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"Milkrun 4.0" for Smart Manufacturing

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***Abstract*—** *The aim of this paper is to focus on the advanced concept of in-plant logistics system known as Milkrun 4.0. This system will obtain data from the warehouse, pickup or delivery stations, and logistics employees. Then the data will be updated to the production planning and control system, which will illustrate material flow all over the production plant. Based on the material flow, employees responsible for production logistics and material handling will get directions to collaborate with manufacturing stations and assembly lines.*

***Keywords*—** *In-plant logistics; Industry 4.0; Distribution; Milkrun; Milkrun 4.0; Smart manufacturing*.

I. INTRODUCTION

In the competitive world of manufacturing, elimination of any non-value adding activity is a critical factor. Therefore, continuous supply of raw materials to the production line is important. If the material supply is not properly planned and balanced, unexpected production shutdown will occur. For this reason, material handling and waste elimination from internal logistics becomes unavoidable. So, internal logistics must be flexible enough to facilitate material supply at the least possible cost. Consequently, the milkrun system is applied to supply material from supermarket to production line via small trains. [1] If a proper material handling system can be established in a manufacturing facility, the cost will be decreased by 10 to 30 percent. In a typical factory, material handling utilises 87 percent of the production time and occupies 55 percent of the factory space. [2] The motivation of this paper is based on the widespread industrial revolution known as Industry 4.0. Industry 4.0 is also referred as smart factory or smart manufacturing. [3] Smart manufacturing practises an intelligent material handling system. This feature can enhance the quality of the conventional milkrun system to a much robust production environment. This in-plant milkrun transformation which is carried out to integrate with smart manufacturing into a dynamic system, is known as *"Milkrun 4.0".* This dynamic system consists of a supply train with a predetermined digital map. The train driver will have to perform a specific sequence of tasks. He or she is provided with the information about the delivery point, delivery pick up or drop time, and the quantity of materials to be delivered from the warehouse. [4] Therefore, it will be appropriate enough to adhere with latest manufacturing scenario. This paper focuses on in-plant logistics, implementation of milkrun as in-plant logistics tool, the transformation of milkrun, and its smart features to cope with smart manufacturing.

II. LITERATURE REVIEW

Smart manufacturing combines information from several trades, sales, and products. This combined information is used to form an instruction which will be followed in production lines or overall network consisting of suppliers, manufacturers, and customers. The instruction will be used to make the manufacturing process more precise. It will also create an interactive environment for employees, partners, and suppliers. An open space will be available for suppliers and manufacturers to make decisions based on facts and data. So, related personnel will be able to see the solution based on the whole picture. [5] In a manufacturing plant, two types of exertion can be found. One type focuses on producing goods and the other one emphasizes on the delivery of goods which is also known as logistics. If the logistics are confined to the production line and remains inside the plant boundary, it is under the control of company management. The production logistics helps to achieve optimization as well as makes the performance level higher. [6] It also ensures 8 types of advantages. 1) enhancement of resources utilization, 2) decrease in product lead time, 3) decrease of manufacturing inventory, 4) reduction of cost, 5) flexibility in manufacturing and logistics process, 6) increase of transparency to support lean philosophy, 7) increase in product quality, and 8) integration of production logistics by means of Enterprise Resource Planning (ERP) system. [7]

Cyclic goods transportation also known as milkrun was originated in northern England. This transportation system sorted out the supply and delivery problems of milk. Trucks were used to supply bottles filled with milk and they visited each station while following a predesigned route. As they followed an intelligent path planning system, these trucks also collected the empty bottles on the way back to the milk house. Later, this plan has been widely applied in production, distribution, and other sectors. [8] Milkrun concept is frequently used for in-plant logistics, for supplying the raw materials from supermarket to production lines as well as delivering the complete products made by manufacturing and assembly stations to warehouse. [9]

The in-plant milk run system is similar to the classic milk run system which works outside the plant. The assigned vehicle will start its journey from storage, visiting the stations on its way and then it will return to its initial point in a periodic manner. In this case, the vehicle will start the journey from the supermarket and go through the whole production area where it will supply materials to assembly lines and also gather finished products along with empty bins. [1] Figure 1 illustrates the system which is based on small amount of material delivery. It has two different lines. One line is given for collecting items, another is for supplying finished products from manufacturing stations. [6]

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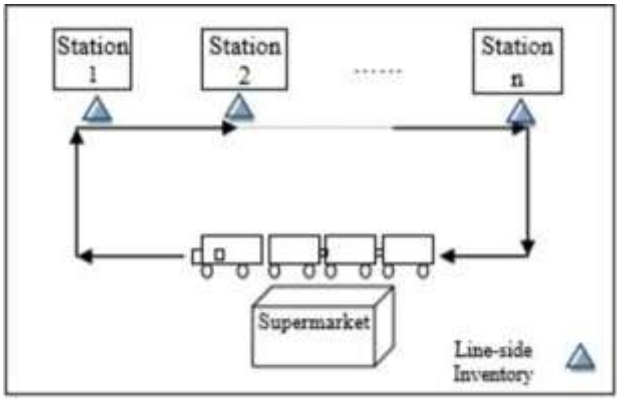

Fig. 1. In-plant milkrun model. [6]

III. Evolution of In-Plant Logistics

If One of the most important goals for the success of any type of industry (such as mechanical, automotive etc.) is to obtain an effective logistics, which ensures quality and accuracy in production. It also helps to obtain proper machine arrangement, updates storage and provides a route to deliver material, semi-finished goods, and finished goods. In the past, forklifts, trucks, and pallets were used to support internal logistics. It caused a huge amount of delay due to high assignation time of the trucks which was up to 60% of the total production time. Then the companies started using milkrun to support their internal logistics as shown in Figure 2. [10]


Fig. 2. Milk Run system as a part of internal logistics. [10]

Since then, this intralogistics system is entitled as in-plant milkrun. An in-plant milk run is a transportation process where different kinds of materials are delivered to several different points in a single trip. Usually, a fixed route is followed but sometimes fixed time interval is also followed. [1] The advantages of this system are: 1) transferring of various types of material at the same time, 2) higher flexibility and 3) comparatively lower investment and cost compared to forklifts and trucks. [10]

IV. Current Situation

In the in-plant milkrun system an employee drives the whole manufacturing area using an electric vehicle. This trip is made in every hour. During the ride, the employee checks in each station and collects the information about required materials from warehouse and also the amount of completed production orders. This causes several number of trips from manufacturing area to warehouse and it only focuses on refilling materials as per necessity. So, this method cannot utilize its full potential and consumes a huge amount of time than expected. For this reason, it can be noted as an inefficient method. [4] Another noteworthy drawback of this system is inadequate information for the milkrun driver. When the driver starts his trip usually he does not have any idea about 1) current status of the stations, 2) station that is waiting for him to pick up the finished products, 3) any emergency situation that has to be taken care of immediately, and 4) material necessity. [11] But in the smart factory and smart manufacturing, information availability is a must. Information concerned with manufacturing process should be given whenever it is needed, by means of manufacturing supply chain and product life cycles. [12]

V. Milkrun 4.0

Use This milkrun 4.0 includes a train which can map its route digitally. During material collection from production or gathering parts from warehouse its own system identifies: 1) stock changing station, 2) stock changing time, and 3) amount of change. It becomes possible by the use of barcode or QR code in batches in every station, as shown in Figure 3.


Fig. 3. Recording material flow by scanning QR code. [4]

Whenever a supply or pick up is made, it is recorded and updated on the computer. [4] So, the first step for implementing milkrun 4.0 is applying barcodes to all documents, pallets, pick up or delivery stations which can be recorded by electronic means. In the next step both the production planning system and enterprise control system will be tapped. Instantaneously barcode scanners and tablets will be supplied to the concerned employees. The generated data will be gathered and recorded in digital form, so that a transparent map will be created which will be able to give a whole picture of material flow through the production. This will be possible with the help of logistics operators. Operators

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will scan the barcodes attached with the documents they receive. The scanned information will be fed into the planning system based on the number of orders to be moved. This process will be carried out by means of an application given in tablets to the employees as illustrated in Figure 4.

Fig. 4. Information provided in production planning and control system. [11]

The similar procedure will be followed in pick-up and delivery stations. Thus, in the background, a virtual material flow map will be created. In the next stage, the virtual map will be transformed into a route which contains the time for parting and stoppage. This information will be shown on the tablet's display of milkrun driver shown in Figure 5.

Fig. 5. Milkrun 4.0 supply materials as per information shows in tablet. [4]

Moreover, a smart algorithm will be applied to calculate optimum traveling time on the basis of trip numbers made per day and the required amount of material. [11]

VI. CASE STUDY

This scheme was implemented in WITTENSTEIN bastian's facility where the products are gear wheels. After successful implementation, it was found that this system has a massive potential and the results obtained were close to the predicted simulated value. The study shows if the smart components are interconnected then the number of trips completed, and the amount of distance covered can be reduced to half. [11] The logistics can be made more transparent although it does not require intricate technologies of Industry 4.0. [4]

VII. DISCUSSION

Considering the above factors, milkrun 4.0 is a more efficient and flexible than the conventional in-plant milkrun. The manufacturing companies should focus on implementing this in-plant logistics scheme to be able to trace material flow all over the production. As information will be available, everybody working for production logistics will have a clear guideline to interact in any situation. Further research is to be carried out to find an optimum route for load carriers and products across the production plant which will help to build a smoother and faster material flow controller.

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