Evaluation of Material Handling System by Using Multi-Attributes Decision Approach –A Case Study

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Abstract - Manufacturing Industries need to be furnished with new & updated effective tools for rapidly changing and highly competitive nature of today's global world. So, Industrial Automation lead to Flexible Manufacturing Systems (FMS) that allows manufacturing systems to excel under highly customized production requirements. The right selection of material handling system on the basis of performance measuring parameters is Multi-Attribute Decision Making Approach (MADM). MADM is a method used to solve problems involving selection from a finite number of alternatives. The Highway industries limited Company is facing enormous problem of material rejection & the multiple reason for such rejection are ,outdated machinery, less skilled worker but among these the most crucial factor is lack of flexible material handling system ,which resulted in loss of profit, quality, production rate etc. The main idea behind research study is to propose a suitable material handling system for crank shaft machining line of Highway industries limited manufacturing organization by using graph theory and matrix approach (GTMA) and analytical hierarchy process (AHP) methodology. In these five different flexible manufacturing systems have been considered so as to reduce waiting time of machine, work in process (WIP), labour cost and increase in machine utilization. The unique values of numerical index value are calculated to decide the ranking among the various flexible manufacturing systems. The cost analysis of different proposed flexible manufacturing system was evaluated & compared with existing system in the organization. For this it was proposed that the existing system may be replaced by flexible manufacturing system (FMS II) so as to decrease the labour cost and maintenance cost and to enhance quality & productivity.

Keywords – FMS, Graph Theory and Matrix Approach (GTMA) and Analytical Hierarchy Process (AHP), Different Material Handling System.

I. Introduction

With the changing demand and customer needs in global market, manufacturing industries are facing many critical issues such as how to develop a product in less time and at lower cost. Companies are finding that conventional practices of manufacturing can no longer face the rapidly changing customer's demands. Companies are trying to adopt modern manufacturing techniques in order to avoid the costly and time-consuming activities associated with conventional design and manufacturing approaches (Hamid, 2007).Flexible manufacturing system (FMS) is defined as automated manufacturing system consisting of multi-functional machines interconnected by a material handling system (Jain et al., 2006). It is an important tool for increasing productivity and reducing the total production time (Tashnizi et al., 2008).

Material handling can be defined as an integrated system involving activities such as moving, handling, storing and controlling of materials by means of gravity, manually or with machinery. Material handling is an important area of concern in flexible manufacturing systems because more than 80% of time that material spends on a shop floor is spent either in waiting or in transportation, although both these activities are non-value added activities. Efficient material handling is needed for less congestion, timely delivery and reduced idle time of machines due to non-availability or accumulation of materials at workstations. Safe handling of materials is important in a plant as it reduces wastage; breakage, loss and rejection etc. The idea behind this case study shows that there is very less or little evidence on selection of material handling system by implementation of graph theory and analytical hierarchy process (AHP) available in literature. The focus of the study is on large and medium scale manufacturing enterprise of Northern India, because these are the organizations facing the problem of material rejection due to manual material handling system which resulted in lower productivity, quality & profitability. So, the present research work is a step to design flexible manufacturing system for the existing layout in the present organization.

II. LITERATURE REVIEW

In today's world, manufacturing system has undergone a complete change in the few decades. The manufacturing units are continuously trying to update & automate themselves by acquiring or developing new technologies. At present, the survival of Indian industries depends upon effective utilization & adaptation of new technologies. To demonstrated the systematic and logical method to solve complex and difficult problem that have wide range of alternatives. The hybrid decision making method of graph theory and matrix approach (GTMA) and analytical hierarchy process (AHP) shows the systematically way to assign the values of relative importance to the attributes. The electroplating system selection, robot selection and welding process selection are solved by using "analytical hierarchy graph theory and matrix approach (AHGTMA) method Singh and Rao (2011).

III. RESEARCH METHODOLOGY

The manufacturing units across Indian Manufacturing Industries are continuously trying to update themselves by acquiring or developing new technologies. Mainly the new technologies are not utilized up to the extent. The reasons may be; technologies acquired only for the image of the company, choosing wrong area for technology up-gradation and overlooking socio-psychological barriers. To demonstrate the proposed methodology for the selection of material handling systems (MHS), a case study approach has been conducted in a Highway industry limited. Five different material handling systems are considered. These systems are selected on the basis of their suitability for particular job, availability cost & layout. The performance of these selected systems depends upon certain parameters. These parameters are called attributes. These attributes are identified for measuring the suitability of the system for a particular time & situation. For measuring the performance of a particular MHS, various attributes such as labor cost, work in process inventory, effect on quality of product, installation and maintenance cost, floor area occupied, flexibility of the system and machine utilization are selected. The methodology employed in the study has been depicted in Figure 1:

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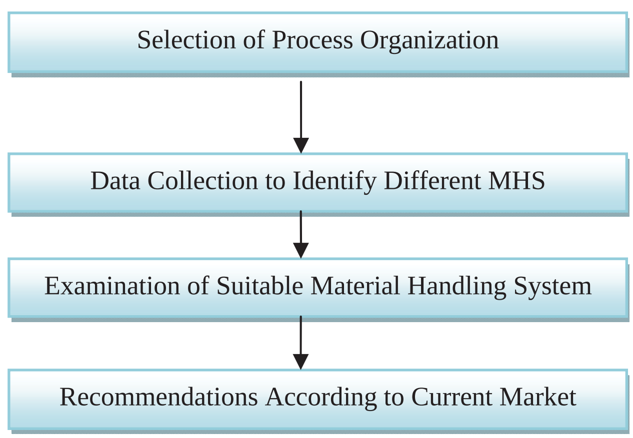

Figure 1: Methodology used for the study

IV. FLEXIBLE MANUFACTURING SYSTEM I (EXISTING SYSTEM)

This is the existing material handling system, used in crank shaft machining line. Presently, material from one machine to another machine is moved manually. At least two tables per machine are used for placing in process material. There are six machines in crank shaft machining line. Four workers are required for moving the material. Sometime dent on the surface and mixing of in process material occurred due to improper handling. The layout of line shows the location of different machines. As the material moves from one machine, it has to be inspected by line inspector. Line inspector after ensuring the quality, allowed the material to move to next operation by placing a green tag in the material. Figure 2: show the layout of the existing system.

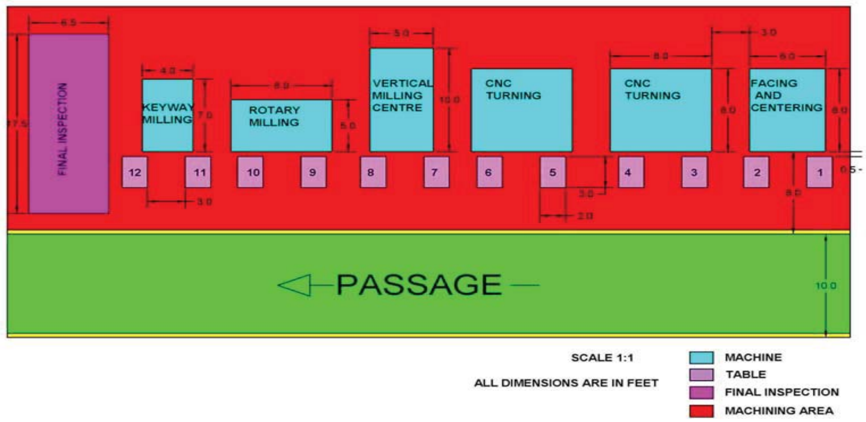

Figure 2: Layout of Existing System FMS I

V. Flexible Manufacturing System II (Modified Conveyor System)

In this system conveyor or shoots are used for moving the material from one machine to another. A Conveyor is used when a material is moved very frequently between specific points and the path between points is fixed. Conveyors combined with modern identification and recognition systems like bar code technologies have played a significant role in the transportation and sorting of a large variety of products in modern warehouses. Figure 3: show the layout of this system.

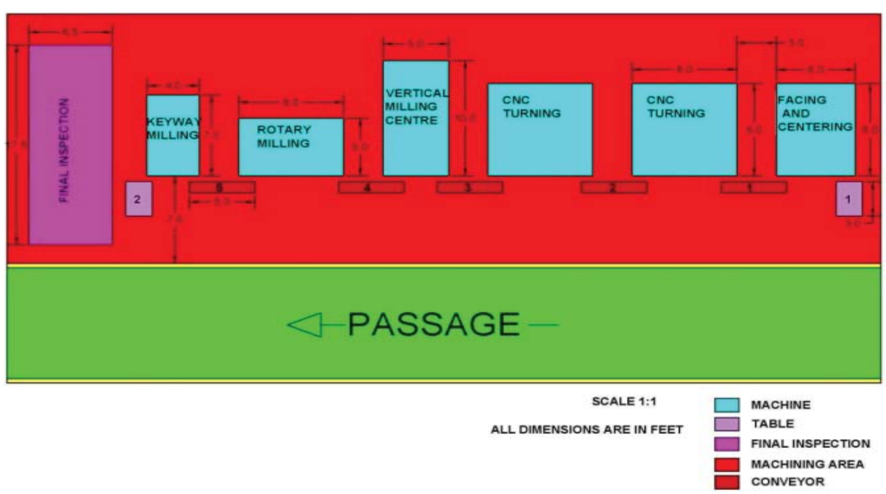

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Figure 3: Modified Layout of Conveyor System FMS II

VI. DISCUSSION OF RESULTS

In response to the fast alternations in worldwide industrial markets, many manufacturing enterprises have begun to adopt new, innovative ways to manufacture. Compared with the past, customers demand are changing day by day for low-cost, reliable and high- quality products with increasingly shorter and more reliable delivery times (Alvi and Labib, 2001). Since assembly constitutes an important part of most product manufacturing, any improvements to the assembly process are welcomed by the manufacturing enterprises. In order to deal with the continuous production of varying mixtures of products and the quick changes of production requirements in response to the changing demands in the market, the assembly system must have a high degree of flexibility (Arora and Kumar, 2000). In the present research, the important process variables are taken into consideration for the purpose of evaluating numerical index value of material handling system. All these attributes are non- beneficial attributes. Objective values of all such attributes are measured during the experimentation. Table shows the values of all the attributes.

The permanent of this matrix is a FMSSI (Flexible manufacturing system selection index) value. The permanent function contains only positive terms, therefore higher values of A and *aij* will result in an increased value of the FMS index value. The various material handling systems can be arranged in descending or ascending order of FMS index value to rank them for the given machining line. These are called the ranking values of the system for the considered machining line. The system for which the value of FMS index value is highest is the best choice for the crank shaft machining line considered. Table1: shows the FMSSI value in descending order. .From the above discussion, it can be concluded that FMS II is the suitable system for crank shaft line. If FMS II is replaced with existing system, then, it gives profit after 5^{th} month of installation and three workers per shift are saved. Table:1 shows the installing cost of different systems and their payback period is calculated by comparing considered systems with existing system.

Table 1: FMSSI (Flexible Manufacturing System Selection Index) value.

S No.	FMS Index value	Type
1	10.3917	FMS II
2	8.0696	FMS IV
3	7.3470	FMS I
4	6.36749	FMS V
5	4.7202	FMS III

VII. CONCLUSION

The following inferences have been drawn-

- FMS index value indicated that flexible manufacturing FMS II has been ranked first, followed by FMS IV and FMS I has been ranked third.
- FMS Implementation remarkably shows tremendous results.
- On the basis of payback period, FMS II is ranked 1^{st} followed by FMS IV, FMS I, FMS V and FMS III.

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