

Research Article

Design Concepts in Set Parts Supply Implementation

¹Suhartini Mohd Jainury, ¹Rizauddin Ramli, ¹Mohd Nizam Ab Rahman and ²Azhari Omar

¹Department of Mechanical and Materials Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

²Department of Manufacturing Solution, GICT, Proton 40918 Shah Alam, Selangor, Malaysia

Abstract: The increasing number of parts variants on an assembly line requires an improvement for a cost efficient and flexible parts supply system. For that reason, the Set Parts Supply (SPS) system was introduced by Toyota as a new material handling system for supplying parts in sets based on the kitting concept. In this study, we investigate the consideration of design concepts in SPS implementation at one of Malaysia's automotive manufacturers through a case study in a mixed-model assembly line that contains many parts to be assembled to the car body. From our case study, we found that the design of the 'parts only' or *minomi* concept on the component racks contributes to the elimination of waste; *mura*, *muri* and *muda*. Finally, we present the lean approach in the *minomi* concepts that used in designing the component racks.

Keywords: Assembly line, component racks, lean, manufacturing, parts, production

INTRODUCTION

The automotive industry is facing fierce competition with high demand for a wide variety of products at minimum cost. Globally, the automotive industry continues to enhance its profitability and streamline the operation by continuously improving the production system. The implementation of SPS is one of the improvement activities using the Just In Time (JIT) concept with a variety of lean principles, tools and techniques to solve problems arising on the assembly line. At Toyota Guangzhou, SPS has been implemented successfully because it is very easy for unskilled workers to understand and concentrate on the jobs (Nomura, 2008). Wang *et al.* (2010) studied the implementation of SPS which can reduce the man power allocation in the assembly area, reduce assembly operation time and reduce the size of the logistic area. Three alternatives for material flow were compared by Deechongkit and Srinon (2009) with three different aspects. The results showed that the SPS method was better than the traditional method which can reduce the distance of part supply, total time for part arrangement and investment in the method.

This study is concerned on how design concepts in the SPS implementation contribute to the reduction of three types of waste; *mura*, *muri* and *muda*. A case study was done to investigate the design concepts by focusing on the component racks using the *minomi* concept. *Minomi* is a Japanese word and in the production system, it can be defined as a unit load

where no container is used for supplying parts to the assembly line (Hanson, 2011). *Minomi* is also known as parts only and can be simplified as a peanut without a shell (Liker and Meier, 2006). This study is very important as an attempt to expand the understanding on the *minomi* concept that used in the production system.

CASE STUDY

The case study was conducted on one of the assembly lines with 28 workstations on the right and left side in the trim and final shop. The methods of observation, interview and analyzing documents were used to gain the information. To improve the JIT principles, the phases of SPS implementation were approved by management as a *kaizen* effort to solve the problem. The area of implementation is called an SPS Island. Figure 1 shows the model of three workstations along the assembly line on the right and left each side before the SPS implementation. Most of the parts were put in the containers and placed on the shelves of the pallet component racks. The component racks were fixed with different sizes on the line-side assembly line.

In this case study, three types of waste should be eliminated; *mura*, *muri* and *muda*. *Mura* is defined as an uneven pace in an operation, inconsistency or irregularity. *Muri* pertains to excessive workload or overburden and the word *muda* means any activity that does not create value to the assembly process (Liker,

Corresponding Author: Suhartini Mohd Jainury, Department of Mechanical and Materials Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

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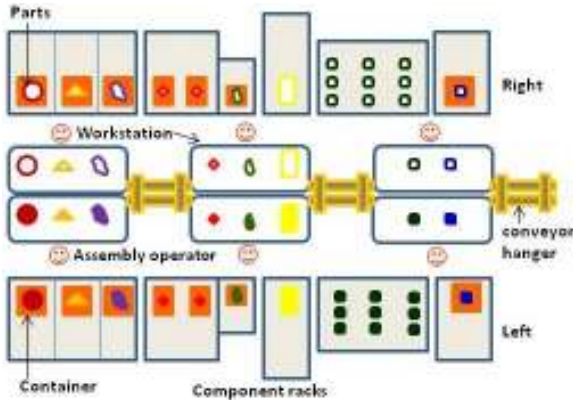


Fig. 1: Traditional assembly line

2004). The wastes arise especially in relation to parts and material handling such as unnecessary movement, transportation, waiting and defects. For example, the parts were placed in the containers which required space to locate the containers as well as space for the returnable empty containers. The assembly operator had to move several steps to arrange the containers in the area for the returned containers. This situation was non-value-added to the assembly process. Another waste that occurred in the traditional assembly line arose from the parts not being well arranged in the containers and because of the restriction on the quantity that could be accommodated, meant that a frequent supply to the line side assembly line was required. It also created defective parts due to material handling and storage on the component racks. The excessive inventory also made the workplace look messy and lacking in 5 S appearance.

RESULTS AND DISCUSSION

Set parts supply implementation: Figure 2 shows the model after SPS implementation which shows an SPS trolley at the conveyor hanger between the two workstations. At the end of the workstation, the empty SPS trolley is pushed to the component racks area by the shopping man. Then, the shopping man looks at the order sheet and picks up the required parts from the component racks. After the set parts are placed on the SPS trolley, the trolley is then pushed to the assembly line for the assembly operator to do the task of assembling parts to the car body.

After the SPS implementation, the parts are supplied just in time to the workstation. The set parts on the SPS trolley arrive at the workstation and the assembly operator picks up the needed parts to assemble to the car body with no movement required to search and reach for parts from the component racks. The total cycle time of the assembly process is reduced from 2257 s to 1735 s. In addition, the assembly process also is reduced from 24 to 20 processes. The extra assembly operator was transferred to become the shopping man.

After the new design of the component racks with the concept of *minomi*, some of the parts did not use the container anymore and the area for returnable containers was eliminated. The concept of *minomi* increased the number or quantity of each parts supplied. As a result, before the *minomi* concept, Part A could be supplied with 20 per supply, but after the new rack, the parts increased to 75 per supply with the synchronization. Part B also increased from 60 to 90 per supply and the trips of supply were reduced from 4 to 3 trips per day. By using the *minomi* concept, the parts can be arranged better with one specific part in one rack. The parts can be easily seen by the operator and the handling of parts is much better.

The flow of parts supply before and after the *minomi* concept is shown in Fig. 3. Before using the *minomi* concepts, the parts were supplied from supplier in the containers and after receive the parts, the manpower placed the containers on component racks. At time the parts need to supply to the line side at the assembly line, the manpower arranged the containers on the towing truck and ready to supply. However after *minomi*, the parts were put on the component racks. After receive parts, the manpower can supply parts to the line side. The stocks were reduced from 60 to 12 set of parts in the component rack area. The time for parts replenishment was also reduced from 2 h to 22 min.

Minomi: In this case study, the design concept for new racks is 1500 mm height, 2000 mm length and the width can be adjusted depending on the size of components. Frequently the range is not more than 1500 mm. Three lean concepts were considered in the design of the component racks:

- Error-proofing or *poka-yoke*
- Visualization
- First In First Out (FIFO)

The component racks were designed with the error-proofing concepts for preventing mistakes while preparing the parts as shown in Fig. 4. The mistakes that always occurred when using the containers were misplaced parts and missing parts. The component racks also were designed by considering the size and shape of the parts. The racks are light and moveable. The parts hang on a hook or special hanger, on a gravity flow rack, on a specially designed rack and on a 360° rotating rack.

In the concept of new racking, the parts are visible and obvious at a glance. This provides the real time information and feedback of the status of the production on the assembly line. The parts were arranged on the racks with signs and labels. This situation helps the shopping man to respond if there are abnormal conditions or defects before the parts are supplied to the assembly line.

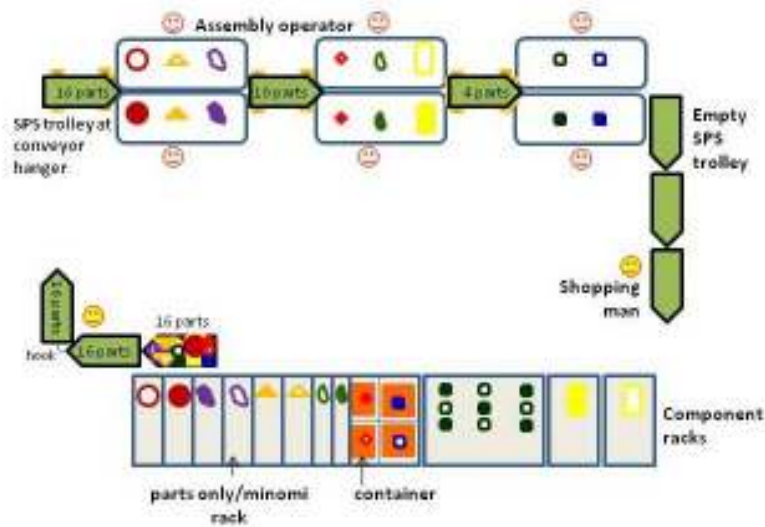


Fig. 2: SPS implementation on the assembly line

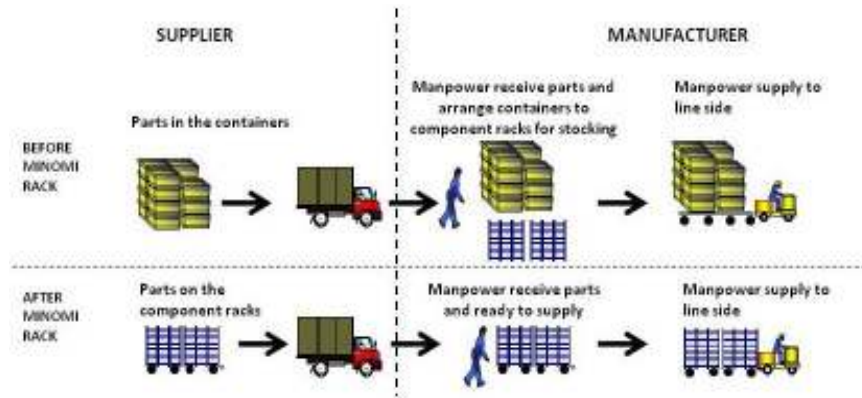


Fig. 3: The parts supply flow before and after using racking with the minomi concept

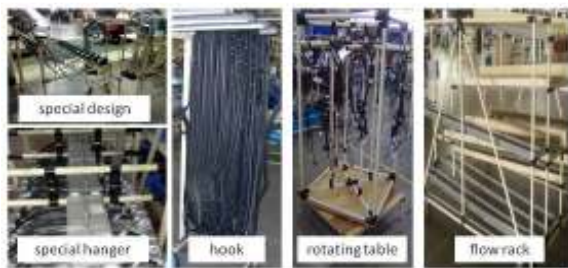


Fig. 4: The various types of design in the minomi concept



Fig. 5: The FIFO method in the minomi concept

The FIFO method was used in the design of the *minomi* rack as shown in Fig. 5. FIFO means the first parts placed on the rack will be used first and whatever comes later will be used later. By using this method, there is no pile up of old parts on the production line. Using the FIFO method also prevents the value and aging of the parts such as color fade, dusty, grain, dirty and scratched due to material handling and storage. In the design stage of the racks, FIFO was considered especially for synchronizing parts to ensure that only the correct parts were supplied to the manufacturer and assembly line.

CONCLUSION

SPS was introduced as an improvement of parts supply with Just In Time practices on the assembly line. The design of *minomi* concept with lean approach of error-proofing, visualization and FIFO method can reduce *mura*, *muri* and *muda*. The space area on the shop floor can be optimized and the numbers of

transportation trips were reduced by increasing the number or quantity per supply. The new racking also improves the searching and selection process in preparing parts for the workstation. However, this research is limited on one case study. Therefore, there is a need for extensive research on the various aspects concerning SPS implementation and the *minomi* concepts.

This research contributes to the knowledge on SPS implementation with the design concepts of *minomi* in the component racks. In order to fulfill the research gap, there is a need for extensive research on the various aspects concerning SPS implementation. It will also be valuable to examine how the *minomi* can be performed by using the conveyor system or automated guide vehicle. This kind of research will contribute to expand the knowledge concerning the lean production system as the most productive approach in the automotive industry.

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