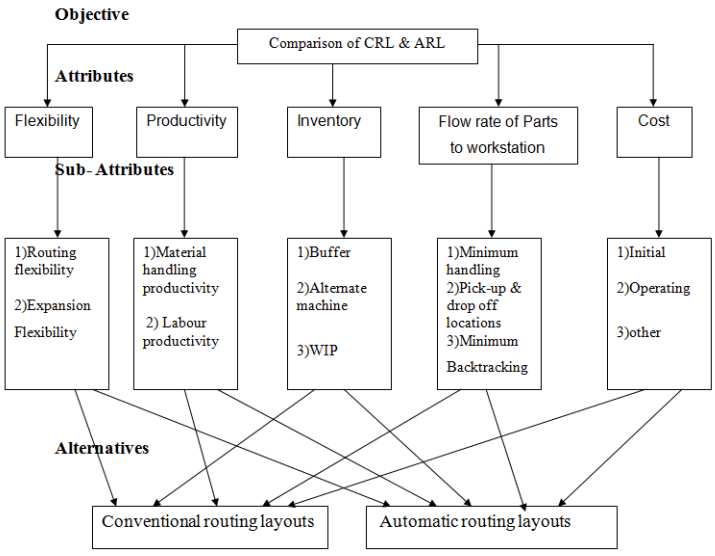

Fig.5.1 Showing Model of AHP

4. 6. CONCLUSION

This work discusses about the flexible manufacturing system and its components. Routing of machines in case of failures and in order to optimize different attributes like flexibility, productivity is also explained. Identification of core attributes for design and select of routing is done through exhaustive literature review and . Further in the major project/dissertation AHP will be applied for that purpose Steps for implementing of AHP are also explained in this work.

5.

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