Continuous Improvement in a Warehouse of Short Bark Industries

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Abstract *— In the company Short Bark Industries is manufacturing military clothing and accessories. This company has a problem in the organization and excess inventory in the warehouse. For this they need to implement two Lean methodologies to improve performance of the warehouse. The 5S methodology helps reduce the waste of the warehouse and improve its organization. Through an elaborate diagram is explained as 5S optimization helps the warehouse. Also implemented Kanban methodology where help establish better communication between the warehouse with a production line to avoid overproduction. With the help of these methods can be implemented Lean other methods to increase production which is the goal of the company and save money with the stated issues.*

Key Terms *— Kanban, Lean, Warehouse, 5S.*

INTRODUCTION

The manufacturing industry has grown to large scale. This is the reason for industries tend to be more competitive and aggressive at the time to satisfy the customer. Today there are models such as "Lean Manufacturing" that are focused on creating flow to deliver maximum value to customers, using the minimum necessary resources. Creating flow focuses on the reduction of the eight types of "waste" manufactured goods: overproduction, waiting time, transportation, over processing, inventory, motion, defects and underutilized human potential. All these are achieved by eliminating waste, improving quality and reducing production time and cost. This project shows how a warehouse operation can be improved using lean concepts and techniques.

Warehouse improvement requires optimizing material flow, order picking, replenishment, and dock operations. Although many traditional lean techniques maybe difficult to apply, the concepts of improving material flow and eliminating waste can be used to make significant improvement in warehouse lead time.[1]

Short Bank Industries provides clothing and military equipment that meets or exceed customer's expectation. This is a textile company in which all parts are assembly to produce military uniform. Like any other industries they have a warehouse in which receive from the suppliers all different kind of textiles. There is person in the warehouse who is in charge of cut all the textiles with the corresponding measures. They need about 1,200 pieces of textiles to make a bullet proof vest. The problem is that in the warehouse the inventory in stock isn't arranged correctly and also machines not in use. This problem is very important to be resolved, because the company needs more space, organization and in couple of days they will increase the production of the company.

CONTINUOUS IMPROVEMENT THEORY

Creating a lean warehouse (or distribution center) is not something that can be accomplished overnight. It takes vision, planning, strategy, tools and tactics. Relative to people is necessary to need develop team members into problem solvers and then provide a leadership infrastructure to support their efforts. Identifying and solving problems may seem basic; however experience would suggest it can prove elusive in application. The results achieved through your lean efforts can be quantum in nature. Improved customer fill rates, decreased inventory levels, decreased inventory carrying costs, improved inventory accuracy, increased asset and team member utilization are all benefits of lean warehousing. [2]

A warehouse operation can be improved using lean concepts and techniques. Warehouse improvement requires optimizing material flow, order picking, replenishment, and dock operations. Although many traditional lean techniques maybe difficult to apply, the concepts of improving material flow and eliminating waste can be used to make significant improvement in warehouse lead time. Many lean practitioners consider the term warehouse and lean to be mutually exclusive. However, regardless of how fast inventory is turned, warehouses will always exist to allow a company to deal with variations in customer demand. The key is to reduce the non-value added steps in the warehouse as much as possible and to improve velocity and flow. Implementing a lean warehouse starts with value stream mapping. After the current state value stream map is created, improvements can be easily develop d to eliminate extra material handling, excessive travel time, and time spent looking for products. Various lean improvement techniques such as material flow analysis, quality improvement, and application of the 5S's can be used. A warehouse improvement example is presented to show how warehouse lead time, order picking time, and material handling can be reduced by 50% using lean concepts. [2]

Over the past few years the production areas have been upgraded without a corresponding enhancement of the warehousing activities. Companies are now experiencing problems with the warehouse and distribution areas keeping pace with the product as it is received from the various processing areas. Space utilization, material handling, and data collection are just some of the challenges that arise. There has been a trend of increased labor to support the warehousing requirements.

METHODOLOGY

Continuous improvement (Kaizen) can be used to eliminate or reduce all the unnecessary inventory, equipment, and tools from the workplace. A method called "5S" or Visual Management can perform this cleanup activity at the workplace. A neat and clean factory has higher productivity probability and is a safer place to work in Visual Management is divided in five (5S) areas these are: [3]

- Sort (Seiri)
- Set in Order (Seiton)
- Shine (Seiso)
- Standardize (Seiketsu)
- Sustain (Shitsuke)

In Figure 1 is a typical 5S methodology that act like a cycle of continuous improvement

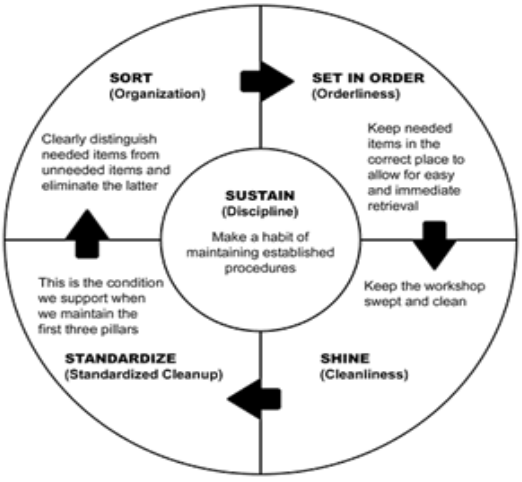

Figure 1
5S Methodology Steps

Sort

All items from the workplace that are not needed for the current production or clerical operations should be removed. The Red-Tag strategy is a simple method for identifying unneeded items, evaluate their usefulness, and deal with them appropriately. In Figure 2 is a typical red tag which helps identify unused items. These items are to be discarded in a local red tag area for removal. [4]

Steps to Sort are:

- A team that includes people from other areas will perform the red-tag analysis in one or two days.
- Typical Red-Tag questions:
  - Is this item needed?

- If it is needed, is it needed in this quantity?
- If it is needed, does it need to be located here?

- All the results must be documented

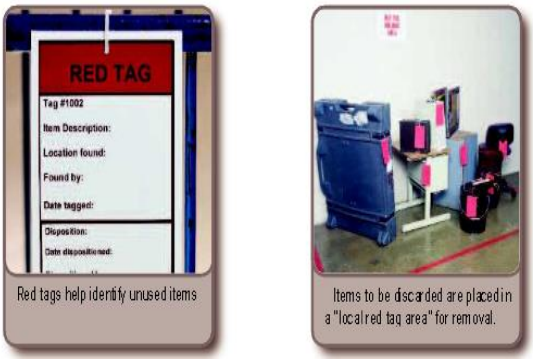

Figure 2
Typical Sort Procedure

Set in Order

Arranging needed items so that they are easy to use and labeling them so that they are easy to find and put away. It eliminates waste like searching, walking, human energy, excess inventory, and unsafe conditions. Visual controls are used to communicate information such as where items belong. In Figure 3 is a tool board in which identifies each item and in the other picture is max/min stocking levels for inventory. [4]

Figure 3
A typical set in order

Steps to Set in Order are:

- All principles must be learned to decide the best location for tools, parts, equipment, and machinery.
- Things must be located in the workplace according to their frequency of use.
- The next step is to store items together if they are used together and in the sequence they are used.
- The crew should device a "just let go" arrangement of tools.
- The crew should storage places larger than the items stored.
- The crew first must identify the best location so that everyone knows what goes where, and how many.
- The crew must develop signboard strategy to identify what, where, and how many.
- The crew must use painting strategy to identify locations on floors and walkways.
- The crew must use color coding strategy to identify which parts and tools are used.
- The crew must use outlining strategy to show which tools are stored where.

Shine

Shine means that everything must be swept and clean. The purpose is to keep everything in top condition so that when someone needs to use something, it is ready to be used It is not only sweeping floors and wiping off machinery, cleaning also means inspection. In Figure 4 is a typical shine environment. [4]

Figure 4
A Typical Shine Environment

Steps to Shine are:

- The crew must plan a shine campaign.
- Next must be chosen targets, perform five minutes shine.
- Incorporation of systematic inspection procedures to the shine procedures.

- Assignment of cleanliness and inspection jobs, determine methods, correct equipment problems (instant maintenance or requested maintenance).

Standardize

Is not an activity, is the method use to maintain the first 3S – sort, set in order, and shine. If we do not standardize conditions go back to their old undesirable levels. The purpose is to prevent setbacks in the first 3S, to make them a daily habit, and to maintain them fully implemented. In Figure 5 is a rotation schedule in which assign activities to each member. [4]

	Activity	Responsibility
1	Sweep the entire area at the end of the shift	See Rotation
2	Put away any material that was removed from its assigned storage location	Kevin
3	Take empty pallets out of the area and store in an appropriate location.	Team
4	Empty garbage's as needed at the end of every shift	See Rotation
5	Restock materials from overflow area when space permits	Kevin
6	Move full pallets to designated areas away from shipping dock	Team

Rotation Schedule	Sweeping		Garbage Removal	
	Day Shift	Night Shift	Day Shift	Night Shift
Monday	Diego	Luis	Rudy	Norbert
Tuesday	Lando	Norbert	Kevin	Luis
Wednesday	Edwin	Curtis	Rick	Curtis
Thursday	Rick	Luis	Diego	Norbert
Friday	Ron	Norbert	Lando	Luis

Figure 5
A Typical Standardize Rotation Schedule

Steps to Standardize are:

- Assignment of 3S responsibilities everyone must know their responsibilities and when, where, and how to do it.
- Integration 3S duties into regular work duties visual 5S (everyone should distinguish between abnormal and normal conditions).
- Crew must check on 3S maintenance level using checklists.
- Crew must see Signboard and Checklist.

Sustain

All personnel must make a habit of properly maintaining correct procedures. Without commitment to sustain the benefits of 5S activities quickly falls apart. If the rewards of 5S activities are greater than departing from it, sustain should be something you do naturally. In Figure 6 is a typical score sheet for rewards for the 5S activities. [4]

5S Housekeeping Score Sheet Site Location
Audited: Tech Support - Good Hope Facility Date:_____
Auditor:_____

	NA	0	1	2	3	4	Description of Area
Sort							
1							No old or unnecessary materials in area.
2							Empty/unused ribbons/materials are out of the area.
3							Free of unnecessary equipment, furniture and personal items.
Set in Order							
4							Printers, batteries and adapters are properly identified and stored in designated area.
5							Portable and benchtop printer cabinets are clean and organized.
6							Movable printer carts are in proper location.
7							Inventory neat, organized and identified.
Shine							
8							Tops of machines, cabinets free of dust and debris.
9							Floors are clean around the work area.
10							Benchtop stands are organized and free of unnecessary items.
11							Work station neat, clean and organized.
Standard							
12							Damaged or non-functional printers / equipment is removed from the area or marked for replacement.
13							Electrical Panel area unobstructed.
14							Furniture /chairs/desks are in good condition and clean.
Sub Total		0	0	0	0	0	0

Figure 6
5S Score Sheet

Steps to Sustain

- Creating conditions to sustain plans awareness, time to do it, structure, support, and reward and recognition.
- Roles in the implementation.
- Management – educate, create teams, allow time, provide resources, and encourage involvement.
- Employees – learn, educate other coworkers, are enthusiastic, and promote.

Applying 5S in the Warehouse Step by Step

1. **Sort**: A team that includes people from other areas will perform the red-tag analysis in one or two days. Typical Red-Tag questions: Is this item needed? If it is needed, is it needed in this quantity? If it is needed, does it need to be located here? In the case of Short Bark Industries as is observed in the warehouse there are machinery in which is not in use and it should be eliminate because occupy a lot of space. In terms of the quantity of inventory this factory has two warehouses where one has the total factory inventory which receives directly from the supplier. The second warehouse which is the one improving; it receives from

the other warehouse. In this one they make the cuts that are made daily to fabric's production. The question is whether they shave all things really well located. After conducting the study documented.

2. **Set in Order:** First you have to decide the best location of tools, parts, equipment and machinery. Try to locating it in the work area according to the frequency of use. In this case there are machines that are being used that can be accommodated in a place that doesn't bother. There are also some in which are located in a place out of reach. The next step is to keep things together if they are used together or sequentially. Always identify the best location for everyone to know where things are and how much there is of them. Use signboard strategy to identify what, where and how much there is. In this case you can implement this with the tools and inventory already cut. They are 5 lots of 240 pieces in where they should be properly labeled with a different color for each lot with the corresponding information in each box.
3. **Shine:** This step keeps the area clean in order to keep it all in an optimal condition for when you need something, be ready to use. In the warehouse where it is working they should be given high priority to the cleaning and maintenance of the machinery frequently. It is observed that is not being given proper maintenance to the machinery that is used daily. This is vital because the daily production depends on them. They should give daily inspection and cleaning before use. Another thing to consider is that the manual of each machine must be with her always if a problem occurs with them. For the shine method they should make a cleaning schedule where every day is clean the area for 5 minutes.
4. **Standardize:** Assign responsibilities 3S everyone should know their responsibilities when, where and how to do it. Integrate 3S tasks in regular work. Everyone should know when a situation is normal and abnormal. Always follow the checklist of daily duties 3S.
5. **Sustain:** Creating conditions to sustain your plans – awareness, time to do it, structure, support, and reward and recognition.

Kanban Methodology

The definition according Jean-Baptiste Waldner in the book *Principles of Computer-Integrated Manufacturing "*Kabans maintain inventory levels; a signal is sent to produce and deliver a new shipment as material is consumed. These signals are tracked through the replenishment cycle and bring extraordinary visibility to suppliers and buyers". [5]

Why Kanban?

According to the book *Kabban Made Simple*, Kanban serves two functions for a company: to help control production and to help improve processes. To help control production, Kanban ties different manufacturing processes together, ensuring that the necessary amounts of material and parts arrive at the appropriate time and place. This guarantees that only the required amounts of parts are being used and there is no excess inventory in process. To help processes, Kanban improves operations that are being used in production by emphasizing reduction in inventory costs. A company is able to benefit from using Kanban in numerous ways. By implementing Kanban, a company is able to reduce their inventory a level to only what is needed for each process; this helps lower inventory costs dramatically. Kanban cards also create a visual schedule for production. They state how many parts should be created and when they must be created by. This allows a company to put more emphasis on the orders that are due in the near future, such as a couple days, versus the orders that are due in a couple weeks. The productivity of a company can increase by implementing the Kanban system. This is due to Kanban freeing people up from being overwhelmed with work. Since an operator cannot start producing parts until a Kanban card is received, the employee

is free to work on other tasks or duties until he or she receives a card. If operators are doing more than just producing their required parts, more work is being done which in turn helps to increase productivity levels for the company. If productivity increases, it is only natural that lead times will also be reduced, which will help a company establish better relationships with their customers. [6]

In the case of the factory must implement this ideology and you have inventory problems. It must implement a physical and digital system in which post the material available from the warehouse and production. You must set a parameter to identify when a material is in the red zone in different warehouse and production. In Figure 7 is a typical Kanban logistic control system implemented by Toyota in 1953.

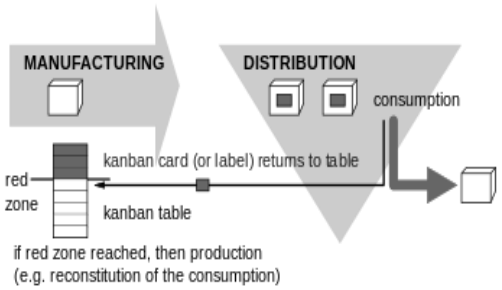

Figure 7
Kanban Logistic Control System

According the book "Getting Started with Kanban" by Paul Klipp there are three basic rules to implementing Kanban:

- Visualize Workflow –Is a visual representation of the process in which lets you see exactly how tasks change from being "not done" to "done right". The more complex a process is, the more useful and important creating a visual workflow becomes.
- Limit Work in Process (WIP) - Get more done by doing less. This is a powerful idea that has been proven time and time again to be true. There is a limit to the number of things you can be working on and still do them well, and that limit is often lower than you think. Whether a project is simple or complex or whether the team is small or large, there is an optimal amount of work that can be in the process at one time without sacrificing efficiency Kanban metrics lets you find that optimal number.
- Measure and Improve Flow- Improvement should always be based on objective measurements, and kanban is no different. Finding and applying good metrics is usually a difficult step, but a few simple measures automatically generated by an application like Kanbanery can give you the information you need to tweak your process to optimize flow and maximize efficiency.

One of the great things about kanban is that you apply it to your existing process. This means that you won't lose the things you are already doing well. No sudden changes means there is minimal risk in applying kanban as part of your improvement journey. [7]

DISCUSSION OF RESULTS

With the implementation of these methodologies the warehouse will notice significant changes in which remove all waste possible. This helps to better organization and improve operational performance of the company. In the case of the 5S methodology is a cyclical methodology: sort, set in order, shine, standardize, and sustain the cycle. When implementing this methodology will reduce waste and optimize productivity through maintaining a tidy workplace and using visual cues to achieve more consistent operational results. The application of this method is to clean and organize the warehouse, essentially in its current configuration, and is typically the first Lean method is implemented. A typical 5S implementation would result in a significant reduction in the square footage of space needed for existing operations. It would also lead to the organization of the tools and materials on the label and storage locations color coded and "kits " containing what it takes to perform a task . 5S is the basis on which you may introduce other lean methods, such as TPM, cellular manufacturing, just-in- time production, and Six Sigma. In the case

of Short Bark Industry Company may benefit from the 5S in the structural sense of the warehouse. They have a very limited space in the warehouse and have many things classified as waste. Among the things that have as waste are machines that are not currently in use because they are damaged. If they remove these machines they will have more space. Another thing that they would benefit from this method would be the organization and cleanliness of the warehouse. Working in a clean environment enables workers to notice malfunctions in equipment such as leaking, vibration, breakage, and misalignments. These changes, if not corrected, can lead to equipment failure and loss of production. In the case of SBI they have a machine to make fabric cuts very vital to the daily production of the company and not being given the necessary maintenance. These machines are a bit old and maintaining them should be vital for optimal use of them. Implementing 5S method workers need to do daily inspection and cleaning machines and equipment. The most important step of the 5S method is the last one, sustain. Making a habit of properly maintaining, correct procedures is often the most difficult to implement and achieve 5S. Changing behaviors can be difficult, and the tendency is often to return to the status quo and the comfort zone of the "old way" of doing things. Sustain focuses on defining a new status quo and standard of work place organization. Without the pillar to maintain the achievements of the other pillars will not last long. In Figure 8 it sees how the ware house was before the implementation of the 5S methodology as see there was an excess of inventory and machines that aren't in use. In Figure 9 after the methodology were implemented the inventory decrease and the amount of waste was reduced. As they see in the Figure 9 now there is more space to maybe in a future increase the production of the company.

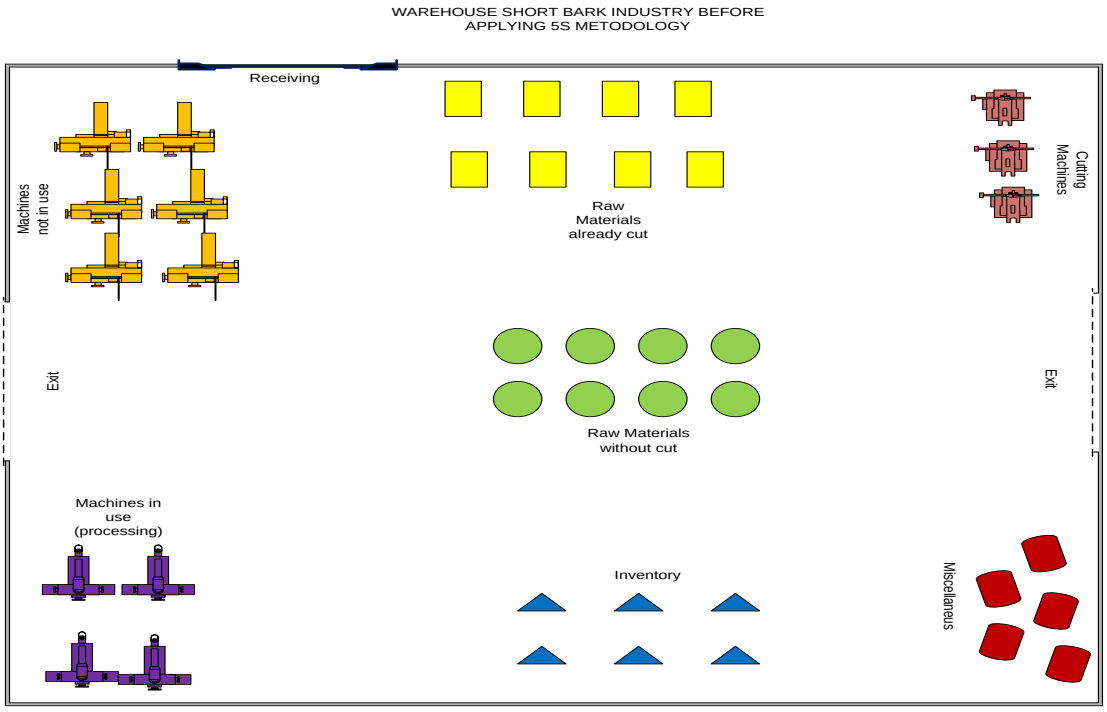

Figure 8
Warehouse before Applying 5S Methodology

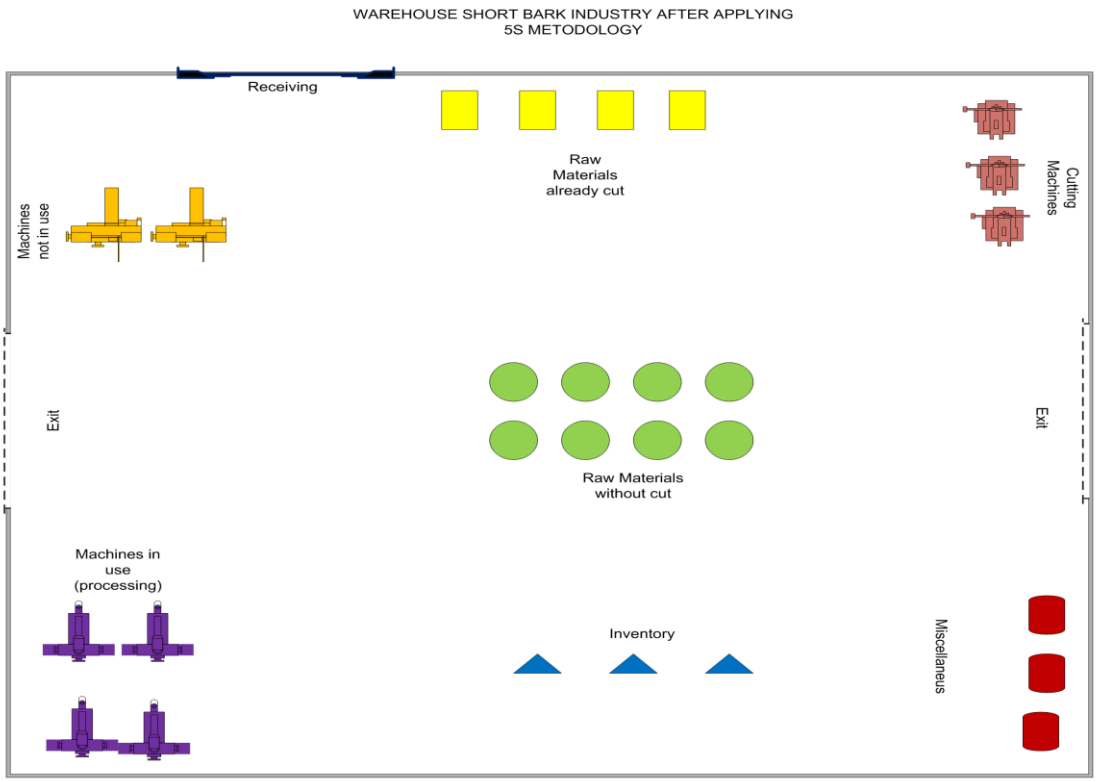

Figure 9
Warehouse after Applying 5S Methodology

The other method to be implemented in the company SBI is Kanban. If the company wants to apply Kanban will help to eliminate overproduction in which affects the environment of the warehouse in three ways. First increase the number of products that must be discarded as waste. The second increase in the amount of raw materials used in production. The last one would increase the amount of energy, emissions, and wastes (solid and hazardous) that are generated by the output processing unneeded. Kanban will benefit the Company SBI in reducing inventory that is a king of waste in the warehouse. This is a big problem that the factory suffers from overproduction. This is due to poor communication between the warehouses to the production line. Another thing that would benefit from Kanban is the amount of raw materials that they will economize. Company suffers from the loss of material in the production line. With Kanban card system this problem is easily avoided.

CONCLUSION/RECOMMENDATIONS

There are many small manufacturing companies are not yet familiar with Lean techniques. In the Short Bark Industries there were implemented two important techniques to improve the quality and efficiency of manufacturing processes. To achieve this they must familiarize or train employees on Lean techniques. The most important thing is that these techniques are needed to be implemented daily to create it as habit and not return to previous trends. For this they must create groups with different tasks for each person to know how, when and where to perform their responsibilities.

By implementing 5S methodology they should be taken into account that this is a cyclical methodology: sort, set in order, shine, standardize, and sustain the cycle. This results in continuous improvement. In the case of SBI should take into account the cleaning and maintenance of the store mainly in cutting machinery which is very vital for

daily production. They should also have these on spare machines to avoid stopping production so in case of troubleshooting. The cleanliness and organization is vital in the warehouse that encourages employees to do a better job and saves time having to search desired tools if they are not in order. The most important thing is 5S methodologies to carry out daily by a work plan due schedule.

Another recommendation is to implement Kanban methodology correctly. The company has communication problems between the warehouse with the production line. This is because the production complains that always send less raw material that it suppose. It must implement a Kanban card system where better communication between both sides. These processes also need to be documented in computers for evidence and avoid problems. Another thing is that the Kanban avoid overproduction improve inventory as it accumulates in the store and produce waste.

REFERENCES

[1] Catalano Ruriani, Deborah (September 2009). Getting Lean to Boost Warehouse Labor Performance.

[2] Cheng, T.C.E. and Podolsky, S. (1993). *Just-In-Time Manufacturing an Introduction*. London: Chapman & Hall

[3] Hirano, Hiroyuki. 5 Pillars of the Visual Workplace (Portland, Oregon: Productivity Press, 1995).

[4] Peterson, Jim, Roland Smith, Ph.D. *The 5S Pocket Guide* (Portland, Oregon: Productivity Press, 1998).

[5] Waldner, Jean-Baptiste (September, 1992). Principles of Computer-Integrated Manufacturing. London: John Wiley. pp. 128–132.

[6] Klipp, Paul (Jun 29, 2011). *Getting Started with Kanban* Holpp L.; Pande P. “What is Six Sigma?” New York, NY: McGraw-Hill 2002.

[7] Gross. John M. and Mclnnis, Kenneth R. (2003). Kanban Made Simple. New York: American Management Association.