Selection of Material Handling Equipment: Classifications & Attributes

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Abstract

Material handling system can be defined as movement, handling, storage and controlling of materials throughout the manufacturing process. The main purpose of using a material handling system is to ensure that the material in the right amount is carefully delivered to the desired destination at the right time at minimum cost. The material handling system ensures the timely delivery of desired quantity of material at desired location with minimum cost and maximum safety. Material handling is not a manufacturing process but involve substantial amount of product cost and labor. Due to daily invention of new technologies material-handling equipment are undergoing continuous automation. Wide ranges of material handling equipment are available in the market and it is difficult to select best one for industries requirement. A material handling system should be chosen in such away so that to reduce manufacturing cost and avoid interruption and damage. On the other side right selection and planning of MH improves productivity, efficiency and profit of a company. This paper focuses on the key points of the material handling equipments. In this paper an attempt is made to set some guidelines for selecting the best material handling system for a particular task out of available ones.

Keywords: Automation, Just In Time Material Supply, Material Handling Equipment, Manufacturing, Productivity etc.

I. INTRODUCTION

Material handling system evolves movement of material, machine from one place to another. It is technique used to deliver the right goods safely, to the right place and time and at the right cost. Combining the handling process means carryout other value adding processes such as Inspection, painting, cleaning while material is moving. A good material handling system seems to achieve the profitable product because about 80% of total cost of product is evolved in movement of material and only 20% of cost is involved in carrying out actual processing of product. Various material handling Equipments should be well installed and mentioned for smooth and continuous flow of material. Activity of material handling equipment before implementation first carry its criteria, specific industry match the particular product.

We functions performed by MH equipment can be classified into four broad categories, that is, (a) transport, (b) positioning, (c) unit formation, and (d) storage. Usually, all the MH functions are composed of one or more combinations of these four primary functions. Equipment in transport category simply moves materials from one point to another, which includes conveyors, industrial trucks, cranes, and so forth. Unlike transport equipment, positioning equipment is usually employed at workstations to aid machining operations. Robots, index tables, rotary tables, and so forth are the examples of this type of equipment. Unit formation equipment is used for holding or carrying materials in standardized unit load forms for transport and storage and generally includes bins, pallets, skids, and containers. Storage equipment is used for holding or buffering materials over a period of time. Typical examples that perform this function are AS/RS, pallet racks, and shelves.

In the Asian countries like India, most of the industrial outcomes depend on automation. Automation is the major need of any material handling system. In any industry, automation in material handling system becomes essential as it influences production rate.

II. METHODOLOGY

A review of literature is usually time consuming, especially in the multidisciplinary field related topics, as relevant journal articles are scattered across various disciplines. To minimize the time and labour 'Google Scholar' was been chosen to be the prime source of searching literature as it is linked with almost all major online journal databases, including Science Direct, Inderscience, ACM digital library, IEEE Xplore, Springer link online libraries, Wiley InterScience, Scopus etc. A number of key words such as automation, material handling equipments and Just in Time material supply were used to search the potential literature.

A. Identification of Resources & Search Strategy

For this review, we selected scientific papers on automatic control of material handling systems. In order to conduct an extensive and comprehensive search of the literature, we selected above mentioned keywords which are closely related to the objectives of our research.

The modernization of automatic handling system is considered after 1990 therefore, the literature search was limited to studies published after 1990. All retrieved papers were stored and duplicates were removed. Papers with the same titles or the same authors and same paper published in journals or conference proceedings were also removed. At the end of this process, only few papers were selected for the review study.

B. Selection of Relevant Papers

In the first stage of screening, papers written in English were scanned for keywords in the titles, abstracts and resulting 77 papers were selected for further review. In the second stage, two investigators related to the field of automation have independently reviewed the full-text published papers for their relevance to the objective of this review. 22 papers were sorted and selected which have discussed the main importance and challenges in the adoption of automation in material handling system.

III. RESULT & DISCUSSION

Initially the accepted articles were examined and sorted based on the area of the research and the factors studied in these papers were selected based on their outcomes.

A. Pravin Kumar Sharma (2015)[1]

The focus of this research is in the area of Selection of Material Handling Equipment in Pump industry to reduce manufacturing cycle time, and cost of manufacturing. Various Material Handling Equipments are used in different shops of Pump industry. For selecting appropriate Material Handling Equipment, it is felt that some Multi Criteria Decision Making Methods must be used due to their ability of converting a complex problem to a paired comparison. These methods are based on some relative Criteria and Sub-criteria. Certain methods such as; Analytic Hierarchy Process (AHP), Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) have studied for solving the problem of Material Handling Equipment selection in different Pump industry. For solving these problems, some criteria (Material, Move, and Method) are selected. The main conclusions drawn from this study are that, Method criteria is more important for selecting Material Handling Equipment, and Conveyor System is more efficient and accurate Equipment for Handling the Material in shop floor of any Pump industry. Today various Pump industries are present in India for manufacturing variety of Pump. In Pump Industry proper and accurate handling of material is very necessary for reducing cost of manufacturing, and manufacturing cycle time. It is also important for increasing the capacity of production, and for improving the working conditions. From the study of this paper author has concludes that, Various Material Handling Equipments such as: Conveyors, Industrial Trucks, Cranes and Hoists are used in Pump Industries. For selecting the best equipment, certain Multi Criteria Decision Making Methods (based on different criteria and sub-criteria) are employed. These methods based on pair wise comparison matrices and after calculating the weights of all selected alternatives, it can be concluded that, the Method criteria is more important for selecting Material Handling Equipment, and Conveyor System is more efficient and accurate Material Handling Equipment for any Pump Industry.

B. Nandkumar Patil (2017)[2]

Material-handling system can be define as movement, handling, storage and controlling of materials throughout the manufacturing process. The main purpose of using a material handling system is to ensure that the material in the right amount is carefully delivered to the desired destination at the right time at minimum cost. Helical compression springs are generally used to absorb the energy due to the impacts and to form a flexible link which deflects under loading and restore the objects to the normal position where the disturbing forces are removed. The author concludes that, by using this material handling system we can transfer material from one place to another place without external power. This material handling equipment can save time, money and labor cost. The cost of this material handling equipment is comparatively less. So it is suitable for small as well larger scale industries.

C. Yangiong Zhang (2013)[3]

The handling equipment optimization problem of material handling system for large ships is discussed in this paper. The optimization models for two supply ways which includes shore-to-ship and vessel-to-vessel are proposed respectively, which are converted to linear programming problems in order to analyze large ship material supply handling system of equipment optimization. Large ship material handling system design as the research background, this paper analyzes large ship material handling system design problems, especially optimization problem and establish equipment selection optimization mathematical model in view of the two supply ways (shoreto- ship supply and ship-to-ship supply). The model is a multi-objective and multi-constraint optimization problem. The future is worth research direction includes: (1)Try various ways to solve the model, such as using Lingo tools to solve typical linear programming problem. With the actual numerical example to verify the practicality of the model, the model can be used in the practice of large ship supply equipment selection optimization problem. (2) Combined with the actual case and comprehensive consideration of various factors, further improvement and optimization of the model and the

in-depth application research can be conduct , in order to adapt to a variety of large ship supply system; (3) To explore all kinds of algorithms which are more efficient and more accurate, instead of using tools computation, intelligent algorithm (such as genetic algorithm, annealing algorithm, particle swarm optimization (pso) algorithm, etc.) can get more optimal solution in a broader solution space to.

D. Johan Karltun (2013)[4]

In today's fierce competitive global markets, customers are demanding adjustable lot sizes, shorter lead times, higher quality and flexibility; in short, they want it all. In order to stay competitive in the market, companies need to attain both customer satisfaction and cost reduction in production operations. Material Handling Systems (MHS) is the place to accomplish this goal, since they have a direct impact on production. Therefore, the aim of this study was to design an in-house MHS that could be efficient for the production it serves. With this intention, a case-study has been conducted in Bosch Rexroth Japan. During the study, the information gathered through various sources; interviews, observations and measurements. Further, the gathered data is evaluated according to main pillars of the theoretical framework, which includes design principles and physical elements, information and software, human and management. By analyzing the findings from literature review and empirical study, first problems and challenges related to MHSs are identified. Thereafter, possible features that the system should possess are elicited and a design is built out of the selected features. To conclude, the results show that the success is not solely depending on system's physical attributes; on the contrary, it is more related to rapid and accurate information sharing within the system. Another vital element is the interaction between system and the people, who are utilizing and operating the system. In general terms, the research took MHS design problems from one-dimensional equipment selection processes and enriches them by adding information sharing, human and management angles to design steps. In the results the author concludes that, this research established the fact that a MHS consists of three main pillars; design principles and physical elements, information and software, human and management, which are equally important in order to achieve a well-functioning MHS on a manufacturing shop floor. Moreover, based on the comprehensive literature review and case company investigation the existing issues with the traditional MHS (manual transportation & forklift transportation) were identified and categorized as; delivery performance, buffer levels, operation costs, delivery quality, information flow, and safety. To cope with the mentioned problems above various methods and techniques such as JIT concept, standardized work methods, hybrid pull/push system, AGV system, and etc. were suggested. However, the core element in an effective and efficient MHS was pointed out as real-time information sharing. The latter fact enables companies to rapidly react to different requests and changes on the shop floor area; and thereby, to obtain increased delivery performance and decreased buffer levels. It was also clearly argued that by integrating information technology with production processes many undesirable material-handling activities could be easily avoided, in addition, the companies would be able to attain increased space efficiency on the production/assembly area and decreased work in process (WIP). Another vital element in developing a new MHS was pointed out as interaction between the new system and its surroundings, particularly, the interaction between the system and people, who are utilizing and operating the system. Therefore, employee involvement and employee training was mentioned as a key component for achieving an effective and efficient MHS. Organizations already have been realized that without employee involvement the success of any system implementation is almost near to zero. However, these needs and contributions should be addressed and defined in earlier stages in order to attain the best outcome of the developed system. On the other hand, companies should not forget the importance of management involvement and support in all stages from design to implementation of a MHS, both in functional and physical levels.

E. Abhilasha Dongre (2015)[5]

In this paper an attempt is made to review the considerations for material flow design problems (i.e. material handling equipment selection, flow path design, facility layout design, routing, etc.) for related product design in the Industry. A concise study on developing material handling technology has been explained in the literature. From it is observed that the material handling is important activity in manufacturing industry. The selection of the most appropriate MH equipment for any particular application can be influence the profit of any manufacturing company. The literature review has shown that researchers have consider the design problems in material flow system and overcome with adequate knowledge base approach, properly design, 3d modeling ,analyzing and using simulation model to validate the system performance for acquiring the MH equipment selection. Thus it concludes that MH system plays a major role in productivity. Distribution, manufacturing, and warehousing and helps to give the best optimization to increase the productivity, reduced cost and idle time, proper utilization of labour, product quality and safety.

F. Michael G. Kay (2012)[6]

Material handling (MH) involves "short-distance movement that usually takes place within the confines of a building such as a plant or a warehouse and between a building and a transportation agency." It can be used to create "time and place utility" through the handling, storage, and control of material, as distinct from manufacturing (i.e., fabrication and assembly operations), which creates "form utility" by changing the shape, form, and makeup of material. It is often said that MH only adds to the cost of a product, it does not add to the value of a product. Although MH does not provide a product with form utility, the time and place utility provided by MH can add real value to a product, i.e., the value of a product can increase after MH has taken place; for example: The value (to the customer) added by the overnight delivery of a package (e.g., Federal Express) is greater than or equal to the additional cost of the service as compared to regular mail service—otherwise regular mail would have been used. The value

added by having parts stored next to a bottleneck machine is the savings associated with the increase in machine utilization minus the cost of storing the parts at the machine.

G. *Guilherme Bergmann Borges Vieira (2011)[7]*

The highly competitive environment, linked to the globalization phenomena, demands from companies more agility, better performance and the constant search for cost reduction. The present study focused on improvements in internal materials handling management, approaching the case of a large company in the automotive industry. Materials handling is intrinsically associated with production flow. Because of this, it has direct influence on transit time, resources usage, and service levels. The objective was to evaluate, in a systematic way, the impact of implemented changes in materials handling management on the internal customers' perceptions of cost, safety in service, service reliability, agility and overall satisfaction. A literature review preceded a case study in the company's manufacturing unit and the questionnaires were completed by 26 employees directly involved in the process. Analyzing the answers, it was possible to suggest that internal customers understood that the new materials handling management system enlarged service agility and reliability and reduced costs, which caused an improvement in overall satisfaction. This study concludes that, due to constant complaints because of failures in service and also low speed in material transport, the company was motivated to innovate and/or improve internal processes that could increase the efficiency of services to manufacturing. The basis of the implanted system was the concept of stock on wheels, practicing materials transport with the aid of a tug internally named "train". The tug pulls the wagons with more load than forklifts (previous system), maximizing travels and loads through a specific route. With the new system implementation the need to assess its real impact in relation to the expected improvements emerged. From internal customers' evaluation there was an increase in overall satisfaction. This increase can be explained by a greater agility (57%), greater reliability in service (33%) and lower cost (10%). The results identified the significant sub-factors and their impacts on the described factors. Besides internal customer satisfaction improvement, which was evidenced by the present study, there was an effective improvement in the internal material handling. The improvement in material flow caused by the use of the proposed vehicle increased the accuracy of materials delivery time inside the company. Operations became safer. The system used was able to evaluate the perceptions of the implemented changes, as well as to identify factors and sub-factors that influenced satisfaction increase. These improvements in the company operations resulted in new subsidies to perform similar studies.

H. *Ramazan Yaman (1999)[8]*

For material handling system design, material handling equipment selection is the first stage. Also the material handling system and facility layout design problems are coupled. Solving these problems needs consideration of these three different problems. Right material handling equipment selection and good design of the material handling system and facility layout can increase productivity and reduce investments and operations' costs. In this study, after describing the material handling equipment selection and pre-design of material handling systems problems and explaining their complexity and solution approaches, it is shown that material handling equipment selection and pre-design of a material handling system can be combined by using a knowledge-based approach. This study describes a decision aid which may be used by a designer who is not very familiar with selection of material handling systems. The case study examples the selection of MHS equipment using the approach and a recommended rationalization procedure. Using the rationalization procedure it is possible to reduce the number of equipment types needed from 35 to 25. The time-consuming task of MHS equipment selection can be handled using a knowledge-based approach, with interaction by a designer. A knowledge based approach can overcome the limitations of analytical approaches which are generally limited with only quant table factors. Rationalizations of MHS equipment will reduce total investment and operation costs.

I. *Vikas Gupta (2013)[9]*

The material handling system ensures the timely delivery of desired quantity of material at desired location with minimum cost and maximum safety. Material handling is not a manufacturing process but involve substantial amount of product cost and labor. Due to daily invention of new technologies material-handling equipment are undergoing continuous automation. Wide ranges of material handling equipment are available in the market and it is difficult to select best one for industries requirement. A material handling system should be chosen in such away so that to reduce manufacturing cost and avoid interruption and damage. On the other side right selection and planning of MH improves productivity, efficiency and profit of a company. This paper focuses on the classification of material handling systems. The challenges in selecting material handling systems are discussed. In this paper an attempt is made to set some guidelines for selecting the best material handling system for a particular task out of available ones. From the above study it has been analyzed that observed that the material handling is an important task in the industry and involves a lot of total product cost. The selection of the most appropriate MH equipment for any particular application is very important and affects productivity and efficiency of an industry. Types of material handling systems are outlined and discussed. Transportation, position and storage material handling equipment are discussed briefly with the few examples. Further some guidelines are provided to select the best material handling equipment for a particular task. Thus the paper concludes that selection of material handling equipment plays an important role increasing productivity and efficiency of the industry and ensures safety of labor and quality of product

J. Rafiullah Khan (2015)[10]

The purpose of this work is to develop a new methodology for automating the determination of a material handling system by combining knowledge based and optimization approaches. The proposed system extends previous concepts of minimization of operating cost by including the cost for reliability, performance and flexibility into total cost. Mathematical model of the cost for Availability, Reliability, Maintainability and capability of different MHE (Material Handling Equipment) is developed. These cost values are then added into total cost (investment, Operating) of the individual MHE accordingly. This overall cost is then minimized by HASSAN'S construction algorithm for selection of Material Handling Equipment. The initial short listings of equipments were performed by the knowledge based system for the available MHE. Suitable code was used to develop the system.

K. Semih onut (2009)[11]

Selection of the suitable material handling equipment (MHE) is a very difficult task for the manufacturing companies because of the considerable capital investment required. There are many tangible and intangible factors for choosing the suitable MHE. Multiple criteria decision making (MCDM) has been found to be a useful approach to analyze these conflicting factors. The evaluation of MHE alternatives within the frame of various subjective criteria and the weights of the criteria are usually expressed in linguistic terms. This makes fuzzy logic a more natural approach to this kind of problems. This paper proposes a combined MCDM methodology for evaluation and selection of MHE types for a company in the steel construction industry in Istanbul, Turkey. Fuzzy analytic network process (FANP) is utilized for assigning weights of the criteria for MHE selection and fuzzy technique for order preference by similarity to ideal solution (TOPSIS) is used to determine the most proper system alternative using the criteria weights attained by FANP. The selection is based on the compatibility between MHE and production characteristics. Objective is to select the most efficient MHE considering also the cost efficiency. The study was followed by the sensitivity analyses of the results.

L. Uday D Bharitkar (2015)[12]

The problem of selecting and specifying material handling systems for manufacturing operations is challenging because of the variety of technologies available for material handling tasks and the significant fixed price of systems. Most of the previous research in this area usually does not address the possibility of selecting from among different types of technology, such as forklift truck and AGVS, neither do they bend back to the possibility of selecting and/or partitioning material handling tasks and assigning them to technology applications. This paper represents a four-step approach to the problem, consisting of task infusion, filtering tasks and sharing them with resources, task collection, and selection of the system. The goal of this research is to develop an approach to material handling system selection and specification that satisfies the following three characteristics: (a) it is a bottom-up approach that uses manufacturing data such as facility layout and parts routing, (b) it is rapid enough so that a system designer can evaluate different options with respect to grouping material handling tasks and technologies, and (c) it can because for both design of new plant sand evaluation of existing plants in the face of changing production requirements. The problem is important because material handling costs account for a major part of manufacturing costs, and material handling systems impact production scheduling flexibility. The research identifies where and how the information for the material handling requirements is to be gathered. Ultimately, the data collection would be part of the manufacturing process specification. Certainly, the elements related to item characteristics and access to the manufacturing process interface should be available to the process designer. Currently, however, a designer has to develop some data, such as locations for pick-up/deposit points. In recent work, the researchers have demonstrated the use of plug-ins for commercial CAD software to extract the pick-up/deposit and the use of automated routines to extract other information. A CAD representation of a plant layout, additional information such as storage location heights (not normally represented on a layout), and parts information such as size and weight have been used to automatically extract the material handling task characteristics and match them with MH resources. Rapid analysis tools have been developed to aid in specifying systems. Current work is focused on aggregation and system selection.

IV. STUDY LIMITATIONS

This review, like any literature review, is highly dependent on the keywords that were chosen and the databases selected. To minimize this, we conducted a background and exploratory study prior to our review to ensure selection bias was avoided as much as possible. In addition, because our reviews embraced complexity and sought to map out the operation of multiple challenges, the search was quite broad. However, we could still only cover a limited number of papers, published from 1990 onwards. Although the review is made in order to focus on the study of recent developments in the field of irrigation, it is still arguable that authors may have missed valuable adoption approaches that are applicable in today's automatic in modern material handling system.

V. CONCLUSION & FUTURE RESEARCH DIRECTION

A. Acknowledgement

This thesis includes detailed information about automatic irrigation systems. The ideas, development and writing up of this paper are the principal responsibility of both the authors and it is done under the supervision of Prof. Pratik Patil.

The inclusion of authors reflects the fact that, the work came from active collaboration between researchers and acknowledges input into team-based research.

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