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Research paper

The Strategic Analysis of Managing Raw Material Replenishment for Product-based Manufacturing System

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Abstract

The product-based manufacturing system is widely applied in manufacturing industries based on the segregation of products and it is mostly designed based on the human dependent processes. To ensure the smoothness of production processess, the raw material replenishment activity plays an important role in terms of avoiding the material shortage. Currently, several concepts have been designed for material replenishment but the issue of material shortage in manufacturing system still occurs and it has interrupted the flow of production processes due to quality issue and production lead time. Thus, the present study investigates and examines the selected concepts in raw material replenishment to determine the optimum solution material replenishment concept. Three concepts of the material replenishment system were identified, namely adhoc, self-service and dedicated, and all of these concepts were examined in terms of waiting time. The result showed the dedicated concept was identified as the greatest concept of managing the material replenishment for product-based manufacturing system.

Keywords: *product-based, manufacturing system, production processes, material replenishment,*

1. Introduction

In manufacturing industries, facility layout is considered as the main element of production system, where it is normally designed with interconnected processes to transform raw materials into a complete product. It is considered as one of the most crucial elements affecting production efficiency because the production layout is normally set-up with permanent machinery, equipment, electrical wiring, gas and water piping. The production layout should ideally be designed according to the principle of wastes elimination in term of material flows, inventory handling, synchronization of the part arrival and completion the assembly between two processes, and also management, work stations and machinery are arranged according to a particular production sequence to ensure meeting optimum efficiency (Che Ani & Chin, 2016).

Designing the production layout is generally divided into four categories depending on the process and product requirements. The category of the production layouts consists of process-based, product-based, fixed-position and project based, and typically, most of the manufacturing industries apply process-based or product-based as their production system (Fernandez Clotet, 2015). A process-based layout generally has separate departments where general-purpose machines are grouped together by function as practiced by mostly precision or semi-automation industry. Therefore, process-based might involve multiple routes of production flow depending on the process requirement and it requires high flexibility due to sharing process with multiple variances of products (Wadhwa, Mishra, & Chan, 2009). The facilities of the process-based are configured according to individual function of the processes in which the processes are grouped based on similarity and these group will be managed by several departments or managements.

While, the product-based layout is designed based on repetitive assembly and process or continuous flow from the raw material until to finished product. The designated product-based produces high-volume, highly standardized products that require highly systematized, repetitive processes, and layout, where resources are arranged sequentially, based on the routing of the products managed by single department or management (Maropoulos, 1995).

Inefficient of production processess will cause unsmooth or interruption of the production flow due to several factors such as quality issues, down time, material shortage etc. Since raw material is main factor contribute into efficiency and smoothing of production processes, it can category as crucial factor during performing production process because inefficient supplying raw material into production process will cause quality issues such as incomplete product, wrong part and other issues (Kuhlang, Edtmayr, & Sihn, 2011).

The focus of this paper is to discuss the implementation concepts of material replenishment system for product-based manufacturing system. The first objective is to identify the current practice concepts of material replenishment system in product-based manufacturing system. A second objective, even though the material replenishment system widely applied in manufacturing industries, especially in product-based manufacturing system, the most effective concepts will introduce based on evaluation from previous objective. In this paper, Section 2 discusses the research approach, and Section 3 discusses the analysis and discussion. Then, the conclusion of this research is summarized in Section 4.

2. Research Approach

The methodology of the present study as shown in Figure 1 is carried out by identifying the concept of material replenishment system practices by manufacturing industry through published literature. Since, the focus of this study for product-based manufacturing system, the articles related with product-based especially automotive industry were skimmed through to be chosen for detailed analysis. From there, the most concept of material replenishment system will be selected. Once the several concepts of material replenishment system of was identified, then all steps of the processes involved needed to be understood and identified. The actual steps of each concept were then investigated.

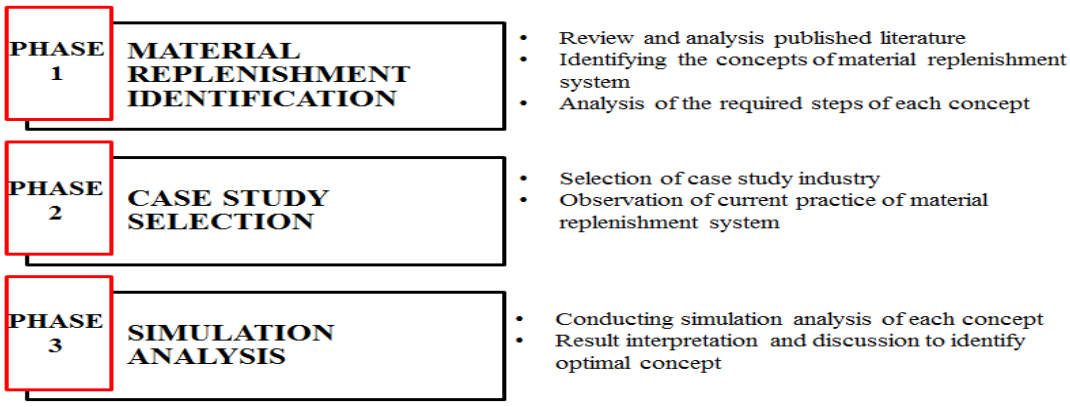


Figure 1. The Research Approach.

3. Analysis and Discussion

The research was began with the first phase which is identification several concepts of material management system. From the reviewed results of published literature, shows that three concepts of material replenishment widely employed in product-based production system. The first concept is the replenishment activities performed by production itself, which is the worker who are required the raw material will picked-up the raw material from work-in-progress (wip) area (Costanza, 2003; Jones, Beebe, Marrs, & Castle, 2003). This concept known as self-service, because the production worker performing the replenishment based on their requirement in term of quantity and time.

The second concept is the raw material replenishment was performed by third party department, which is from non-production worker. The person those are performing the replenishment activity known as material handler and he/she task only performing the material replenishment activity. Based on intensive analysis, this concept can be devided into two categories, which are the material handler will replenish the material once requested from production process based on First-Come-First-Serve (FCFS) order without considering the location of production process (Trevino, Liao, & Chopra, 1994; Zhao et al., 2010); this concepts known as ad-hoc concept. While the second category is the material handle will replenish the material based on designated area (Hao & Shen, 2006). This situation known as dedicated replenishment concept.

Based on the results of material replenishment concept identification, the summary was made, currently three concepts of replenishment system currently employed by manufacturing industries which are self-service, ad-hoc and dedicated concept. These three identified concepts was comprehensively studied through simulation process in following phase to identify the most optimal concept for material replenishment system in product-based manufacturing system.

Prior performing the simulation process for all identified concepts of material replenishment system, the selection of case study industry was carried-out in second phase. The case study company is an automotive assembly company which involves final assembly of the vehicle manufacturing. The layout of the production shop floor consists of single production assembly line and is divided into five main sections which are trim, chassis, final assembly, accessories assembly and final inspection. The warehouse has been set-up with different building and the part preparation is performed in the warehouse before transferring into the production shop floor. Each process is managed by different group of management and it needs efficient part preparation activity to ensure smooth production system. Figure 2 illustrates the overall layout of production process and warehouse.

In the second phase, the case study related with product-based production system was selected and the requirement steps of material replenishment activities were analysed through observation the flow of replenishment activity. The current method of the part replenishment system was studied and all the involved steps were recorded.

In the third phase, based on the required steps from selected case study, all the selected concepts identified in the first phase was analyzed by constructing the simulation using Witness software. The purpose of the simulation process is to determine the optimal concept of material replenishment system for product-based manufacturing system to ensure the smoothness of production processes. Once the results were obtained from simulation models, analysis process was then conducted to identify the optimal concepts.

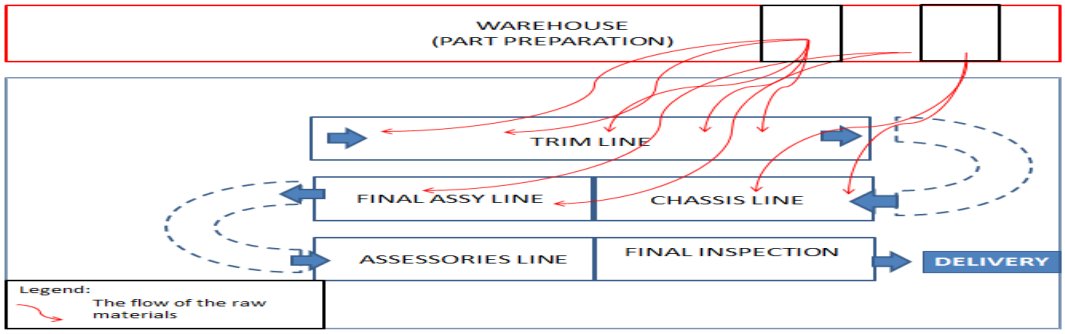
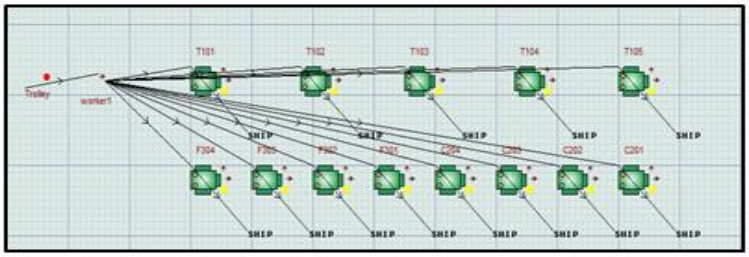


Figure 2. The Production Layout of Selected Case Study Industry

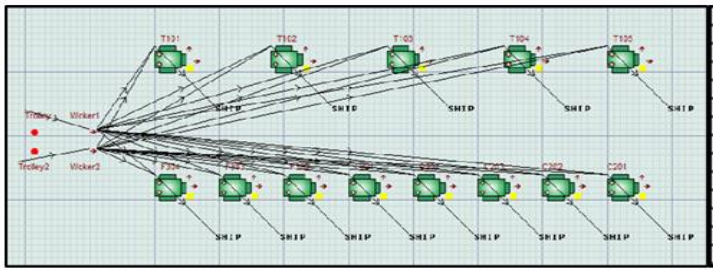
As the production process consists of five sections, the selection of the pilot improvement project has been conducted. The production processes consists of Trim, Chassis, Final Assembly, Accessories Assembly and Final Inspection. Based on these five sections the first three sections identified potential processes towards unsmooth process due to receiving the raw materials from warehouse, while the other two sections which are Accessories Assembly and Final Assembly do not involved with raw material. The Trim section consisted of five processes, while Chassis and Final Assembly only had four processes in each section. Higher number of processes meant the section will deal with higher number of raw materials.

Once the case study was identified, then the simulation process using WITNESS software was performed in third phase as identified concepts in first phase. The first concept was evaluated using simulation is self-service concept. The simulation results of all concepts as presented in Figure 3, 4 and 5.



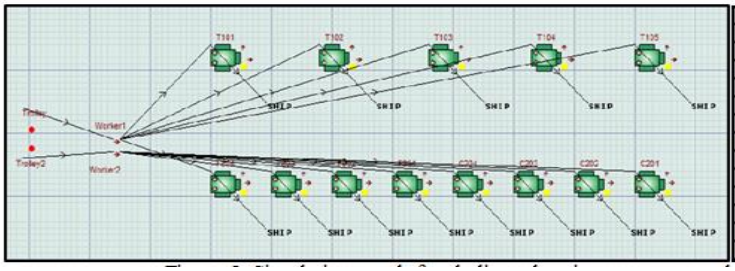
Name	% Idle	% Busy
T101	82.50	17.50
T102	82.50	17.50
T103	82.50	17.50
T104	82.50	17.50
T105	82.50	17.50
F304	87.71	12.29
F303	100.00	0.00
F302	100.00	0.00
F301	100.00	0.00
C204	100.00	0.00
C203	100.00	0.00
C202	100.00	0.00
C201	100.00	0.00

Figure 3. The Simulation Analysis for "Self-service" concept.



Name	% Idle	% Busy
F304	65.00	35.00
T101	65.00	35.00
F303	65.00	35.00
F302	65.00	35.00
F301	65.00	35.00
C204	65.00	35.00
C203	65.00	35.00
C202	70.21	29.79
C201	70.21	29.79
T102	78.96	21.04
T103	78.96	21.04
T104	82.50	17.50
T105	82.50	17.50

Figure 4. The Simulation Analysis for "Ad-Hoc" concept.



Name	% Idle	% Busy
F304	65.00	35.00
F303	65.00	35.00
F302	65.00	35.00
F301	65.00	35.00
C204	70.21	29.79
C203	78.96	21.04
C202	82.50	17.50
C201	82.50	17.50
T101	65.00	35.00
T105	65.00	35.00
T102	65.00	35.00
T103	70.21	29.79
T104	78.96	21.04

Figure 5. The Simulation Analysis for "Dedicated" concept.

As simulation results, all concepts have the percentage of idling and disturbing the production processes, but, the dedicated concept has been identified as the optimal concept because the idling percentage does not disturb the bottleneck process. The finding shows that there are clear indications of the effects for dedicated paths for replenishment system have significant impacts on the production processes.

4. Conclusion

This paper presents a study of material replenishment system for product-based manufacturing system in selected case study industry. Three part replenishment concepts; ah-hoc, self-service and dedicated assignment are analysed using simulation analysis. The main purpose to evaluate the optimal concept of the part replenishment system to determine the optimal concept towards production smoothness. From the simulation results, shows that the dedicated concept is the most effective concept of material replenishment system for product-based manufacturing system.

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