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# Kanban Supplier System as a Standardization Method and WIP Reduction

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## Abstract

A kanban production planning system is presented for a company which makes temperature control products for trailers and other types of transportation. A Kanban supplier system was established to control the quantity of raw material. Its production process is composed of thermoforming, routing and gluing. This tool will be used to make negotiations with the supplier in order of incorporate the scrap percent into the daily demand looking for a standardization size of the raw material. The sanitation system will help for work-in-process reduction.

## Keywords
Thermoforming, Kanban supplier system, Lead time, Just-in-Time.

## 1. Introduction

This study takes place in a Puerto Rican Company, this company makes temperature control products for trailers and other types of transportation. Each unit is composing by several parts that are produced at this company and then assembled in another plant. Plastic department was the scenario to developed this research with the mainly purpose of establish a Kanban supplier system to control the quantity of raw material. This department is in charge of produces the externals part of each final unit and its production process is composed by three steps: thermoforming, routing and gluing. Kanban system will be the tool to work out with the scrap problem from the beginning to the end of the process. This tool will be used to make negotiations with the supplier in order of incorporate the scrap percent into the daily demand looking for a standarization size of the raw material. There are two variables the company wants to control: the number of size of sheet per skid and the lead time. Controlling this variables the scrap will be quantified as part of the daily demand allowing to have control about what is made, how much is made and when is made in order of have on time delivery, high quality and customer satisfaction.

PRCompany is manufacturing industry that produces most of the parts that are going to form part of the finished product. Also this company sub-contracts some of the parts like are the top covers of the unit. This Company manufactures transport temperature controls system for a variety of mobile applications, including trailers, truck, buses, shipboard containers and railway cars. This paper takes as a base one of the most critical departments at this industry, The Focus Factory of Plastic. This department starts its process acquiring the raw material from Xsupplier. This supplier has its headquarter in the country of United States, this localization is the main problem to deal with the lead time, because most of the time the replenishment of the raw material at the company is inconsistent and the deliver is in big quantities. These two factors make harder the control of the production and these are the principal causes of the high volume of the work-in-process, keeping inventory until three days of production per part number.

Just-in-time (JIT) system comes as a tool to deal with this situation. It is an inventory strategy implemented to improve the return on investment of a business by reducing in-process inventory and its associated costs. The process is driven by a series of signals, or Kanban that tell production processes to make the next part. JIT can lead to dramatic improvements in a manufacturing organization's return on investment, quality, and efficiency when implemented correctly [1]. Kanban is a concept related to the lean manufacturing or JIT production, but these two concepts are not the same thing. Lean manufacturing works with the waste in the process, meanwhile, JIT works with makes right things in a right way in a timely manner [2]. The company started a change process to become lean company since 2003 and Kanban system is the tool as well as many others lean techniques for example: 5'S and (ACP) Accelerated Change Process. The supplier Kanban system is the first system made between this two parties the company and the supplier. The objective of a supplier Kanban system is to reduce lead-time of waiting for material to control the work-in-process inventory. This system will allow the communication between the interested parties and helps both parties to control their demands and inventories. The signal will be through bar code which allows the supplier to know how much inventory is left in the company facility. The traditional manufacturing resource planning model is built around the concept of subassemblies and fabricated components that are produced using lot-size techniques, with raw materials kept stocked in quantities sufficient to assure that inventory is not depleted. In a significant departure from this traditional model, American software (Atlanta, Georgia) has introduced the first midrange-computer-based flow manufacturing software - incorporating a production model that combines elements of just-in-time, Kanban, and traditional planning, to create a pull manufacturing system [3]. Constant material replenishment in small lots is done by means of requisition and production cards called kanbans. According to Steve Carlton, vice president of midrange marketing, the new system is ideal for companies that have problems of mixed-model scheduling and high-volume production: process industry companies, but especially those having some degree of discreteness in regard to their end product-food or consumer-goods industries [3].

Moreover, today the Kanban implementation is everywhere. Most of the companies all around the world have their own teams to assure a secure developing of this concept. There are many forms how to make that this system can be successfully implemented. Simulation has come to be part of this world. The University of Maryland made a research taking in consideration this theme. The principal focus was describe multiple ways to model pull production control and compares them on measures related to model construction and execution for workstations. The results demonstrated that the Kanban workstation reduced user effort. Based on the number of inputs required, a user building a simulation model with this tool should be able to complete initial construction in less than half the time he or she would have required when using conventional means [2]. A similar investigation is done with the main purpose of perform a simulation modeling and control of serial Kanban and CONWIP (Constant Work In Process) pull systems using Arena/Siman as well having a great success. The major advantages of implementing a pull system include reduced cycle time variability, and economic flexibility to make engineering and design changes [4]. While kanban systems maintain tighter control of system WIP through the individual card resources at each workstation, CONWIP systems are easier to implement and adjust, since only one set of system cards is used to manage system WIP. Therefore, simulation can then play a larger role and provide better support for decision makers, which will improve the outcome of many projects [4]. Marek et al. presents simulation modeling and control of serial kanban and CONWIP pull systems [5]. Card level estimation and a heuristic method to adjust card levels controlling system WIP are provided. There is a significant relationship between the design parameters, such as the number of kanbans and kanban sizes, and the scheduling decisions in a multi-item, multi-stage, multi-horizon kanban system [6]. Zhang et al. presented intelligent kanban based on benchmarking [7]. Simulation combined with a genetic algorithm is used for kanban optimization [8]. A decomposition-based approximation method is proposed to generate fairly accurate estimates for steady-state performance measures of a kanban-controlled production system [9]. Lee and Lee analyze different Push-Pull strategies of the re-entrant process [10]. A two-card dynamic kanban system is designed for better performance using a simulated annealing [11].

## 2. Kanban Supplier System

Objectives of this Kanban supplier system are to minimize raw material inventory and scrap during the process, minimize the total lead- time, quantity Standardization of sheet per skid and reduce work-in-process inventory. Data collection was the most critical part. The first step was collecting the demand per part number, once the demands were acquired the second part was to calculate an average of those demands. Table 1 shows the demands. After the demands were collected the second step was calculate the percent of scrap per part number regarding a scarp data base that the department has in order of control the information and keep an updated information to make a control plan to deal with the situation. The following formula was used to determine the number of scrap: Scrap Factor = Number of sheet rejected / Total sheet produced. With the scrap factor calculated the third step was to add this percent to the average daily demand using the following formula: Total Daily Demand = {(Average Demand × Scrap Factor) + Average Demand}. Basically, with the addition of the percentage of scrap to the daily demand each part number increased the demand's quantity. These changes can be seen well in the table 2 shown below. Figure 1 presents this data before and after the scrap factor calculation.

Table 1: Average demand

| Part Number | Daily Demand (Skids) |
|---|---|
| 1 | 25 |
| 2 | 19 |
| 3 | 48 |
| 4 | 11 |
| 5 | 104 |
| 6 | 112 |
| 7 | 110 |
| 8 | 9 |
| 9 | 46 |
| 10 | 102 |
| 11 | 60 |
| 12 | 59 |
| 13 | 55 |
| 14 | 55 |
| 15 | 100 |

Table 2: Average daily demand plus scrap factor

| Part Number | Daily Demand (Skids) | Scrap Factor | Average Daily Demand (Skids) |
|---|---|---|---|
| 1 | 25 | 0.031 | 26 |
| 2 | 19 | 0.015 | 20 |
| 3 | 48 | 0.146 | 56 |
| 4 | 11 | 0.085 | 12 |
| 5 | 104 | 0.074 | 112 |
| 6 | 112 | 0.134 | 128 |
| 7 | 110 | 0.257 | 139 |
| 8 | 9 | 0.088 | 10 |
| 9 | 46 | 0.040 | 48 |
| 10 | 102 | 0.046 | 107 |
| 11 | 60 | 0.049 | 63 |
| 12 | 59 | 0.046 | 62 |
| 13 | 55 | 0.043 | 58 |
| 14 | 55 | 0.150 | 64 |
| 15 | 100 | 0.069 | 107 |

For many companies to have scrap in their processes is a big problem. This big problem means losses in the capital, reducing the productivity performance and the profits earnings. To attack these problems the companies today are taking different ways how to reduce the amount of scarp. For example, PRCompany is seeking the way to incorporate the employees in this project. They are the owners of their processes and have to respond for what is right or wrong while they are leading their jobs at the department. The inspection is deeper and the acceptance range when the units go through the floor is critical. With this new vision implemented and with the idea that everyone has to work in order to improve this problem, the company is making the difference. Implementing these changes the department has have an important achievements. The scrap is less than the past years but it is still an important factor to take in consideration to keep everybody working with the vision to reduce it as much as possible. The capital losses per month during 2006 at the company can be seen in the graph 2. The month of August represented the best savings for the company. Because others factors comes and are hard to deal with it the losses during the August to November has have different variations but have been the best months keeping losses in the average below the losses in the beginning of the year. Incorporated this percentage of scrap into the average daily demand, the scrap is not going to be eliminated, but this strategies will help to control what and how much inventory is at the floor allowing reduction in the work-in-process and better pacification in the production schedule.

To develop this calculations the average daily demand plus the scrap factor were used. The company wanted to add this scrap factor in order of buy the skids of plastic per number of sheets and not per pounds as currently they do. Doing it in this way the company is expecting reduce the excess of work -in -process inventory and make the WIP inventory more controllable. To calculate the number of Kanban per part number was needed to collect safety time and container size plus the average demand collected before. The safety time calculation was done taking in consideration the production time at Plastic Department which is twenty days a month, therefore, the management decided to have a safety time of five days.

$$Safety \quad Time = \frac{days \quad of \quad production}{total \quad days \quad of \quad production}$$

**Container Size Standardization**

The container size standardization was the key to make the Kanban quantities standard. The container size quantity chose was exactly the average demand plus the scrap factor calculated before. In the table 3 shown below the part numbers colored in blue were the exception, because its average demand were too low an arrangement was made. Those demands were multiply by five days of production to make the sheet/skid enough for weeks or days at the floor. To calculate the Kanban numbers was used the following formula:

$$Number \quad of \quad Kanban \quad = \frac{(Demand \quad \times Lead \quad Time) \quad (1 + Safety \quad Time)}{Container \quad Size}$$

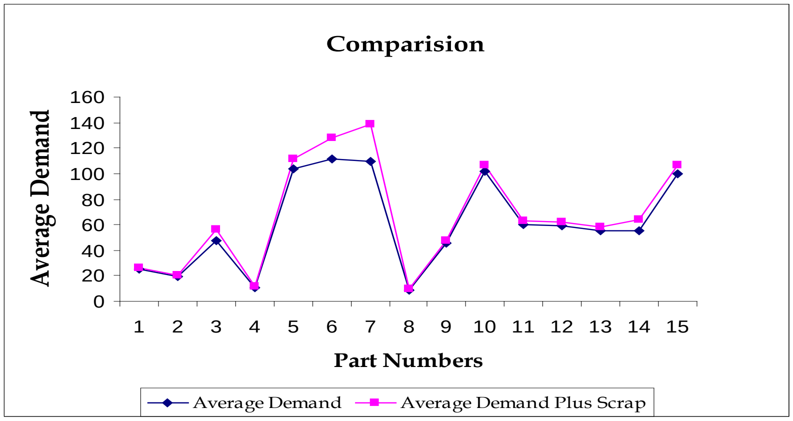


Figure 1: Average daily demand comparison

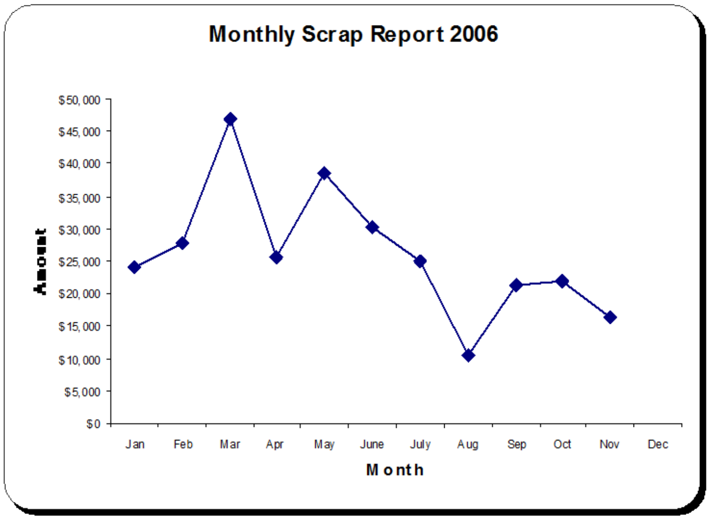


Figure 2: Scrap factor cost

Table 3 shows kanban calculation and container size duration. The agreement made with the Xsupplier at the PRCompany installations achieved one of the main objectives; reduce the total lead time from eight weeks to six weeks. This was possible because of the kanban proposal presented to Xsupplier managers. They were convinced about the kanban proposal and the standarization of skids per part number which is shown in Table 4.

## 3. Stocking Program / Kanban Proposal

The points cited in the following proposal were made by the Xsupplier. PRCompany is studying and consulting the proposal to make the agreement a soon as possible. Xsupplier agrees to inventory "custom extruded finished product" according to PRCompny part specifications. Agreed quantities of each part number will be available for immediate shipment each Monday. The stocking/kanban inventory will be equal to a one week supply of product by part number and will be based on current forecasted production requirements at the PRCompany (currently 100 units per day, 5 day production week). PRCompany agrees to purchase all custom produced inventory "stocked" for this kanban program within forty-five (45) days of sheet production. Xsupplier will notify PRCompany of those items that remain in inventory beyond forty-five (45) days prior to invoicing PRComapny under the established terms and conditions. PRCompany and Xsupplier will jointly re-evaluate required quantities and adjust stocking / kanban inventories at a minimum of every ninety (90) days. In the event of a change in material formulation, part design or any other cause for a change in demand requirements, PRCompny and Xsupplier jointly agree to utilize all finished product in stocking program along with existing raw materials specific to these products, prior to converting to new material specifications or part design. Xsupplier will ship by release (PO Issued by PRCompany) using existing freight arrangements outlined in Supply Agreement, via dedicated motor carrier or LTL to APL – Jacksonville, Florida or loaded directly into "shipping containers" as available. Implementation of this stocking program is contingent upon a Supply Agreement in place between PRCompny and Xsupplier. This document will become an attachment within the Supply Agreement.

Table 3: Kanban Identification

| Part Number | Daily Demand (Skids) | Lead time (days) | Lead time (weeks) | Safety Time | Container Size (Sheet/Skid) | Kanban Calculation | Kanban rounded | Container size duration |
|---|---|---|---|---|---|---|---|---|
| 1 | 26 | 25 | 5 | 0.25 | 130 | 6.25 | 7 | 1 week |
| 2 | 20 | 25 | 5 | 0.25 | 100 | 6.25 | 7 | 1 week |
| 3 | 56 | 25 | 5 | 0.25 | 112 | 15.63 | 16 | 2 days |
| 4 | 12 | 25 | 5 | 0.25 | 120 | 3.13 | 4 | 2 weeks |
| 5 | 112 | 25 | 5 | 0.25 | 112 | 31.25 | 32 | 1 day |
| 6 | 128 | 25 | 5 | 0.25 | 128 | 31.25 | 32 | 1 day |
| 7 | 139 | 25 | 5 | 0.25 | 139 | 31.25 | 32 | 1 day |
| 8 | 10 | 25 | 5 | 0.25 | 150 | 2.08 | 3 | 3 weeks |
| 9 | 48 | 25 | 5 | 0.25 | 144 | 10.42 | 11 | 3 days |
| 10 | 107 | 25 | 5 | 0.25 | 107 | 31.25 | 32 | 1 day |
| 11 | 63 | 25 | 5 | 0.25 | 63 | 31.25 | 32 | 1 day |
| 12 | 62 | 25 | 5 | 0.25 | 62 | 31.25 | 32 | 1 day |
| 13 | 58 | 25 | 5 | 0.25 | 58 | 31.25 | 32 | 1 day |
| 14 | 64 | 25 | 5 | 0.25 | 64 | 31.25 | 32 | 1 day |
| 15 | 107 | 25 | 5 | 0.25 | 107 | 31.25 | 32 | 1 day |

## 4. Conclusions

Implement a kanban system with Xsupplier represent a lot of benefits for PRCompany because the kanban system will reduce wastes in the process, minimize inventory, reduce the lead time and will decrease capital losses. Also the re-localization of the kanban area to a building that is closer to the Plastic Department reduces the time of pull material from the stoking area. The signal for the kanban system is not already defined but exist a higher probability that PRCompany use a scanning method to send the kanban signal to the supplier when the skid will be removed from the stock area. To obtain a successfully implementation of the kanban program with Xsupplier, PRCompany has to analyze the agreement that the supplier offered before according a final agreement with them. The skid of every raw material has to be pack out per number of skid and not by pound. This changes as was mentioned before will help to keep low work-in-process inventory as well as the raw material inventory.

Table 4: Kanban Proposal

| Part Number | Daily Demand (Skids) | Lead time (days) | Lead time (weeks) | Safety Time | Container Size (Sheet/Skid) | Kanban Calculation | Kanban rounded | Container size duration | A<br>Skids | B<br>Skids | C<br>Skids |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26 | 25 | 5 | 0.25 | 130 | 6.25 | 7 | 1 week | 3 | 1 | 1 |
| 2 | 20 | 25 | 5 | 0.25 | 100 | 6.25 | 7 | 1 week | 3 | 1 | 1 |
| 3 | 56 | 25 | 5 | 0.25 | 112 | 15.63 | 16 | 2 days | 6 | 2 | 3 |
| 4 | 12 | 25 | 5 | 0.25 | 120 | 3.13 | 4 | 2 weeks | 2 | 0 | 1 |
| 5 | 112 | 25 | 5 | 0.25 | 112 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 6 | 128 | 25 | 5 | 0.25 | 128 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 7 | 139 | 25 | 5 | 0.25 | 139 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 8 | 10 | 25 | 5 | 0.25 | 150 | 2.08 | 3 | 3 weeks | 1 | 0 | 1 |
| 9 | 48 | 25 | 5 | 0.25 | 144 | 10.42 | 11 | 3 days | 4 | 1 | 2 |
| 10 | 107 | 25 | 5 | 0.25 | 107 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 11 | 63 | 25 | 5 | 0.25 | 63 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 12 | 62 | 25 | 5 | 0.25 | 62 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 13 | 58 | 25 | 5 | 0.25 | 58 | 31.25 | 32 | 1 day | 13 | 4 | 5 |
| 14 | 64 | 25 | 5 | 0.25 | 64 | 31.25 | 32 | 1 day | 13 | 4 | 5 |

A = Max Inventory PRCompny
B = Maximum Inventory in transit
C = Maximum Inventory in Xsupplier facility

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