Implementation of Lean Manufacturing through Supplier Kaizen Framework - A Case Study

Hazri M. Rusli and Ahmed Jaffar
Faculty of Mechanical Engineering
Universiti Teknologi Mara
Shah Alam, Selangor 40450, Malaysia

Suzilawati Muhamud-Kayat and Mohd Tarmizi Ali
Faculty of Electrical Engineering
Universiti Teknologi Mara
Shah Alam, Selangor 40450, Malaysia

Abstract

Lean manufacturing is a production philosophy derived from the Toyota Production System (TPS). It has the ultimate aim of reducing cost by thoroughly eliminating wastes. Lean manufacturing aims to improve productivity and creating continuous flow in the production and strive to create value in the every aspect of the production. This paper studies on the implementation a Lean Manufacturing project done at an automotive component company. The Lean project uses the Supplier Kaizen framework- steps and methodology to implement the lean manufacturing at a Malaysian components manufacturer through kaikaku and kaizen approach. This resulted in substantial improvements in quality, timely delivery and cost saving which in total improves the bottom line.

Keywords
Lean manufacturing, Kaikaku-kaizen, Supplier Kaizen framework

1. Introduction

Lean manufacturing is a manufacturing concept in which its ultimate goal is to achieve efficient production through comprehensive approach to minimize wastes or muda (Tapping et al. 2002). To put it into context, it literally means eliminating over production and excess inventory, eliminate wasteful movement of material and human motion, waiting and delays, the need for rework or corrections and wasteful process. In other words, strive to eliminate thoroughly the 7 wastes in production. Part of Lean Manufacturing is reviewing from time to time, operations for the processes or products that add cost rather than value (Womack and Jones 2003). Each step of the manufacturing process is monitored to determine if it adds value to the product. If it does not add value, continuous improvements or kaizen must be made.
In Malaysia, UMW Toyota Motor, a joint-venture company between Malaysian conglomerate UMW Holdings and Japanese auto giant Toyota Motor Corporation has been striving to implement Lean manufacturing in its business operations since 2007. The manufacturing concept is not only being implemented in the various operations of its manufacturing plant which is Assembly Services Sdn Bhd (ASSB), but also to its suppliers, companies which supplies automotive components and parts to be assembled in ASSB. ASSB has over 60 suppliers which supply localized components and parts for its locally assembled Toyota car models. Through many kaizen activities being done at various supplier companies, a Supplier Kaizen framework was derived which suits the environment and culture of Malaysian companies (Rusli et al. 2013). In this paper, the author verifies the Supplier Kaizen framework thru a real case study done at UA company, a major automotive component manufacturer for Malaysian automotive industry.

2. Methodology

2.1 Supplier Kaizen framework
The Supplier Kaizen framework is depicted in Figure 1 (Rusli et al. 2013). This study will use the Supplier Kaizen framework to perform the Lean transformation at UA company.

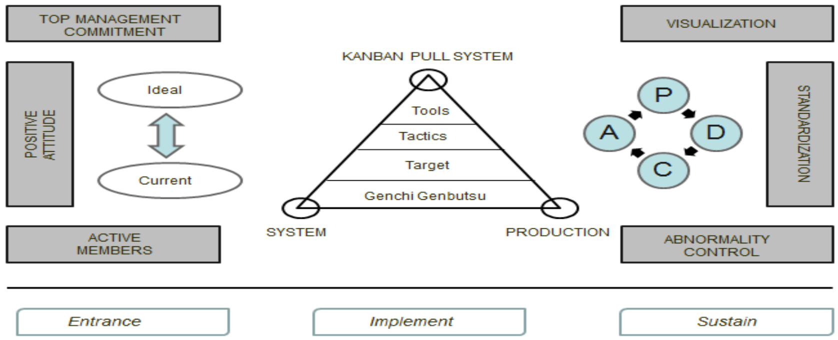

Figure 1: Supplier Kaizen framework

In the Supplier Kaizen framework, a series of steps to be taken in order to perform Lean activities, ultimately creating the Kanban Pull System is established (Rusli et al. 2013). The steps are shown in Figure 2.

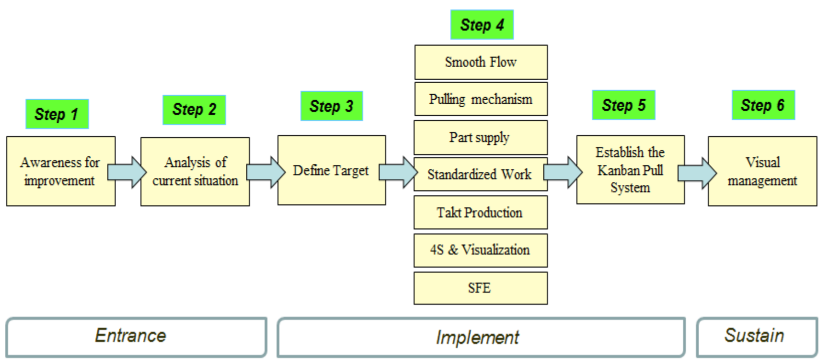

Figure 2: Supplier Kaizen steps

2.2 Kaikaku-Kaizen approach

Kaizen can be roughly translated as continuous incremental improvement and it is most suitable when applied tactically to a product line or to an entire organization that is relatively mature and stable. On the other hand, Kaikaku, which can be roughly translated as radical improvement is more of a holistic transformational process (Seeliger et al. 2007). The Supplier Kaizen approach is the combination of both Kaizen and Kaikaku approach where overall or holistic transformational changes must be done first, through the Kaikaku approach, throwing away old ways to adapt with the new and better ways, then stabilize it from time to time using the Kaizen approach. This approach requires a clear direction from the Top Management, good planning and implementation through synergizing the resources of the company. The Supplier Kaizen approach also emphasizes on creating a Kanban Pull System in order to realize the JIT production, in which profit realization can be achieve by cost reduction through lead time reduction concept (Rusli et al. 2013).

3. Case study at an automotive component industry

UA company is a wholly owned subsidiary of a Malaysian conglomerate, located at Shah Alam, Malaysia and consists of three plants which are Main plant, Stamping plant and Plastic plant. The manufacturing operations are divided into 2 main categories, the Plastic operations and Metal operations. For Plastic operations, the manufacturer produces Air Cleaner products which are the Air Cleaner modules, and Non Air Cleaner products such as charcoal canisters, cylinder head covers, fuel filters, brake reservoirs, and plate holders to be supplied to various auto manufacturer and vehicle assembler in Malaysia. This study was done at the company's production line with a focus on Air Cleaner products ranging from Raw Material incoming until Finish Good delivery. Main process at production floor for the Plastic operations are Plastic Injection Molding, comprises of plastic components and plastic air elements, Paper Pleating, Assembly and QC inspection. The Lean project follows the Supplier Kaizen framework and steps as a guide to implement the transformation.

3.1 STEP 1 – Awareness for improvement

Firstly, the 3 main issues prior to start the project is clarified which are the commitment of Top management, availability of active members and everyone's positive attitude towards the kaizen endeavor. Discussions on resources planning and scope area are done. UA company's Top Management is very much interested and committed to the Lean project and the management is willing to take the lead by becoming the Supplier Kaizen Head. A working kaizen team is created and the Production Manager is appointed as the Kaizen Leader. Key members from Production Department, Production Control Department and Quality Control Department are selected as the Kaizen members that will take on the challenges to do the Lean projects. The members are divided into System team and Production team. The management wants to install the Kanban Pull System in the production area and clarifies the Delivery area, Warehouse, Plastic Injection lines and Plastic Assembly lines as the scope area or the targeted Value Stream to be kaizen.

3.2 STEP 2 – Analysis of current situation

The second step in the framework is to analyze the current condition of the selected Value Stream from the System and Production point of view using the appropriate Lean tools. The list of Lean tools used by the System team and the Production team is shown in Table 1. The kaizen team members studied on the material flow and information flow along the Value Stream, the parts delivery method and timing to the customers, internal parts supply method within the Value Stream, process flow and process sequence as well as production issues regarding productivity. In other words, the kaizen members, using the appropriate Lean tools and techniques, studied thoroughly the Value Stream in terms of Man, Machine, Material and Method.

Table 1: Lean Tools & Techniques

PRODUCTION SYSTEM ANALYSIS TOOLS	PRODUCTION ANALYSIS TECHNIQUES		
	PROCESS ANALYSIS	TIME ANALYSIS	PRODUCTIVITY ANALYSIS
Material & Information Flow Chart	Product Process study	Takt time calculation	Operational Availability
Material Flow Chart	Operator process study	Cycle time study	Line Performance
Shipping Operation Table	Motion Study	Machine time study	Changeover study
Shipping Time Chart		Set up time study Yamazumi/ WBC	

The kaizen team members charted the current production condition using the Material & Information Flow Chart (MIFC) shown in Figure 3. From the MIFC, the problems related to the current production method is highlighted and regarded as kaizen points to be improved.

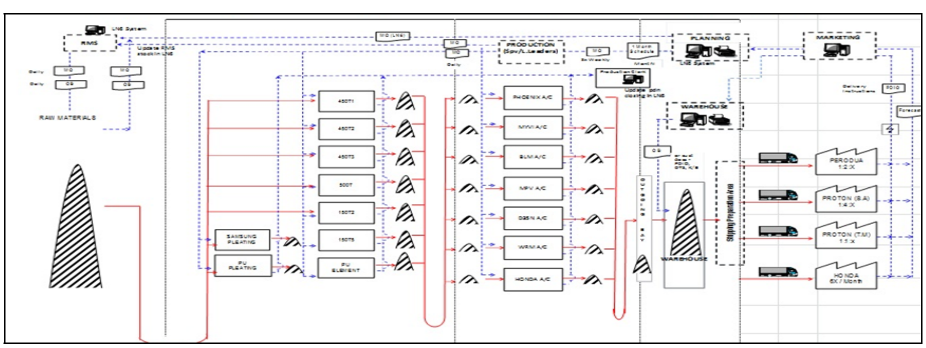

Figure 3: MIFC of current production condition

For the Delivery area and Warehouse, the following are the kaizen points grasped from the MIFC:

- Unclear shipping operation
- Poor stock visualization and storage control
- Excessive stock of Finish Goods stored
- Lack of FIFO Control
- Wrong parts delivered claims by customer
- Mixed part between customers’ Finish Good

For the Plastic Injection lines, it is found out that production are run and scheduled according to monthly forecast and scheduled planning. The production is not tied up with sales and customer requirement thus over production of some models and parts shortage of some models frequently happen. Moreover, by planning, it leads to high raw material and finish goods, high work-in-process (WIP) stock resulting in stagnation of parts flow. The production lead time becomes long and creates a lot of non-value added activities. The components are stored in wire mesh, as shown in Figure 4 as component supply. This leads to big production lot size of the models and creates too many WIP stocks. It also utilizes more space.

Figure 4: Wire mesh used

The team also studied the Plastic Assembly lines. The Plastic Assembly lines are arranged in 6 isolated cell layout configuration which produces 1 part number for each cell. The individual cell limits the sharing of workload between the operators. In TPS terms, this is called Fixed Manpower Configuration cell and it has no flexibility to adapt to demand changes (Rusli et al. 2012). Hence, there is an unbalance in the workload distribution between the production cell which leads to low productivity and poor production visualization. The overall layout and material flow along the Value Stream is not smooth and the internal part supply method is not well established. UA company practices Push production method which leads to long lead time and high WIP stagnation in the Value Stream.

3.3 STEP 3 – Define target

The next step is to define the target according to the data gathered and analyzed in the previous steps. The management of UA company has decided to establish the Kanban Pull System in the selected Value Stream. The management hopes that by implementing the Kanban Pull System in the Value Stream, the list of problems and highlighted in the production can be overcome. In order to gauge the effectiveness of the system, the target is defined in the following Lean metrics shown in Table 2.

Table 2: Lean metrics

No	Lean Metrics	Unit	Current	Target	Improvement
1	Lead time Warehouse Plastic Assy Plastic Injection	Days	 6.5 2.5 7	 4.5 1.75 4.9	30%
2	Space	Sq. ft.	10600	8480	20%
3	Manpower	Man	33	23	30%
4	Productivity	Pcs/Mn.Hr	53	64	20%

3.4 STEP 4 – Decide the kaizen strategy and tactic

To address to the problems stated, the study propose on implementing a holistic approach or kaikaku at the production floor. The kaizen strategies done cover the following aspects:

a. Relayout for smooth flow

Smooth flow must first be established as a pre requisite in creating the Kanban Pull System (Rusli et al. 2012). The Production team members performed relayout of the Plastic Assembly area by grouping the cells between Air cleaner lines and the Non air cleaner lines. The cladding which separates the Plastic Injection lines and the Plastic Assembly lines was demolished to remove the obstruction of material in the Value Stream. The machines are arranged according to process sequence.

b. Streamline the part supply system

The internal part supply system is improved by streamlining the part supply method between the Delivery area, Warehouse, Plastic Assembly lines and Plastic Injection lines. Flow racks and part boxes are created and used instead of wire mesh to store the Raw Material parts, WIP parts as well as the Finish Goods parts. The parts are stored in a fix quantity according to the determined lot size in the part boxes. The flow racks and the part boxes are shown in Figure 5. Furthermore, the part supply route is streamlined by establishing Set Part Supply system. In the Set Part Supply system, the number of Transfer Person (TP), the parts that the TP need to transfer, the route the TP needs to follow in order to transfer the parts, the method and the timing of part transfer are synchronized according to the Takt production. By establishing the Set Part Supply system, material and information can be moved and transferred along the Value Stream according to JIT concept. A Supply Part monitoring board is established to control and visualize the parts supply condition. It is shown in Figure 6.

Figure 5: Flow racks and Part boxes

Figure 6: Supply Monitoring Board

c. Productivity kaizen

Improvement in productivity is done at the Plastic Assembly lines. The isolated production cells are combined thru the Big Island concept (Rusli et al. 2012). By creating the Big Island cell, a multi model cells was created and thru Takt production, the manpower appointed to operate the cell is streamlined and given the correct workload. Waiting time and unbalance workload of the workers are eliminated thus improves productivity by improving the output per man hours.

d. Pulling mechanism

The pulling mechanism is designed into the targeted Value Stream, starting from the Delivery area and Warehouse. The System team performed the Shipping management activities by improving the Shipping operations. The pulling effect start from the pulling from the customers, hence a clear shipping operations and control is vital in establishing the Kanban Pull System. The list of pulling mechanism tools shown in Table 3 are used in creating the pulling mechanism.

Table 3: Pull System mechanism tools

Shipping terminal	PW kanban	Collection post
Shipping lane	PI kanban	Heijunka post
Shipping control board	Child part kanban	Lot formation post
Waiting Post	Picking list	Pattern post
PC store	Set Part Supply	Shikake post
Line store	TP route	Kanban chute

The System team designed the Kanban Pull System using MIFC. In order to have a levelled pulling effect, Heijunka post is used. Line Store is designed into the system to place the FG and the kanban chute is used to place the kanban sequence. As for the internal kanban, dual kanban system is adopted, usage of PW (Parts withdrawal) and PI (Production Instruction) kanban. The system diagram is shown in Figure 7.

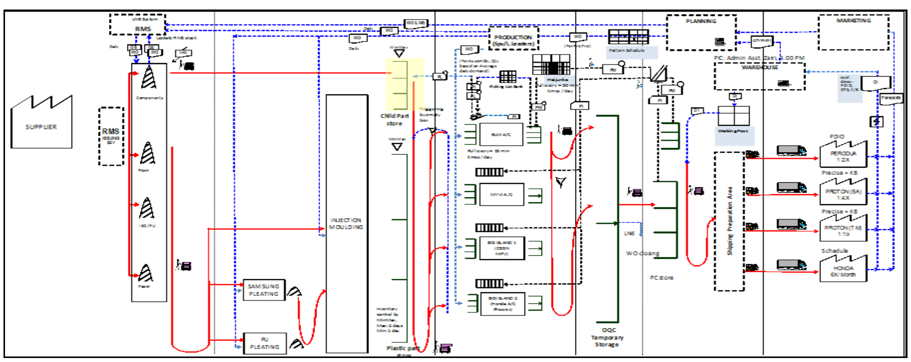

Figure 7: MIFC for the Kanban Pull System

3.5 STEP 5 – Establish the Kanban Pull System

In this step, actual implementation of the Kanban Pull System is done at the targeted Value Stream. The synergy between the System team and the Production team as well as strong leadership and guidance from the Kaizen Head and Kaizen Leader is crucial in the success of the implementations. The Kanban Pull System can be summarized as follows:

a) Information of delivery order from customer is arranged in the Waiting Post. The Waiting Post is located at the Delivery area. The parts for delivery are taken from the Warehouse PC store according to time stated in the Waiting Post. The parts are brought to the Shipping lane and terminal for delivery to the respective customers according to the determined time.
b) PW kanban is attached to the parts in the Warehouse PC store. Once the customer pulls the parts, the PW is detached from the parts and put into the kanban box for collection. According to the time determined, the kanban is arranged in Heijunka Post for production levelling. The Heijunka post has a time scale of 20 minutes, meaning every 20 minutes order is sent to the Plastic Assembly lines
c) Once the time for pull arrives, the PW kanban is taken from the Heijunka post and the kanban is used as a signal to pull the parts needed from the line store.
d) At the line store, the parts are attached with PI kanban and are ready to be pull accordingly. The parts are pulled from the line store using the PW kanban and brought to the warehouse for delivery.
e) The PI kanban attached on the parts are taken out and put on the progressive post. This act as the ordering signal for the production line to produce what the customer has pulled from the previous cycle.
f) The production line will produce parts according to the PI kanban sequence which is leveled between the 4 models.
g) Once produced, the parts are stored at the line store, replenished and ready to be pulled by the next kanban cycle, according to

customer demand.

The pulling effect links also with the Plastic injection lines. By having this linkage, JIT production can be achieved. The Kanban Pull System tools used at UA company are shown in Figure 8 (a) ~ (d).

(a) Waiting Post

(b) Heijunka Post

(c) Kanban box

(d) Progressive Post

Figure 8: Kanban Pull System tools

3.6 STEP 6 – Visual Management

In this step, outcome and effectiveness of the Kanban Pull system is gauged and evaluated using the Lean metrics discussed in the analyze stage earlier. Standardization of the production method, training on the new method to the workers and enforcement of the the production rules are done. Visual management and abnormality control is performed in order to sustain the system through PDCA cycle and kaizen or continuous improvement.

4. Results and Conclusion

The results from this study are summarized in Table 4. The results show big improvements in terms of lead time, WIP stocks, production floor space utilization and usage of operators. Moreover, the productivity after implementing the Big Island cell is higher compared to the previous one. Great savings in monetary value shows that the activities done can give huge impact to the profitability of UA company. There was also significant improvement in quality of the parts produced as a result of the Lean project. As a total, the Kanban Pull System established gives positive impact to the company.

Table 4: Results

No	Lean Metrics	Unit	Before	After	Improvement	Savings
1	Lead time Warehouse Plastic Assy Plastic Injection	Days	 6.5 2.5 7	 3 1.5 3	50%	Cash flow MYR515k
2	Space	Sq. ft.	10600	6110	42%	MYR82k/year
3	Manpower	Man	33	20	40%	MYR312k/year
4	Productivity	Pcs/Mn.Hr	53	73	37%	MYR12k/year

A success implementation of Lean Manufacturing was done using the Supplier Kaizen approach at a real manufacturing company. The Supplier Kaizen framework can be adapted in the effort to implement Lean Manufacturing step by step. All levels, from Top management to the working members must play their roles and have clear understanding of Lean for a success implementation. With a strong leadership, willingness to change attitude, active members with correct knowledge and skills on Lean, a substantial improvements in quality, timely delivery and cost saving was able to be achieved which in total improves the bottom line of the company.

Acknowledgements

The authors would like to extend their appreciation to UA company management for giving fullest cooperation which made this research paper possible. The authors were given exclusive access to its production lines and insight of its operation while doing the research and case study there. Special thanks are also given to Universiti Teknologi Mara for providing ample resources and means for the authors to proceed with the research.

References

J. Seeliger, K. Awalegaonkar, C. Lampiris, G. Bellamo, So you want to get lean kaizen or kaikaku, Oliver Wyman, 2007.

M.H.M. Rusli, A.Jaffar, S. Muhamud-Kayat, Toyota's Supplier Kaizen Framework for Malaysian automotive component industries, *Proceeding of the International Research Conference of Higher Education*, Manila, Philippines, October 3 – 4, 2013.

M.H.M. Rusli, A. Jaffar, M.T. Ali, S. Muhamud-Kayat, Integrating Big Island layout with Pull System for Production Optimization, *World Academy of Science, Engineering and Technology 72*, Page(s):260-264, 2012.

Tapping, D., Luyster, T., & Shuker, T.,Value stream management: Eight steps to planning, mapping, and sustaining lean improvements. New York, NY: Productivity Press, 2002.

Womack, J.P. and Jones, D.T., Lean Thinking: Banish waste and create wealth in your organization. NY: Free Press, 2003.

Biography

Hazri M. Rusli received his Technical Diploma from Tsuruoka National College of Technology, Japan when he completed the Kosen Mechanical Engineering course in 2000. In 2008, he received his B.Sc in Mechanical Engineering with Honours from Universiti Teknologi Mara, Malaysia (UiTM) and obtained his Master degree in Engineering Management in 2010 from the same university. He is currently pursuing his PhD degree in Mechanical Engineering specializing in Lean Operations and Industrial Engineering at UiTM, Malaysia. He is a Manager at Toyota Malaysia, heading the Supplier Kaizen Unit which specializes on Lean Operations and Consulting for the 62 supplier companies that supply components parts to Toyota Malaysia. He has worked with and consulted companies such as Kayaba Malaysia, Yuasa Battery, APM Group, Toyota Boshoku, Toyota Autobody Malaysia to name a few on its operations and supply chain with respect to the Toyota Production System. He has published journal and conference papers.