Application of 5S and Visual Management to Improve Shipment Preparation of Finished Goods

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Abstract. The purpose of this paper is to present a lean case study to resolve issues related to shipment preparation in the finished goods store of a manufacturing industry. The process was first investigated through cause and effect diagram. Several root causes detected, including unorganized finished goods inventory, the absence of first-in-first-out (FIFO) rule in process flow, lack of visibility and inadequate inventory data recording and keeping. The two lean manufacturing tools, notably 5S and visual management were deployed in the finished goods store as the countermeasures. This leads to a significant improvement where the shipment preparation was seen reduced by 50%. The offshoot benefits include increased awareness and motivation for lean manufacturing by the involved staff.

Keywords : Lean manufacturing, 5S, Visual system, Shipment, Due date

1.0 Introduction
Inventory is defined as the stock of any resource used in manufacturing. Inventory levels can be viewed as indicators of process capability and production efficiency [1]. Inventory ill-managed however would bring forth storage issue, poor response to customer demand, hiding production problems etc [2]. A crude categorization of inventory would be raw materials, work-in-process (WIP) and finished goods. WIP represents products that yet to be completed in the production. The primary functions of WIP are to cushion against production disruption and to respond to fluctuations in customer demand. Another more special form of inventory is safety stock. Safety stock (also called buffer stock) is a term used to describe inventory in keeping to prevent stock out and back order situations. It protects against deviations in delivery date, meeting customer requirements, delivery quantity and other types of inventories [3].

The paper aims to present a framework to improve the shipment preparation of finished goods by deploying lean manufacturing principles, techniques and tools. The second aim would be to demonstrate the deployment of framework using existing resources (people, technology etc.) in a manufacturing organization without incurring additional cost to achieve the improvement.

A single case study approach has been adopted in this research. It has been proposed in the literature that case studies can be applied to the area of theory development as well as problem solving [4]. In general, case studies are often preferred when researchers have little control over the event and when the focus is on a contemporary phenomenon in some real-life context [5]. Case study approach is selected after careful consideration of several issues. First, one key aim of the study is to empirically identify inventory related difficulties. Manufacturing take place in a complex environment. Hence, it is critical to capture the experiences of the relevant people and the context of their actions to better understand inventory management practices and related difficulties. Second, as the research deals with the difficulties and challenges manufacturer are currently facing, this research deal with a contemporary event [5-6]. This research study begins with intensive review of relevant literature and the past research study. This is followed by the selection of company to carry out the implementation. Then, the existing finished goods storing process was studied. The related problems were identified and the corresponding countermeasures were formulated. This was followed by implementation.
The paper organization is as follows. In Section 2, the relevant literature on lean manufacturing, tools specifically 5S and visual management were reviewed. In Section 3, the problem and the solution of inventory management of the case study company would be discussed in details. The result and discussion presented in Section 4. The research study conclusion is the last section of this paper.

2.0 Literature review

2.1 Lean manufacturing

Lean manufacturing, one of the popular management philosophies, has been adopted by manufacturing and servicing organizations since the last two decades. It can be distinguished in two perspectives:- philosophical perspective or a practical perspective. The philosophical perspective relates to the guiding principles or overarching goals. Lean manufacturing has been defined as an integrated manufacturing system intended to maximize capacity, utilization and minimize buffer inventories through the minimization of system variability. The tenet is to do more with less, in terms of human effort, equipment, time, and space [7-8]. On the other hand, practical perspective involves implementing a set of shop floor tools and techniques aiming to reduce waste within the plant and supply chain [9-10].

One of the signature concepts of lean manufacturing is the identification and elimination of wastes throughout a product’s entire value stream [11]. A waste is any activity in the manufacturing processes that does not create value to the customer. Seven wastes are identified in the lean manufacturing [12]. First, defect implies parts that cannot be sold “as is” or that must be reworked. Second, overproduction means making number of parts exceeding the quantity that can be sold. Third, waiting is a stage whereby parts are idling between processes. Forth, transportation indicates moving parts or materials to various storage locations, from process to process, etc. Fifth, inventories are parts not sold representing committing money and storage space. Sixth, motion indicates moving parts more than the minimum needed to complete and ship them. Finally, extra processes are doing more “work” to a part than is required.

In reducing these wastes, lean manufacturing involves deployment of lean tools. Common lean tools include value stream mapping, kanban, kaizen, heijunka, poka-yoke, etc. According to Che Ani and Chin [13], lean tools in application provide a complementary effect as they are based on a same underlying philosophy. This ensures the sustainability of the practice. Two of the fundamental lean tools related to this research is 5S and visual management. Originated from Japan, 5S comes from five Japanese words- Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize) and Shitsuke (Sustain) [14]. The main idea is to organize workplace to reduce time wasted by looking for things and to maintain process stability. Several literatures [15-17] reported that implementing 5S brings forth multiple benefits to the organization such as improved usage of working area, work environment improvement, prevention of tools losing, reduction in pollution, employee discipline, employee awareness and moral, improvement in the internal communication and internal human relation. In transferring the knowledge of autonomous maintenance to vendor, Chong et al. [18] showed how 5S is developed by the case study companies. Tan et al. [19] devised a 5S system including a checklist for electronics assembly plant to reduce the material losses at the front-end process. Chong et al. [20] implemented 5S in a packaging company through their lean incipience framework. Vipulkumar and Hemant [21] applied 5S in a ceramic industry and increases the process efficiency of the company. In another application of 5S, Agrahari et al. [8] achieved additional 30% of storing place and reduce unproductive time with 10%.
### Table 1. Terms and feature of 5S [22]

| Japanese Term | Equivalent “S” term (5S) | Equivalent “C” term (5C) | Features |
|---------------|--------------------------|--------------------------|----------|
| Seiri         | Sort                      | Clear                    | • Search useful and useless items.  
                |                           |                          | • Separate both items & Classify them.  
                |                           |                          | • Critical items should be kept for use nearby.  |
| Seiton        | Systematize or Set in order | Configure                 | • Arrange useful items properly.  
                |                           |                          | • Discard useless items.  
                |                           |                          | • Give color according to their use.  |
| Seiso         | Sweep or Shine            | Clean and Check           | • Clean and polish all working places.  
                |                           |                          | • Remove trash or dirt properly.  |
| Seiketsu      | Standardize               | Confirmity                | • Maintain cleanliness.  
                |                           |                          | • Tested/Inspected randomly.  
                |                           |                          | • Convert into high standard.  |
| Shitsuke      | Self-Discipline           | Custom and Practice       | • Motivate employee towards work.  
                |                           |                          | • Generate self discipline.  |

Another common lean tool is visual management. Visual management is defined as a set of techniques to create visual communication, visual control and ultimately a visual workplace. Visual management also defines performance improvement in any type of organization using strong graphic visualization techniques [23]. Tezel et al. [24] identified nine functions of visual management i.e transparency, discipline, continuous improvement, job facilitation, on-the-job training, creating shared ownership, management by facts, simplification, and unification. In this sense, visual management facilitates employee autonomy, serves to eliminate waste, fosters continuous improvement, allows for quick response & recovery, leads to information sharing, exposes abnormalities and maintains gains. For an example, a visual board installed at the workplace displays performance of production, attendance, quality concern, etc. Goh et al. [25] developed a visual board to regulate the flow and WIP between processes between manufacturing cells. This reveals key production statuses in a glance [26].

### 3.0 Case study

A manufacturer of ferrite was selected in this research. The case study company is a make-to-order (MTO) manufacturer of ferrite core product. The company produces four types of products, namely product R, product C, product T and product D. The monthly order volume is 100 tons to 120 tons. The percentage of the each product type is 65%, 20%, 10% and 5% respectively. Product R was selected because it significantly impacts performance of the company.

### 3.1 Improvement framework

The existing shipment preparation process was analyzed and described as below. Informal interviews, personal observations, and archival documents (finished goods despatched note, stock card etc) were the sources of data. PDCA cycle was used to systematically improve shipment preparation process. The four underlying phases are P(Plan), D(Do), C(Check) and A(Act). In “Plan” phase, the improvement framework starts with forming a multidisciplinary team. It was leaded by a project manager, with team members including three storekeepers, one store clerk, one selection and packing supervisor, and one internship student. Next, the improvement goal was defined. The existing process and material flow
were analysed by using tools such as process mapping, value stream mapping etc. The root cause is
determined through applying cause and effect diagram. Suitable countermeasures to resolve the root
cause are proposed and the details of the improvement steps are formulated. In the “Do” phase, the
proposed countermeasure is implemented by using various strategies and tactics in order to achieve the
project objectives. The project team members would be trained through on-job-training (OJT) approach.
The OJT is the practical training and the training was carried at the real life environment rather than
theory explanation in the classroom. In the “Check” phase, the performance of the implementation is
evaluated in order to seek the further refinement. The “Act” phase is the area where the improvement
cycle would be repeated in case the goal is not attained. The project would be closed if the goal is
attained.
START

FORMING PROJECT TEAM

STUDY EXISTING PROCESS AND SYSTEM

IDENTIFY THE DRAWBACKS OF THE EXISTING SYSTEM

DEFINE PROJECT GOAL

ROOT CAUSE ANALYSIS AND COUNTERMEASURE DEVELOPMENT

IMPLEMENT COUNTERMEASURE

DEVELOP STANDARD AND ON-JOB TRAINING

MEASURE PERFORMANCE AND GOAL ATTAINMENT

GOAL ATTAIN?

Yes

END

No, require refinement or new countermeasure

Figure 1. Shipment preparation process improvement framework
3.2 Plan stage
The shipment preparation process started with the storekeeper receiving shipment advice from the sale department. The storekeeper checked the stock card and finished goods despatch note file to verify the product quantity in the store against demand stated in the shipment advice. The storekeeper then brought the finished goods despatch note to the storage area to retrieve the product lots for shipment. The product lots would then be placed and arranged onto plastic pallets. Then, the storekeeper recorded the products lot number and quantity (kpcs) into the shipment traceability form. After recording, the product lots would be transferred to a wooden crate. The lot was then placed at a temporary storage area to wait for delivery. The completed shipment traceability form was kept in the associated folder. The storekeeper spent 6.5 days to complete the shipment based on completion rate three wooden crates per day. Twenty wooden crates were needed for each Friday weekly shipment. Shipment postponement to the following Monday happened incidental to insufficient pack to store quantity. This affects three forth of the shipments.

The existing shipment preparation process was broken down into sub activities of value-added (VA) and non-value added (NVA). Non-value added activities could be eliminated or replaced with more efficient methods. The existing shipment preparation process of a wooden crate (288 cartons) consists of twelve activities contributing to 3.58 hours. The details of these activities are described in Figure 2.

Cause and effect diagram was developed. Several causes related to method were unorganized inventory, lack of visibility, and inadequate inventory data recording and keeping. A cause related to man was failed to follow first-in-first-out (FIFO). The product lots received from upstream (selection and packing) was stored at the area without clear location and indication. This entailed the storekeeper to spend on average 40 min to search and retrieve product during shipment preparation. The third cause was lack of visibility. The inventory details were kept in the finished goods despatch note file and stock file. The storekeeper compared the stock file record to determine the product quantity available with the finished goods despatch note. After that, the details were filled into shipment traceability form. The forth cause was inadequate inventory data recording and keeping. The store clerk spent significant amount of time to perform double entry works. She keyed in the product lots quantity (kpcs) into the Excel spreadsheet and the stock file separately. The data required for shipment preparation process effectively which was required data like lot number of the carton box. The storekeeper needed to obtain the lot number from finished goods despatch note.
**Figure 2.** Current shipment preparation process flow chart

| Details of method                                                                 | Operation | Movement | Inspection | Delay | Storage | Time Spend (min) (Current State) | V/NVA Activity |
|----------------------------------------------------------------------------------|-----------|----------|------------|-------|---------|----------------------------------|----------------|
| 1) Verify quantity requested in shipment advice.                                |           |          |            |       |         | 10                               | NVA            |
| 2) Check against stock card quantities and FIFO then record information into the shipment advice. |           |          |            |       |         | 20                               | NVA            |
| 3) Verify lot numbers, number of cartons and quantities (Kpcs) in the finished goods despatch note. |           |          |            |       |         | 30                               | NVA            |
| 4) Look for physical cartons of product in the identified storage location.     |           |          |            |       |         | 40                               | VA             |
| 5) Gather the relevant cartons of product and place it on the wooden pallet.    |           |          |            |       |         | 20                               | VA             |
| 6) Transfer the wooden pallet of cartons in front the wooden crate.             |           |          |            |       |         | 10                               | VA             |
| 7) Record the lot number, number cartons and quantities (Kpcs) into the shipment traceability form by 1st storekeeper. |           |          |            |       |         | 15                               | NVA            |
| 8) Verify the shipment traceability form record against physical cartons of product by 2nd storekeeper. |           |          |            |       |         | 5                                | NVA            |
| 9) Fill the cartons of product into the wooden crate.                           |           |          |            |       |         | 45                               | VA             |
| 10) Close the wooden crate (hammer and nail) while completed fill in process and stick identification label. |           |          |            |       |         | 15                               | VA             |
| 11) Transfer the wooden crate to the awaiting shipment area.                    |           |          |            |       |         | 5                                | VA             |
| 12) Waiting for shipment.                                                       |           |          |            |       |         | 0                                | VA             |

Min: 215  
Hour: 3.58
Several countermeasures are developed in corresponding to the root causes defined previously. As aforementioned, the key concepts to drive the development are 5S and visual management. They are shown in Table 2.

**Table 2. Countermeasure development**

| Root Cause            | Description                                                                 | 5S Tools   | Visual Management Tools | Countermeasure                                                                 |
|----------------------|-----------------------------------------------------------------------------|------------|-------------------------|-------------------------------------------------------------------------------|
| Inventory Unorganized| The fresh product lots and the old product lots were placed together at the store area without status indicator. | Seiri      | Yellow outline          | • Redesign the finished goods store layout.                                   |
|                      |                                                                             | Seiton     |                         | • Re-layout the products location in the finished goods store, controlling the left over product from the previous years. |
|                      |                                                                             | Seiso      |                         |                                                                               |
| Incompliance to FIFO rule| No clear indication of the product lots received from the upstream (selection and packing). | Seiketsu   | Red sticker             | • Indicating the product lots with red sticker written STORE DATE after completed packing process. |
|                      |                                                                             | Shitsuke   |                         |                                                                               |
| Lack of visibility   | Product lots placed at the storage area without clear information of each carton product. | Seiketsu   | Stock list              | • Prepare a store list for each location to indicate the details like lot number and number of carton. |
|                      |                                                                             | Shitsuke   |                         |                                                                               |
| Inadequate data recording| Use inefficient method to data collection and storage cause                  | Seiri      | Excel spreadsheet       | • Convert the hardcopy of finished goods despatch note into                    |
|                      |                                                                             | Seiton     |                         |                                                                               |

**Figure 3.** Cause and effect diagram of long shipment preparation time
3.3 Do stage

3.3.1 Implementing countermeasure for lack of visibility. The existing finished goods store was re-laid out, as shown in Figure 4. The storage column was designed according to the size of the pallet (4ft (L) x 1.5ft (W)) and ten pallets of product lots can be placed in each storage column. The column was identified by a location indicator with alphabet in ascending order from A to Z and associate with customer name. A stock list display (made of clear folder and metal plate) was installed in front of the storage column to keep the stock list. The information in the stock list includes customer name, product code, lot number, number of carton and quantity in kilo-piece (kpcs). The storekeeper could refer to the stock list at ease to find the location of the product lots to be retrieved.

Figure 4. Improved layout of finished goods store.
3.3.2 Implementing countermeasure for unorganized inventory. As aforementioned, inventory was now to be arranged on predetermined columns. Furthermore, each pallet of products would carry an individual stock list holding the information about the product lots and the assigned storage column. Clear directive was given to the storekeeper to abide to the new layout and inventory storing arrangement.

3.3.3 Implementing countermeasure for in compliance to FIFO rule. The product lot was labelled with a red sticker written with store date after completed packing process to facilitate storekeeper to comply with FIFO.

![Store Date sticker on a carton](image)

**Figure 5.** Store Date sticker on a carton

3.3.4 Implementing countermeasure for inadequate inventory data recording. Excel spreadsheet (Figure 6) replaced the manual recording of finished goods in hardcopy despatch note. The spreadsheet contains the information of products, lot numbers, quantities, net weights, production date, and location. The spreadsheet search function aids storekeeper to identify product lot location.

![Excel Spreadsheet of finished goods despatch note](image)

**Figure 6.** Excel Spreadsheet of finished goods despatch note
3.4 Check phase

3.4.1 On job training. On-job training (OJT) was introduced to the finished goods store personnel. It was done when the project manager accompanied the store personnel to carry out the improvement activities. Any concern raised during implementation and training would be resolved immediately if possible. This motivated store personnel and built trust, and hence provided the impetus for future improvement.

3.5 Act phase

After implementing the countermeasures, the time spent for shipment preparation reduced to 1.83 hours per wooden crate. Also, activities were reduced to eight from the previous twelve. Data entry process was shrunk to 2 hours. No further modification is required, as the system has been running smoothly as designed over the next two months.

| PROCESS FLOW CHART | ANALYST | PAGE |
|--------------------|---------|------|
| Shipment Preparation process flow chart | KY Liew | 1 of 1 |

Details of method

1) Retrieve data from the Excel finished goods despatch note and generate shipment traceability form with lot number, number of cartons and quantity (kpcs) based on shipment advice request.  

2) Look for physical cartons of product in the identified storage location.

3) Gether the relevant cartons of product and place it on the wooden plate.

4) Transfer the wooden pallet of cartons in front the wooden crate.

5) Fill the cartons of product into the wooden crate.

6) Close the wooden crate (Nail gun) while completed fill in process and stick identification label.

7) Transfer the wooden crate to the awaiting shipment area.

8) Waiting for shipment.

Figure 7. Future state shipment preparation process flow chart

4.0 Conclusion and future work

Through the project, the shipment preparation process was significantly improved by using the developed framework. This provided sufficient time for storekeeper to carry out stock-taking daily. The workload of the store clerk was also streamlined by the removal of the work redundancy in recording. PDCA ensures systematic running of the project. Two primary tools deployed in the framework are 5S and visual management. Evidently, 5S allows system inefficiencies to be categorized and addressed separately. As the shipment preparation process is manual, the installation of visual management provides instant vital information in task execution. This also stabilises the process when the variability was reduced. The framework also promotes human touch and team spirit as problem solving was
demonstrated as a shared effort. The future improvement of task is using barcode system to manage the flow of the product lots in the finished goods store.

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