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Study Model of Lean Manufacturing and Optimization in an Automobile Industry

Disha Chauhan, Jagmail Singh*
Department of Mechanical Engineering, Haryana College of Technology and Management, Kaithal, Haryana, India

ABSTRACT

Lean manufacturing and company integration in Yamaha Faridabad industry to provide a sharp and distinct understanding and embodiment, of how Faridabad Yamaha company in the machining industry work with improvements in general and lean in particular, an extended definition of company integration and how it plays a critical role in a company's performance about its internal interaction. Collecting data was done by conducting case studies of Faridabad factory. The data was then compiled and categorized to provide a summarized comprehensible representation of all data. The result, in addition to achieving the purpose above, is two management tools that are direct descendants of their respective topics, aiming to solve problems related to them.

Keywords: lean manufacturing, Yamaha, lean production, improvement, people and partners, lean problem solving

****Corresponding Author***
E-mail: dishahctm@gmail.com

INTRODUCTION

There are several different ways to improve a company's performance, one of which is called lean. Lean is a company-wide performance improvement philosophy that uses different tools for problem solving, continuous improvements and standardization. While traditional effectiveness focuses on output versus input, "Lean Effectiveness" rather focuses on the amount of value adding time, time the customer is paying for, in processes. The goal of lean is to reduce the non-value adding time, which in lean terminology is called waste. Although lean has a goal, lean should be viewed as a never-ending journey, which can be divided into several implementation projects. While lean traditionally is focused on the producing departments of a company it is important to understand that if a lean transformation is to be successful it will require cooperation within, as well as between, departments, functions and hierarchical levels. The process of creating and facilitating this cooperation is, in this master thesis, referred to as company integration (CI) and is divided into vertical-, horizontal- and cross-functional integration depending on the parties included.

Lean Manufacturing

The Yamaha Production System, or lean as it will be referred to in thesis master thesis, is the car manufacturer Toyota's unique approach to manufacturing. Their approach to manufacturing is one of the best worldwide [1]. The following section covers the references used for lean and will focus on the philosophical areas rather than the different tools and methods, commonly associated with lean. However, the last section will briefly cover the tools and methods that is mentioned in the master thesis. Note that all lean- concepts,

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expressions and technical terms (indicated by cursive text).

The competition in the manufacturing industry is growing and concerned companies have been pressured to take measures and change their manufacturing processes to stay competitive on a global market. Such initiatives have, in many cases, been aimed towards implementing lean manufacturing [2].

The concept of supply chain and lean manufacturing has been around ever since first mentioned by Womack, Jones and Roos in their bestseller, the machine that changed the World from the year 1990. One of the reasons and the foundation of the book, behind developing the term lean manufacturing were to describe the methods in the production system invented by the Yamaha Motor Company [3]. This so-called waste could come in many shapes, but are basically all activities that do not add any value to the products from the customer's point of view [4]. The activities the customer does not pay for shall the company carry out to as low degree as possible.

Benefits with supply chain management are, besides the reduction of waste, also the increased quality of the products, increased effectiveness of equipment and shorter lead times. Furthermore, it facilitates better communication between work centers and improves the morale of the workers [5]. In Sweden the global metal processing company Alfa Laval has been influenced by TPS and strives towards implementing Lean manufacturing to all of their divisions around the world [6]. The company has acquisitions of other companies and organically. Today the company has customers worldwide in almost 100 countries with 42 production units in four continents, to be able to put the concepts of Lean manufacturing in a practical context and to assist Alfa Laval with the integration of the Yamaha Faridabad Factory [7]. By performing a case study in a manufacturing environment, the possible consequences when not using Lean manufacturing will be identified and addressed. An example of a common consequence, that is also covering other problems in the plant, is large inventories. Problems hidden by high inventory levels could then come in the shape of long lead times, delivery delays, defective products, etc. [8, 9].

Yamaha Production System

Yamaha Production System (YPS) is Yamaha's approach to manufacturing. Many of the concepts in lean manufacturing come from YPS. YPS has been a major influence on the trends in manufacturing during the last decades. Yamaha's methodology to implement a lean concept is very different from other companies. It is possible to allege that a lean enterprise is achieved if YPS is applied to all business areas in a company. Yamaha has defined lean manufacturing as a five-step process; defining customer value, defining the value stream, make the value stream flow, pulling from the customer and striving for excellence. To become a lean enterprise, the company culture also requires that everyone is striving to improve continuously. Taiichi Ohno, one of the founders of YPS, has made the following statement: "All we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes" [1].

Waste—Muda

Muda is Japanese for waste and are all activities that do not add any value to the finished product. Yamaha was among the first companies that, through YPS, defined the sevens wastes in a manufacturing environment. Later, these wastes have been translated and interpreted to work in

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other businesses as well. [10]. Liker has included another, eighth, waste. This is unused employee creativity. This is considered as a waste, since it is not engaged or listened to employees' ideas or not had used their skills that could result in the improvement opportunities of getting lost [1]. It has been have defined three overall categories to describe the nature of activities in a manufacturing context [10]. These categories are value adding activities, non-value adding activities and non-value adding activities but necessary. When referring to waste, value adding activities can be overlooked since these are the activities contributing in the transformation of the product from raw material or work in progress into a finished product. In other words, the activities the customer in the end is paying for. At the other end of the spectrum there are non-value adding activities, which are pure waste and can come in any of the seven, or eight, shapes listed earlier in this chapter. Lastly, there also exist non-value adding activities, which are necessary under the current manufacturing conditions in certain plants. For example, some types of transportation might be necessary in order to move a unit from one position to another or unpacking supplies. These activities are essentially waste but requires large changes in for example layout, which cannot be altered instantaneously.

YPS Compared to Mass Production

YPS be the opposite of mass production. Instead of economies of scale, spokesmen for YPS advocate a one-piece flow. There are many differences between mass production and YPS for example, the view on machine downtime. Mass production philosophy states that machine downtime is something that should be avoided, because then machines cannot produce parts that could generate money. YPS argue that it is good to have a machine shut down since it can prevent overproduction, and this is one of the most important wastes to address in according to the YPS philosophy. In YPS a company should strive after building up small inventory of finished goods and not produce according to a fluctuating demand. If that is achieved the company can level out the production schedule. This leads to small variations in the production schedule and a smooth manufacturing flow. The major focus of the philosophies is completely different. Mass production focus on everything that is not value adding while YPS focus on everything that is value adding. Instead of trying to identify waste, the overall philosophy of YPS is to identify activities that add value and reduce everything else.

PURPOSE AND OBJECTIVES

The purpose is to develop a plan, layout and material flow, with a lean manufacturing for manufacturing on a plant level, suitable for the products, processes and customer needs connected to the Yamaha Faridabad facilities.

The objectives for this master thesis are the following:

- Perform a detailed analysis of the operations at the factory.
- Make a high-level analysis of lean manufacturing and optimization for plant.
- Configure different material flows through the factory to meet the demand from internal and external customer.
- To come up with a recommendation of a preferred future scenario for the Yamaha Faridabad factory.

LITERATURE REVIEW

The literature review was the first step of the case study and be the foundation to it. Relevant theoretical topics and concepts that have been used when collecting literature were supply chain management and Yamaha Production System. The

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databases and search engines were chosen due to their eligibly large records of literature within operations and supply chain management. It is common to use more than one database in order to satisfy the need of the research.

Voss *et al*. (2002) mentioned recently, the research questions in this thesis are mainly focused on "how something is" [11]. This kind of research question suits the method of case studies. It is, according to, important to state the research questions and align the strategy accordingly. Both sources exemplify what kind of research strategies that are the best choices in situations of different questions.

Stuart *et al.* (2002) common mistakes made by researchers are misjudgments of the knowledge and research already existing within the concerned field [12]. In other words, they do not know what kind of questions they are investigating. For example, there may already exist a fundamental model describing the same phenomena as the researchers are investigating, they try to use explorative research question while the study really is asking questions better suited as theory extensions or refinements. Conducting such a mistake could result in rejection of the paper. With this is mind, it is recognized that the questions asked in this report are aiming towards investigating already present models and concepts within the field of operations. They can therefore be claimed to facilitate theory extension/refinement.

Liker (2004) an A3-report is basically a way of conveying all the information needed to make a complex decision on an A3-sized piece of paper [1]. This is achieved by streamlining comprehensive written information and organizing it in an easily understood fashion. A3-reports speeds up a company's written internal communication by eliminating long complex reports that take vast amount of time deciphering. Status boards is not an established concept, but is in this master thesis to be considered as the common term for KPI board, pulse board, BSC board, meeting board, etc. These expressions are common in the industry and are all a visual tool for keeping track of the status for and performance of a current situation or period. All status boards have their own design, tailored to fit the company, or specific function, that uses it.

Commonly they are constituted by:

- A balanced scorecard (BSC) that defines which of the company's dimensions that is of interest when measuring performance and progress. Common BSC dimensions are: personnel, quality, delivery and cost.
- Sets of key performance indicators (KPIs), each belonging to a certain BSC dimension. These KPIs quantifies and makes each BSC dimension measurable by dividing it into smaller more precise areas. Common KPIs are: delivery on time percentage, production costs for product X, defect percentage for product X, etc.
- A production plan, which in some way convey that what is to be done, when it is to be done and by whom it is to be done.

Golicic *et al*. (2005) the inductive approach often gives the researcher a deeper understanding of a not-previously known issue [13]. The basic steps involved in an inductive research would be to first gather all qualitative data specifically linked to the issue set out to investigate. Next, based on this data, describe the issue and lastly to explain the matter. The result from such a research will be a thorough theory of the issue that describes it in a deep manner. In other words, inductive research approach can be described as process that starts with a specific phenomenon and then develops a theory or framework to explain it with.

Deductive research approach will then, in an opposite way to inductive approach, start off with the study of relevant literature and secondly form a theory based on that literature review. Next the researcher should apply that theory on the field and see how well it acts in accordance with reality. This is also the most common research approach within the field of logistics. Even if these approaches most frequently are carried out independently, they could also be combined. By not following the typical steps and instead going back and forth between the two approaches, a third approach is formed. This approach is described as the balanced research approach.

Lee-Mortimer (2006) to be able to put the concepts of lean manufacturing in a practical context and to assist Alfa Laval with the integration of the Wood Dale Factory into their organization a case study has been conducted on the factory in Wood Dale [14]. By performing a case study in a manufacturing environment, the possible consequences when not using Lean manufacturing will be identified and addressed. An example of a common consequence, that is also covering other problems in the plant, is large inventories. Problems hidden by high inventory levels could then come in the shape of long lead times, delivery delays, defective products, etc.

Spens and Kovacs (2006) inductive and deductive are also mentioned but instead of the balanced research approach they refer to the adductive research approach [15]. The steps in an addictive approach can in a basic manner be explained as a method to help. In the beginning of this study there was a phenomenon that needed to be investigated, which was the material flow in at Alfa Laval's plant in Wood Dale. This corresponds to the initial step in an inductive approach. However, the actual approach when working with this phenomenon has been to first perform a broad literature review. From this review a frame of reference based on relevant literature has been set up. Consequently, this frame of reference has been tested in a real-life environment, resulting in the development of new knowledge. In other words, the research approach of this study complies with the approach of a deductive one.

Berk and Toy (2009) Jidoka is a Japanese term that, roughly translates to "production problem warning system that alerts everyone" [16]. The concept of Jidoka is to stop the entire production line if a problem is detected. The reason for stopping the entire line is to avoid the risk for adding value to defective pieces.

Yin (2009) to clarifies even more what the most suitable method is, can be studied [17]. Yin puts a lot of emphasize on the importance of matching the research questions with the research strategy, like what have already been discussed. However, sometimes it may not be as simple as just choosing the strategy based on the design of the research questions. Situations could occur where several methods match the questions. In these cases, other factors can help to decide the proper strategy, i.e. factors like the possibility to control the variables in the study and at which point of time the study is focusing on. Describes five methods used when conducting research. These are experiment, survey, archival analysis, history and case studies. In addition, Yin emphasizes three major questions that need to be answered and considered when deciding which method to use;

- What is the design of the research questions?
- Are there any possibilities to manage behavioral elements?
- Is the focus of the study on present events?

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The researcher gain knowledge on theories in a deductive way, which an inductive approach then could be used to verify.

DESIGN AND METHODOLOGY

Problem Description

The task, along with its supporting assumptions, as issued by Supply Chain, reads as follows:

Although lean is not a new phenomenon, it is still highly present in industry today. SC sees a potential to include lean in their service offer but will need more information about the spread and trend of lean in the industry as well as the customers' needs and problems. This is to get a clear picture of how a potential future lean service, provided by SC could look like. The below following problem description has been formulated. Examine how SC's customers and metal working industry in general, use lean in their efforts to increase productivity. This is important for SC to know to understand if SC's assumptions are correct, and if so, to develop competence and selling strategies in this area. Typical areas of questioning towards machining companies will be:

- Why, how and where do they use lean? And if they do not, why?
- What Lean tools do they use?
- How successful have they been?
- What kind of challenges do they encounter?
- What parts of the organization is involved?
- How do they see machining in relation to lean?
- What kind of support do they need?
- How do they look at machining tool suppliers, like SC, in relation to lean?

Assumptions

Many of Yamaha's larger customers are performing lean transformation and are using in-house lean teams to do this. These customers often perform internal lean training, in which Yamaha's personnel has been invited to partake. As these customers are experienced in lean, Yamaha believes that if they are to secure business as a future provider of lean services, it will require that:

- Yamaha SC can talk the "Lean-language" of the customer.
- Yamaha understands the customers' challenges.
- Yamaha can be part of lean projects.
- Yamaha ensures that the customer understands that machining is an important area for lean.
- Yamaha understands that many of their services and tools are in fact lean tools and that they need to be able to explain their benefits from a lean perspective.

Introduction to Yamaha Motors India

Yamaha Motor was first introduced in India 1985 as a joint-venture with Escorts India limited.

Principal and Motto of the Company

- Basic Motto of Company: "Exciting company which creates the Yamaha uniqueness".
- Purpose: To enrich people's lives through exciting experiences.
- Core Competency: Excitement (stylish, sporty).
- Brand Slogan: "Beyond the Limit".

METHODOLOGY AND RESEARCH APPROACH

There are three steps working of above methodologies. (1) Cost Improvement Activity 2018. (2) Manpower Optimization Activity 2018.

Cost Improvement Activity 2018

- Cost impact is very high of this cutting tool (insert). Cost is Rs 6.0/Engine.
- This insert is used in gear 1st wheel, gear 2nd wheel and gear 5th pinion for face Grooving (HFPL 5004 and GIF 8.00 E0.80 IC830—Iscar Make)

(1) Alternate source development for low cost insert of same properties (Hardness, Toughness, etc.)—ME
(1) Tooling Arrangement—ME
(2) Cutting Trial and Evaluation—ME, QE and Mfg
(3) Procurement of New Tool—Purchase
(4) Product ionization with New Tool—Mfg

- Cost impact is very high of this Cutting oil (Neat Cutting Oil)—Rs 8.7/Eng
- This cutting oil is used in gear soft machining (deep drilling, broaching, shaving operation) and in crank machining (deep drilling operation).

(1) Exploring alternate source for low.
(2) Cost oil of same properties.
(3) Viscosity, Lubricity, Anti wear property, etc.—ME.
(4) MSDS study of new Oil—EHS Team.
(5) Price Negotiation with existing Supplier—ME, Mfg.
(6) Arrangement of oil for trial (In case of oil change)—Purchase, ME.
(7) Trial and Evaluation—ME, Mfg, QC.
(8) Regular use in production—Mfg.

Manpower Optimization Activity 2018

Background

- In 2GS package line 1, gear 1st wheel and gear 2nd wheel are made.
- Three manpower are deployed per shift in this line as per current condition. If we finish bore diameter at turning operation instead of broaching operation, one manpower could be saved per shift.

Role

(1) Bore ovality control at turning operation through programme modification, cutting parameter change etc- ME and Mfg
(2) N-30, N1500 evaluation at Turning operation—ME and QC.
(3) N-30, N1500 evaluation at Hobbing Operation—ME and QC.
(4) Process Std modification as per New Process and MM Chart modification—ME.
(5) Training to each Line Manger/GL—Mfg.
(6) Discussion with IR/Union if any issue occurred in implementation as per new MM chart.

Background

- There are Two Package Lines of Axle Main in Gear Soft Machining Section
- Total 4 manpower is deployed in each shift.

Role

(1) Thread rolling operation shifting at Oil hole drilling machine (One Thread rolling machine will be spared)—ME
(2) Tooling arrangement for Oil Hole Drilling (Brother VMC) m/c—ME
(3) Cutting Trial and evaluation—ME, Mfg, QE
(4) Elimination or Automation of Manual Debburing of small spline in Axle Main through Process Improvement-ME, Mfg
(5) Process Std modification as per New Process and MM Chart modification—ME
(6) Training to each Line Manger/GL—Mfg
(7) Discussion with IR/Union if any issue occurred in implementation as per new MM chart

Background

- One operator is running two turning machine adjoining to axle drive package line. One cluster of two machine is kept at one side of axle drive package line and another cluster of two turning machine is kept another side of axle drive package line.
- Performance efficiency of these two operators is very low. But due to Pillar obstruction, all 4 turning machines cannot be kept at one location.

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Role

(1) Location fixation for keeping these 4 machines at one place—ME, Mfg
(2) Crank case fixture shifting from gear 1st wheel 1GC package line to soft machining Q gate area—Mfg
(3) New Layout preparation- ME
(4) 1CK PDN line machines (Takisawa-2 no's, Hobbing-1, Brother m/c—1) shifting to 1GC 1st Wl Package Line—PEM.
(5) These 4 turning machine shifting to above place (where 1CK PDn machine was there)—PEM
(6) N30 evaluation, than regular product ionization

RESULTS AND DISCUSSIONS

In this study, the results are being calculated and are being compared among the previous study and present study. The results show a very positive outcome after the change in the layout.

COST IMPROVEMENT ACTIVITY-2018 BASED ON TOOL MAKE

- Total cost of Iscar Make is Rs 6/Engine and Kennametal Make is Rs 4.45/Engine.
- Project Total Saving—Rs 1.55/Engine.
- Cost down by 20%.

Table 1. *Comparison of Iscar make rough insert and finish insert.*

Rough Insert–Iscar Make			
GEAR	**COST**	**LIFE**	**COST Rupees/Engine**
1st WI	2539	1000	2.5
2nd WI	2539	2000	1.3
Finish Insert–HFPL5004			
Gear	**Cost**	**Life**	**Cost Rupees/Engine**
1st WI	1258	1100	1.14
2nd WI	1258	1200	1.05

Table 2. *Comparison of Kenametal Iscar make rough insert and finish insert.*

Rough Insert–Kenametal Make			
Gear	**Cost**	**Life**	**Cost Rs/Eng**
1st WI	1200	800	1.5
2nd WI	1200	1600	0.8
Finish Insert–HFPL5004			
Gear	**Cost**	**Life**	**Cost Rs/Eng**
1st WI	1258	1100	1.14
2nd WI	1258	1200	1.05

Here, the above results the drop of cost manufacturing in engine by changing the machine tool from Iscar Make to Kenametal Make.

COST IMPROVEMENT ACTIVITY-2018 BASED ON OIL SUPPLIER

Table 3: *Table of schedule activity.*

Activity	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18
Alternate Source development	→						
Tooling Arrangement		→					
Cutting Tool Trial and evaluation (10 PC)			→				
Procurement of New Tool				→			
Productionization with new Tool						→	

Table 4. *Comparison of Daubert and Daubert/IPOL Cutting Oil Supplier.*

Cutting Oil (Supplier)	**Daubert**	**Cutting Oil (Supplier)**	**Daubert/IPOL**	**Project Saving**
PRICE	RS 138/LTR	**PRICE**	RS 110/LTR	Rs 28/LTR
COST	8.7 RS/ENGINE	**COST**	7 RS/ENGINE	Rs 1.70/Eng

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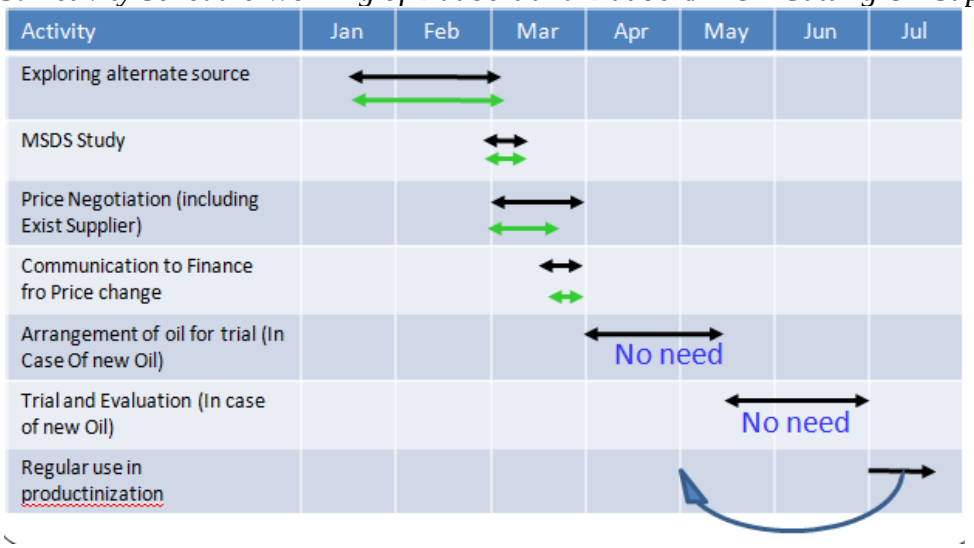
Table 5: *Activity Schedule Working of Daubert and Daubert/IPOL Cutting Oil Supplier.*



MANPOWER OPTIMIZATION ACTIVITY-2018

Manpower Optimization Activity-2018 (STEP I)

Previous Approach

- 1st operative—4 Turn Machine
- 2nd Operative—Deburring + Washing
- 3rd Operative—Broaching+ Washing+ Hobbing

Steps of Working

(1) Turning-1
(2) Turning-2
(3) Deburring
(4) Washing
(5) Broaching
(6) Washing
(7) Hobbing

Proposed Approach

- 1st operative—4 Turn Machine (Same)
- 2nd Operative—Deburring + Washing+ Hobbing

Steps of Working

(1) Turning-1
(2) Turning-2
(3) Deburring
(4) Washing
(5) Washing
(6) Hobbing

Total Saving: 3 Manpower/Day

Besides this, one broaching machine and one washing machine will be spared and below the time period of the processes as under:

(1) Cutting Trial to control Bore Ovality at Turning: MARCH to APRIL
(2) Ovality report making for Evaluation: APRIL
(3) Cutting trial at Hobbing: MID APRIL to MID MAY
(4) N 30, N1000 Evaluation (Lead Bias etc): MAY to MID JUNE
(5) Cutting trial to achieve existing pitch time at Turning Machine: JUNE
(6) MM chart correction
(7) Regular production as per new MM chart: after JUNE.

Manpower Optimization Activity-2018 (Step II)

Previous Approach

- 1st Operative—2 Turn Machine + Manual+ Deburring + Deep Drilling
- 2nd Operative—OH Drilling M/C + Hobbing + Thread Rolling

Proposed Approach

- 1st Operative—2 Turn Machine+ Manual Deep Drilling+ OH Drilling-(Line 1)

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- 2nd Operative—Hobbing (Line 1) + Hobbing (Line 2) +Visual inspection (1 box certificate)
- 3rd Operative—2 Turn Machine+ Manual Deep Drilling + OH Drilling- (Line 2)
- Total Saving—3 manpower/day. One thread rolling machine will be spared

Manpower Optimization Activity-2018 (Step III)

Previous Approach

- Two Operator—4 Turning Machine
- Formation Efficiency—55%

Proposed Approach

- One Operator—4 Turning Machine

Formation Efficiency—100%.

Manpower Optimization Activity-2018 (STEP IV)

Previous Approach

- Two operator- 4 turning machine
- Formation efficiency- 55%

Proposed Approach

- One operator—4 turning machine
- Formation efficiency—100%

Table 6. *Activity schedule working manpower optimization activity-2018 [Step I].*

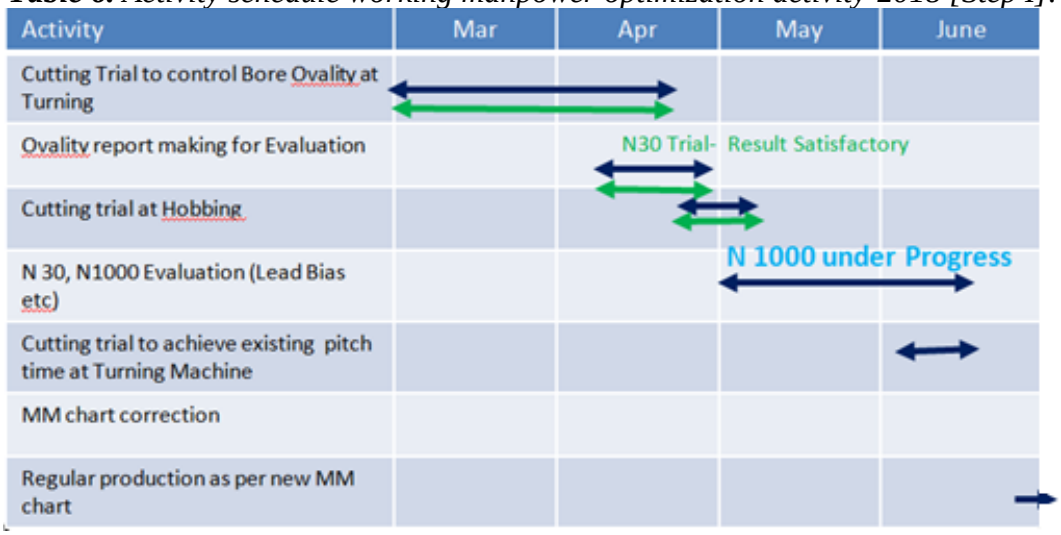

Table 7. *Activity schedule working manpower optimization activity-2018 (Step II).*

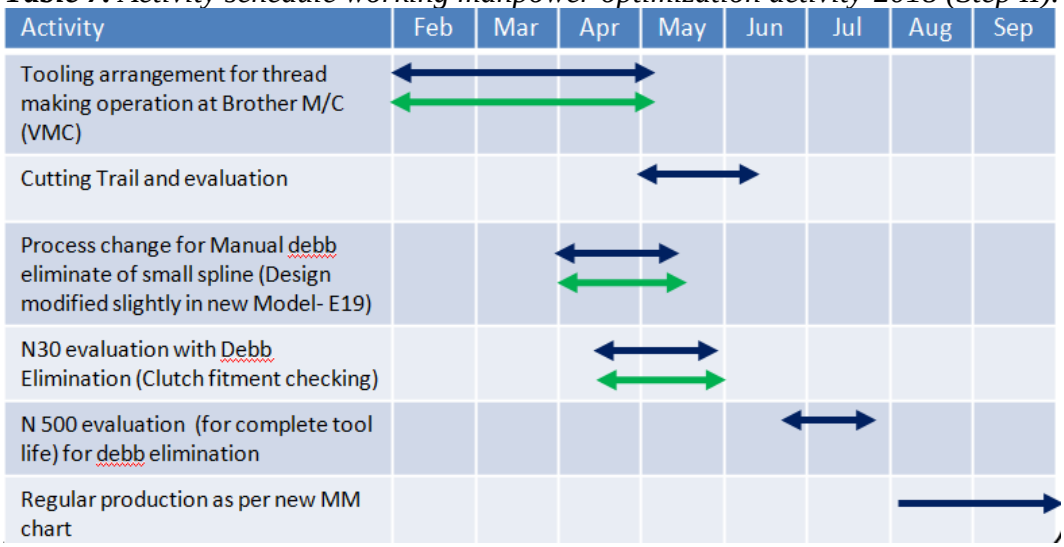

Table 8: *Activity schedule working manpower optimization activity-2018[Step III].*

Activity	Feb	Mar	Apr	May	Jun	Jul	Aug
In Gear 1st WI -1GC package line space creation through C Case Fixture shifting to Soft Q gate Area		↔	↔				
Layout Finalization			↔				
1CK PDN Line Machines shifting to Gear1st WI -1 GC Package LIne				↔			
Turning Machine Shifting at the place of 1CK PDN Line				↔			
N 30 Evaluation of all Machines					↔		
Regular production as per new MM chart					→	→	→

Table 9. *Activity schedule working manpower optimization activity-2018 [Step IV].*

Activity	Feb	Mar	Apr	May	Jun	Jul	Aug
In Gear 1st WI -1GC package line space creation through C Case Fixture shifting to Soft Q gate Area		↔	↔				
Layout Finalization			↔				
1CK PDN Line Machines shifting to Gear1st WI -1 GC Package LIne				↔			
Turning Machine Shifting at the place of 1CK PDN Line				↔			
N 30 Evaluation of all Machines					↔		
Regular production as per new MM chart					→	→	→

Manpower Optimization Activity-2018 (Step V)

Line 1: 2GS Package Line 1

- *Key Activity/Scope:* Broaching operation elimination by making final bore diameter at turning operation.
- Target (MP Redn/day): 3
- In charge: AK/PT/AR/RK

Schedule

- Cutting trial and evaluation (N30).
- Cutting trial and evaluation (N100).
- MM chart correction and product ionization.

Line 2: Axle Main Package Line

- *Key Activity/Scope:* Thread rolling operation shifting to OHD (VMC) machine and manual scrap elimination by process improvement
- Target (MP Redn/day): 3
- In charge: AK/PT/AR/RK

Schedule

- Tooling Arrangement for VMC Machine.
- Cutting Trial and Evaluation.
- MM chart correction and Product Ionization.

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Table 10. *Activity schedule working batch turning line.*

Line	Key Activity/Scope	Target (MP Redn/ day)	In charge	Schedule
				Jan Feb Mar Apr May Jun Jul Aug
2GS Package Line 1	Broaching Operation elimination by making final bore dia at Turning operation	3	AK/ PT/ AR/RK	Cutting Trial and evaluation (N30); Cutting Trial and evaluation (N100); MM chart correction and Productionization
Axle Main Package Line	Thread rolling operation shifting to OHD (VMC) machine and manual debb elimination by process improvement	3	AK/ PT/ AR/RK	Tooling arrangement for VMC Machine; Cutting Trial and evaluation; MM chart correction and Productionization
Batch Turning Line	Clubbing of 4 Takisawa machine at one place . (Lay out change) Earlier 1 Opr- 2 Machine Future 1 Opr- 4Machine	2	AK/ PT/ AA/RK	New Lay out preparation; Machine Shifting; Evaluation. Then Productionization

Line 3: Batch Turning Line

- *Key Activity/Scope:* Clubbing of 4 Takisawa machine at one place. (Lay out change)
- Previous 1 Opr—2 Machine
- Proposed 1 Opr—4 Machine
- Target (MP Redn/day): 2
- In charge: AK/PT/AR/RK
- *Schedule*
- New Layout Preparation.
- Machine Shifting.
- Evaluation. Then Product Ionization.

DISCUSSIONS

All the data has been collected and recorded on the basis of observations of Yamaha Faridabad, Haryana India. The previous and proposed study of the research gives a huge optimization in the results. The purpose of the Lean study was positive. The study was based on all aspects including the manpower, manufacture and the supply/purchase of the product. It was a versatile study, which can provide Yamaha a lot of profit. The study was based on plant optimization and the aim is to provide lots of monetary profit.

CONCLUSION

To strengthen the quality of the research and its result, we thoroughly explored appropriate research methodologies and how they could obtain reliable information. Furthermore, it reviews to what extent the different aspects of achieving trustworthiness and quality of the research, has been achieved.

- The multiple case design was chosen because it enables the possibility of building theories/perceptions about the studied subject. This has proven to be an excellent choice, since the company visits together have generated enough data to reach valuable insights and conclusions of the current situation. It has also provided us with a strong foundation to establish theories concerning both LS and CI.
- The embedded approach has also proven to be a favorable choice as the

case study division into sub-parts has provided valuable insights into details that otherwise could have been overlooked. These detailed insights have made it possible to study how lean tools and methods will fail if the overall Lean approach is misdirected. Furthermore, the embedded approach has enabled us to find relevant areas of interaction as well as how CI can be used to improve these areas.

- The chosen strategy for the research has proven to be favorable. It has provided us with the opportunity to collect data properly and summarize it into something comprehensible.
- Audit trailing has been performed by continuously checking that the steps taken are only taken without bias to what we want the research to result in.
- Reflexivity has been achieved by deploying several means throughout the research. We have regularly held discussions on whether the research needs to change due to new circumstances or insights. Also, we have continuously reflected on the different methodological choices made, in order to avoid bias in the findings from the choices.
- A thick description has been a major part in the research. The authors have aimed at describing methodologies as well as findings at such a detailed level, that the reader never should find him- or herself uncertain of what we are trying to explain. By doing so, the reader should find it possible to transfer and/or apply our findings to other contexts or situations.
- The tools applicability to the problems described: The first issue that might arise, is whether or not the tools will be applicable to the problems that they are developed for. It could be that the tools need adjustments that would only be detected once the tools have been tested in practice. Hence, the tools need further studies before they are to be considered as successful.
- The time required vs. potential gains of using the tools: Currently, it is uncertain how much time the tools will require to be used. Furthermore, it is hard to measure the potential gain of obtaining the outputs from the tools. Therefore, it could be questioned whether the tools are to be used in an actual company setting or if they are better utilized as tools for describing LS or CI in a theoretical context.
- The tools applicability is highly dependent on the user: Deploying the tools might require a person or persons that have superior abilities when it comes to changing people. This is not an ability gifted to everybody; hence there is a risk that the tools will only be useful for a small set of users.
- Lean manufacturing is widely considered to be the next manufacturing generation, succeeding *Taylorism* (mass production). Importing is most often associated with bringing goods from an external source into one owns jurisdiction. But how does one import/copy something as intangible and intricate as Lean? This question must have been one of the first questions asked by the pioneering manufacturing westerners (Americans and Europeans) that visited, read and studied Lean, and recognized its greatness. Having studied a wide array of Lean theory, as well as how it is being reacted, we dare us to try to answer this question.
- Lean theory for westerners by westerners is basically transcribed synthesized observations. The depth and insightfulness of these observations have developed over time. This ability to gain and transcribe in-depth insights of Lean is dependent

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of the observer's ability to comprehend abstractness. Gaining this ability has taken a long time for western observers; it can be described as a process that roughly contains two consecutive phases, where each phase has resulted in distinctly different literature.

- It has a low level of abstractness. Here the observers have observed and transcribed what has been most obvious, namely the tools and methods. These require no deciphering and can essentially be translated into a list of very concrete means of improving manufacturing. These books are typically structured to have a brief introductory part, where lean is described as a "Philosophy" that has to "be lived". However, no effort is put into exploring/explaining how a company is to "Live by the Lean Philosophy". This due to it being exceedingly abstract and hence very difficult to describe. Instead the rest of the book systematically goes through and explains different lean tools/methods and how to use them.
- This literature, derived from these observers with a low level of abstractness, is very popular due to it being so concrete and easy to comprehend. This is the reason why this type of literature is adapted by universities, teaching students about lean, as well as by companies that are new to lean. The result is people and companies with a "toolbox understanding" of lean i.e. people believing that to "be lean" is simply to implement some of the tools/methods described in this type of literature.
- These observers have gone through the first phase, tried it out and then slowly, reluctantly and painstakingly concluded that their version of lean. Most of these observers gave up lean, saying that it is embedded in the company's culture and hence impossible to copy. However, some persisted and continued to study lean, aiming at truly comprehending its abstractness, i.e., culture, philosophy, etc. This pursuit has resulted in books that severely tone down the importance of lean tools/methods, simply denoting them as measures to support a lean journey. Instead, focus is put on exploring the "hidden" truths of lean.

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