The challenges of lean manufacturing implementation in kitting assembly

A F H Fansuri[1*], A N M Rose[1], N M Z Nik Mohamed[1] and H Ahmad[2]

[1] Manufacturing Focus Group, Faculty of Mechanical Engineering, Universiti Malaysia Pahang, 26600, Pekan, Pahang, Malaysia
[2] TATI University College, 24000 Kemaman, Terengganu, Malaysia

[*]Corresponding author: anithfanz@yahoo.com

Abstract. Literature studies shows that lean manufacturing goes way back with the original founder Eli Whitney in year 1799. The main purpose of lean manufacturing is to identify and eliminate waste in production. The application of lean manufacturing can be carried out in any industrial processes with regards to the understanding of lean principles, theories and practices. Kitting is one of the important aspects in a successful production. The continuous supply of materials from store to production has to be systematic and able to achieve lean standard for it to be successful. The objective of this paper is to review the implementation of lean manufacturing in kitting assembly. Previous papers show that, the implementation of lean manufacturing in kitting assembly may be beneficial to the organization such as reduce in space occupancy, part shortages, lead time and manpower. Based on previous research, some industries may tend to change between kitting and line stocking which are due to lack of understanding when implementing kitting and causes longer lead time and materials overflow in store. With a proper understanding on what to kit, where to kit, how to kit, why to kit and who kits the material with a standardised process flow may ensure the success of kitting.

1. Introduction

Lean manufacturing has been recognised as the centre spotlight of the current global industry to implement it as to achieve the higher level of leanness in today's competitive industries. Lean system is focusing on the demands of the customers and the lean philosophies should be flexible enough to meet the needs of customers [1].

Most of the companies have implemented lean manufacturing principles such as just-in-time (JIT) production which are deemed to be an ideal solution [2]. In the ever changing of the world economy, the manufacturing industries must be able to produce products or services with shorter lead times and therefore lean manufacturing has been a well-accepted philosophy by many organisations [3]. Lean manufacturing is also focused on the elimination of waste and non -value added activities [4].

Through lean manufacturing, the concept of a proper material feeding flow will determine the ability of the organisation to meet customer's demand. In this paper, the authors will review the implementation of lean manufacturing in kitting assembly. In assembly lines, parts are needed to be restored without any interruption, and the parts are needed to be replenished along the assembly line based on production plan [5].

Kitting is a process of materials feeding to the assembly station. Parts are sorted and transferred to assembly station in pre-sorted kits where one assembly product parts is in each kit [6]. The initial reasons of implementing kitting in a production assembly line is usually involves parallelised

assembly system, product with various part numbers, quality of the assembly and products with high volume [7]. With kitting, parts can be kitted in advance (temporarily stored in store) before it can be delivered to the production assembly line. Therefore, with kitting, no inventories are kept at the production floor [8] .

2. Literature review

Kitting is one of the important processes of material feeding in a manufacturing company. However, the implementation itself needs a thorough understanding in lean principles before it can be carried out. It is believed that through lean manufacturing practices, the company could eliminate wastes [8]. Based on previous research, kitting is implemented successfully in many organisation [9]. However, it is also causes major problems when the implementation is not based on the production requirement such as level of work in progress, space allocation in production and walking distance for operator [10]. Due to increased production volume and demands, kitting system is considered the best option for material feeding instead of line stocking [11]. In addition, the critical success factors for a successful lean manufacturing implementation must be considered especially the top management commitment [12].

3. Kitting assembly

With the growing demand from customer, line stocking is deemed to be unsuitable for material feeding to production assembly. There are factors need to be considered by the organisation such as floor space, work-in-progress (WIP) and material security before implementing kitting process. Many companies are unsure about when a kitting system should be implemented and what is the method fits to their environment. Many researches developed kitting methods, but still these theories are difficult to be applied in production assembly [13]. Besides that, there are also few highlighted issues on the confusion of the implementation of kitting assembly due to lack of understanding in kitting principle on when and where each type of material feeding system such as (line stocking or kitting) should be used [14]. The advantages and disadvantages of kitting are listed in Table 1. It shows that the company will gain benefits on parts management and production flexibility including quality control. As a result, the production can be run smoothly and successfully towards production target.

Table 1. Advantages and disadvantages of kitting assembly [11].

Advantages	Disadvantages
Saves production space	Increase storage if kit is done in advance
Reduce operators walking and searching time.	Time consuming on making kit
Better control of WIP at assembly line since the components are stored in storage area	Part shortage from store may cause operator to kits short thus reducing the overall efficiency.
Increase flexibility at assembly line as product changeover can be done with ease.	Defect components during assembly causes additional actions and time to provide the spare piece.
Increase in product quality due to possible quality checks earlier before material is transacted to production.	Poor kitting design in picking process may cause injuries and unmotivated personnel.

Based on advantages and disadvantages of kitting, it may be implemented successfully if the companies have taken into consideration on the following factors [15]:

i. Products quality and line assembly support.
   According to Hanson and Brolin [15] research, kitting may improve product quality since the operator at the assembly line does not have to concern what are the parts to be assemble and what material to pick. It also provides a learning support when the kitted material is arranged in a manner which reflects the assembly operation.

ii. Man-hour consumption.
Kitting can reduce man-hour consumption as the operator does not need to spend their time to search for parts. Besides that, without kitting production with high variety and high volume of products requires more space to store parts in production line. In addition, with increased number of part numbers, the walking distance and time for the assembly operator is also increased. Thus, through kitting, the kitted material is easily accessible by the assembly operator.

iii. The flexibility in product changeover.
Through kitting it will create more flexibility in changing one product to another, or product of different colour shades as the parts are not stationed at the assembly area. Besides that, racks at the assembly station causes hindrances to the quantity of parts which can be presented at the workstation. Thus, kitting is more flexible in this area as kitting can handle high product volume, varieties and can be kitted even with uncertain demand.

iv. Inventory volumes and space requirement.
Even when kitting can save space at the assembly station however, kitting needs more space for kit preparation before transact to assembly station. Product with high variations may requires multiple storage location in line stocking. Therefore, kitting could be advantages as it only requires a kitting space.

To overcome the kitting disadvantages as stated before, research by [5] proposed an economic model in order to identify the cost breakeven points based on measurable parts features to determine which material feeding policy is more convenient and suitable [13].

4. Material flow in kitting assembly

Before kitting process, component parts were placed in racks at the assembly station. The parts are supplied directly by continuous supply from store to assembly line, hence consumed a lot of production space. As for kitting, the kit are done in kit preparation area and transferred to assembly line which reduces material occupancy in assembly line as shown in Figure 1 [15].

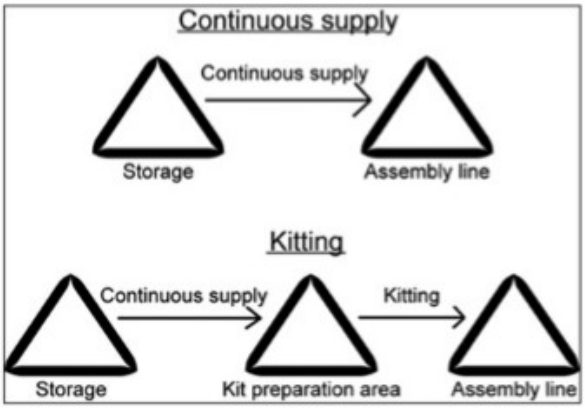

Figure 1. Schematic diagram of material flow [15].

Kitting is calling for components to be prepared and gathered before it could be sent to the assembly line. The components are retrieved from its storage location by picking operations and then it will be placed in a containers or trays or trolleys to hold all the kitted parts. Once the operation is completed, the kit is then transferred to assembly line depending on production sequence [16].

Kitting can be done in the central pick store or a decentralised area which are close to assembly workstations. Kitting may be done by either the assembly operators or operators that specialised in kitting assembly only. The materials that need to be kitted can be moved towards operators (part-to-picker) or the operators has to move to the picking materials location (picker-to-part). Supermarket style of picking is one of the example of picker-to-part scenario [17].

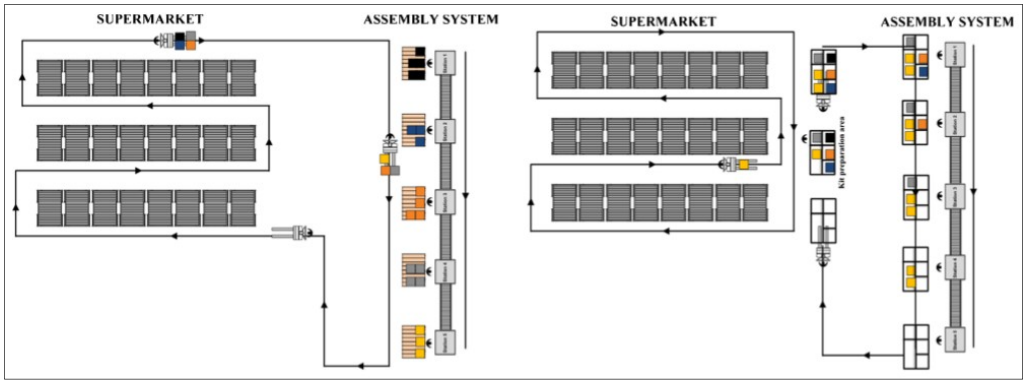

Figure 2. Line stocking (*left)* and kitting picker-to-part (*right)* [16].

Figure 2 shows the material feeding choices between line stocking and kitting assembly. The illustration shows material flow in kitting assembly. The materials needed for production is able to be determined before production assembly thus reduce the risk of part shortages. Kitting requires operators to pick the items in warehouse (picker-to-part) thus increases material handling [16].

5. Lean kitting

Kitting is considered a waste due to it needs component racks, Kanban signals, and operators to pick materials from warehouse. However, the elimination of these activities may influence more wastes to the organisation such as inflexible, parts mixed up and etc. Thus, it may cause disruption to production process and reduce line efficiency. In year 1997, Toyota has implemented a kitting process call Set Part Supply (SPS) in their production assembly [18].

The implementation of SPS is to contribute in the reduction of wastes known as *Muda* (waste), *Muri* (Overburden) and *Mura* (Unevenness). The SPS is known by using *minomi* concept. This concept used no containers for supplying parts to the production line assembly as in Figure 3 [19]. At Toyota, the minomi concept is used after stamping process of coiled steel in which the parts are stacked together based on their shapes which can reduce motion waste, scarps and scratches.

Figure 3. Examples of Minomi Concept [24].

There are few factors need to be considered in implementing a lean-kitting assembly [18] such as:

- Waste related to machine downtime which causes in invalid kitting has to be eliminated.
- Kitting assembly has to be done right for the first time.
- Any waste found in kitting assembly has to be eliminated.

The kitting crew will receive list of materials to be kitted from the store department and then, the parts will be delivered by using pallets to the production area. Therefore, production operators do need to walk to pick required materials at decided area. As a result, this method could give advantages to the Toyota such as;

- The elimination of non-value-added activities such as walking distance from assembly station to flow racks to pick materials. This could increase operator's concentration in installing parts. Thus, increase the value-added time for assembly operator.
- Reduce space occupancy in production area and creates clean work areas with better control.
- Provides leaner and easier training for assembly operator as the job scope for the operators is narrowed down.

However, based on Carlsson and Hensvold [11] research, in order to achieve lean manufacturing system, a pulling of material flow has to be implemented. By implementing the kitting system as continuous supply, production area will be able to reduce the usage of bins and provide more spacious on floor area. The level of understanding and correct kitting implementation are the crucial factors in contributing for a leaner production in assemblies with high variations [11].

6. Conclusions

Based on previous research, most researchers agreed that the implementation of kitting is the best way for material feeding in order to achieve a status of lean manufacturing. Factors such as inventory, floor space occupancy and operator walking distances have to be reduced and therefore, lean kitting assembly is considered the suitable method to be implemented in production area which has high variation and volume compared to line stocking [10]. In addition, kitting assembly can also be affected by three of these factors such as the sharing of components, uncertain demands and also lead time [20].

Kitting may be beneficial if the implementation is done correctly. Common problem in kitting or material feeding is when the synchronisation in material purchasing and supply chains is not in equal. It might cause part shortage thus halted production assembly. Besides that, non-value added activities in kitting have to be identified and a proper kitting procedure has to be implemented [21].

There is still not much research in the implementation of lean manufacturing principles in the kitting production assembly line. Therefore, many authors from previous research suggested further or continuation of research in:

- Identifying and analysing the factors that influenced the material feeding policy and where to implement the Kanban and kitting assembly system [22].
- To identify the appropriate measure to in analysing work exposures levels during materials picking [23].

As been discussed earlier there are many hidden wastes in the production line including kitting process, the authors would like to further investigate and analyse the possible causes and suggestion for better kitting methodology.

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