Assembly Line Improvement With in the Automotive Industry

Gajotam Yadav, R K Tyagi
Department of Mechanical and Automation Engineering, Amity School of Engineering and Technology, Amity University Noida, Sector- 125, Uttar Pradesh, India

Article Info
Article history:
Received 25 January 2016
Received in revised form
20 February 2016
Accepted 28 February 2016
Available online 15 June 2016

Keywords
Manufacturing industry; line assemble; quantitative data; right product

Abstract

In today's manufacturing industry there is an increased focus to produce the right product at right time and in the automotive sector the pressure on suppliers in order to deliver is high. In this matter the organization has to have clear and reachable goals together with a production system that can meet these goals.The aims of this study was to observe and discover improvements in the assembly line at a company working in automotive Industry. The line assembles the whole electric and switches system of Honda Motorcycles. This case study also includes literature studies in order to support the results found in this Research. This Research includes a rich picture of the current state at the line for understanding how the line operates. Along with this observation and interviews have been made. Observations are supported by quantitative data and analyses to justify the problematic situation in the production line. The current state has been analyzed with the help of the theories used and it revealed a distinct gap between the actual production and desired goals for the organization. The company used a methodology of solving the everyday problematic issues by temporary solutions which led to the reappearance of problems again. The Research ends with a discussion of the methodology used along with the findings obtained. The three research questions are answered along with discussions regarding how we could have done this research in a different manner. The research sums up with a section for reliability of the data collected and what future studies can be conducted in the area.

1.Introduction

The main aim of this Research was to identify the root causes behind the problems causing disruption in the flow of Assembly line and suggest suitable improvements and recommendations. Furthermore to design a structured process to solve the everyday routine problems at the assembly line along with generalizing the findings to an overall production development strategy for the company.

1.1 Method Approach and Implementation

The company had previously carried out several projects on the assembly line but couldn't achieve sustainable results. Thus to understand the problem from different perspectives, the company gave me free hands and didn't specify the exact problem area .This gave me the freedom to study the assembly line and apply theories and methods used in my academic program. Thus it was a challenge to identify the problem area .This gave me the freedom to study the assembly line and apply theories and methods used in my academic program. Thus it was a challenge to identify the root causes of their problems. Out of the literature used in this case study, the main framework, namely Porras and Robertson organizational framework is relevant to this study. Furthermore this framework involves the interaction of four categories namely; organizing arrangements, technology, physical setting and social factors. The interaction of these factors creates individuals perception about the workplace and thus influences his or her on the job behavior. Thus this and thus influences his or her on the framework helped me to identify factors that can influence the workers on the job behavior in a more positive manner. The use of Porras and Robertson organization framework has definitely increased the validity of the Research. I also believe that the extra sources used as a complement to the framework have been beneficial. As the company is working with lean production such literature also has been used in the study. Furthermore, the literature selected was established after my pre-study at the company as I got the opportunity to get familiar with the line in the sense of production and communication. As the thesis project progressed further, more time was spent on collecting data. My main methods for this were observations and time measurements. My observations, however, lacked the expected validity due to the problematic situation at the assembly line e.g. downtimes, shortage of labor and machinery problems which made it difficult to observe the production flow. Therefore to increase the validity, I collected various other quantitative data over a period of 17 weeks. Moreover, the measurement data has been very time consuming but has given me enough numbers to analyze the line. Using observations and Porras and Robertson's organizational framework I was able to establish a picture of the current working conditions at the line and with the support from measurements I could justify my statement. The applied state was established with the Soft systems methodology (SSM) and I could develop recommendation in how the line should work. Even though the SSM is a methodology used in the IT world I wanted to find the exact nature of the problem and what were the underlying reasons for the company.

In order to get a more overall view of the line I conducted interviews which gave valuable inputs when analyzing the

Corresponding Author,
E-mail address: gajotamyadav12345@gmail.com;
Phone No--+91-999 -937 -3569

line. The interviews were conducted with several different personnel that work with the specific assembly line. The challenges during the interview were to follow the planned structure of the questions as the interviewed persons had different inputs which made the interviews progress in other directions. Thus, I think that the structure was followed in most of the cases. Moreover the collected data were of primary type but with one exception: the shift records were of secondary type and displayed the difficulties e.g. breakdowns, machinery problem, and availability of labor force during each shift. From this data I calculated the different type of measurements such as OEE, production efficiency etc. I believe that the methodology chosen for this thesis project has met the requirements and answered my research questions. Furthermore this methodology helped me to identify the current state for the production line and this was also confirmed by the company to ensure that my project was going in the right direction. As I discovered that there are more factors causing problems at the line I believe my course of action has been the right one. If I should criticize e.g. what I could have done better, My literature study could had been more intense and wide but this project had a more practical approach so I feel confident with the chosen literature and methodology. Moreover the period during which quantitative data was measured could have been extended to increase the validity of the research. However since most of my data was gathered from shift records, the records for the previous year contained severe discrepancies and thus restricted me in analyzing data over a longer period of time. In this case detailed data from the shift records could have helped me with more accurate data. The reliability of the research is dependent on the type of data that will be collected. The measurement will vary but the end results of the research would be moreover the same. For example the interviews could be formed in another way with answers neglecting my study. If the improvement suggested will be implemented and the study repeats it's very likely that the findings will vary. However the core finding will be the same. By conducting this type of research with the use of SSM in a manufacturing industry, I believe that my research can be validated to some extent. As mentioned, the concern lies in the transformation of SSM to the manufacturing industry. The validity is also justified since I believe I have been able to answer the research questions formulated.

2. Analysis and Results

2.1 Identifying System Processes

In order to understand the current situation at the company I identified the nature of working and I derived the model seen in Figure Below. The model is inspired by system thinking processes (Senge1999).Systems generally operate by means of processes, regenerative and balancing processes. The parameter which was required to be balanced was productivity. The productivity parameter in this case was defined as the ratio of the number of Honda Bike Electric section manufactured which passed from EOL to the required target. If there was rework or scrap goods they were not included in the productivity measurement. In this system, a number of external factors influenced the balancing process of maintaining consistent productivity. The nature of working of the system is described in the following figure 1.

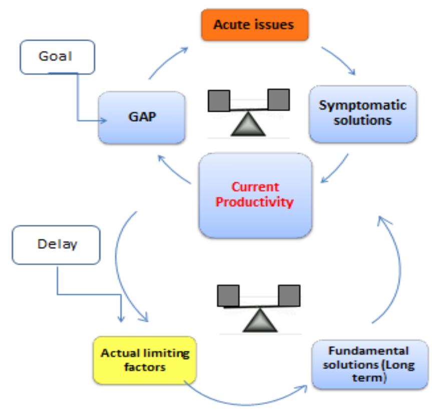

Fig. 1 The nature of working of the system

As seen in the Figure the productivity at the assembly line was of major concern and there was always a perceived gap between the desired goals and actual productivity. The company followed a strategy of resolving everyday production problems e.g. the acute issues at the line such as technical breakdowns, imbalance of line and quality issues with the use of temporary countermeasures. But these were symptomatic solutions whose effects wore away within a short time period and often reappeared in future. Therefore the perceived gap was never diminished. Thus it is required to implement a more proactive approach to address these issues instead of symptomatic solutions. The proactive approach had its limitations due to certain limiting factors or constraints for e.g. resources, time etc. The proactive approach entailed a deeper understanding of root causes but due to the constraints this never took place making it difficult to implement the fundamental solutions. Therefore the company found the path of least effort and got caught in a vicious circle of symptomatic solutions. To understand the system better I developed a practical approach described in the figure below.

2.2 Building a rich picture

After understanding the system processes at the line, I tried to elaborate more on the acute issues and their root causes. For the purpose of deeper understanding of the system, I differentiated the working of the system into current and required states.

2.2.1 Current state

The performance of the line was measured based on measurement of production efficiency and was displayed on the activity boards in the form of day-by the hour-production. In my analysis I have calculated this performance efficiency based on weekly intervals and it is shown in Figure below. The data is collected from the shift records provided by the company.

As seen from the above graph, the efficiency varies in the range from around lowest of 48% to highest of 93%. The variation was found high in nature and not pertaining to any specific pattern. This figure gives an overall picture but has limited use so as to understand which specific area needs to be improved. It should be further assisted with the help of other performance measurement criteria. In order to fully understand the high variation I analyzed by comparing production efficiency and downtimes of robot cell and EOL. The need of another performance parameter is justified if I observe the figure shown below. The Figure 3 shows a comparative graph of downtime percentages of Robot cell and EOL with the production efficiency. I chose downtime parameter since it had highest contribution from different factors that constitute OEE i.e. availability, performance efficiency and FTT. In the figure 3 the colors shows are:

Red - Downtime EOL
Blue - Downtime Robot Cell
Green - Production efficiency

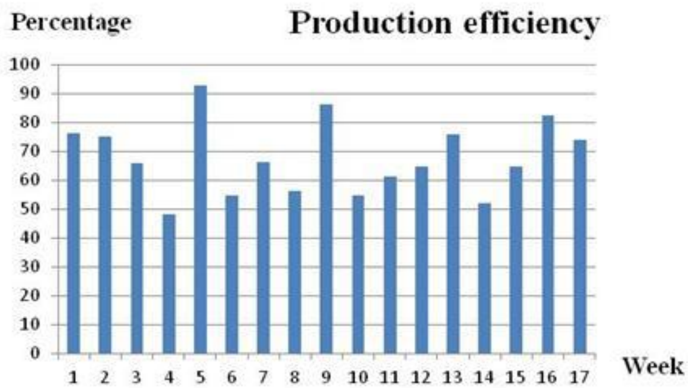

Fig. 2 Production efficiency per week

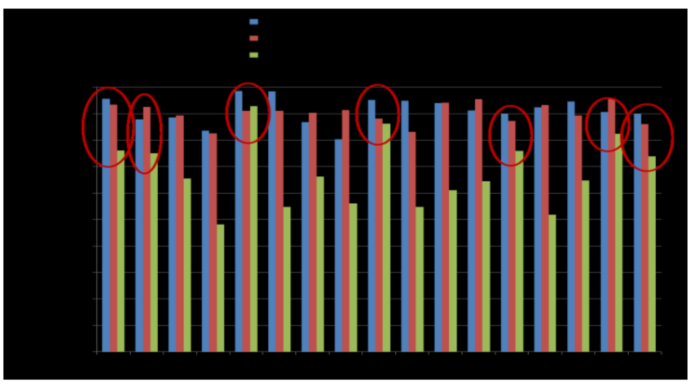

Fig. 3 Downtime percentages of Robot cell and EOL with the production efficiency

For the weeks highlighted as shown in the figure above (week number 1, 2,5,9,13,16 and17) there was a considerable mismatch between production efficiency and downtime. If I take a closer look at week 5, it seems very strange since the production efficiency is very high as compared to the combined downtimes. According to my opinion, this was due to the fact that the efficiency can be increased by use of inventory products during the breakdown of robot cell. Buffers were created when there was a breakdown of either EOL or robot cell.
Which led to batch production and therefore efficiency was increased for a certain amount of time. Thus efficiency parameter does not provide a clear picture of the performance of the system. It is therefore required to check the finished and unfinished product inventory levels. For the remaining weeks the production efficiency matched with the downtime percentages as it was considerably low when downtimes were high. As seen above, weeks 1, 5, 9 and 15 suffered from low productivity where the downtime was high followed by a low OEE. During these weeks I observed continual breakdowns of both robot cell and EOL along with a low number of operators which affected the rate of efficiency. One major issue during these weeks was that it was hard getting technicians when machinery breakdowns occurred, this resulted in standstill and the operators themselves applied the usual countermeasures such as rebooting the system (EOL). Going deeper in the weeks with high productivity with low downtime and high OEE I saw that the common problems occurred to a minor extent. This made it easier to have a continuous flow with a high level of productivity. There was no pattern in the timings for occurrence of the problems at the line but I identified the most frequently observed problems. In order for me to fully understand the current state of the system, I developed the following figure 3.

3. Description of Problems

When I took a closer look at the Figures I understood the different problem categories with their frequencies. For the robot cell, some of the frequently occurring chronic problems were dropping or throwing of parts, robot not setting the parts correctly, crashing of the robot arms with the plastic enclosure. One problem was "empty conveyor" which meant that after the body shell was assembled, the robot gets stuck and it couldn't put the assembled body shell on the conveyor for the next cell. These were problems which led to medium and major stoppages. These issues can be related to the equipment or the design of the assembled components. According to my opinion the arms of the robot and the gripping devices needed to be checked first in order to examine the cause of the problem. The other frequently occurring problems were home runs where the robot got stuck and changes had to be made in the computer to make the robot return to its home position. The reason for this can be sensor giving error in the reading or a chronic robot issue. From our perspective these issues were serious in nature and these should occur mostly during production startup as per theory of wastes in TPM, but in reality these were found to be everyday common problems. As seen in Figure 4.8 the most common problem category for EOL were rebooting of computer, re runs and robot crash. After discussion with the operators I found that these problems were related with each other. The robot got stuck when the final tests were going on and this lead to frequent computer hangs. Therefore it needed to be rebooted. This was also a cause for minor stoppage. According to my opinion the cause for this could again be sensor issues or maybe due to friction in the slide ways of the EOL which carried the clamping devices. There could however be other causes related to the built-in-quality from the previous stations. Since there were apparent problems in the robot cell such as not setting parts correctly, breaking of parts, etc. this could result in poor quality which made the robot arm getting stuck when it tried to pull the lever in different directions. Also, EOL was the final testing station and there were no quality checks after the robot cell except some visual checks for scratches. Thus, the in-process quality could be a serious issue.

4. Conclusions

The purpose of this study was to identify the root causes behind the different problems causing a high variation and disruption in the production flow. As said, due to the complexity of the line I choose an approach using an organizational framework to identify communication, problem solving methodology etc. Along with the qualitative data I used different quantitative performance measurement data to strengthen my result. I am of the opinion that I have managed to identify the reasons for not meeting the production targets and what should be the steps taken to reach those. The main recommendations for the assembly line are as follows:

1. The current performance measurement parameters are not enough to get the real picture of Assembly line. The other parameter that should be included is OEE.
2. The daily maintenance activities are inadequate and the company should initiate the implementation of TPM.
3. The process of TPM implementation should be started by working on the frequently occurring as robot dropping the parts, robot not putting parts in conveyor. For the EOL rebooting of computer and crash should be an area to begin focusing on. Furthermore constant monitoring of the problems should be carried out by the maintenance department.
4. The operators should be involved in the problem solving processes and should work with the maintenance department to identify root causes of the problems.
5. Training with regards to identifying waste as well as maintenance procedures should be given a priority.
6. In order to increase productivity the assembly line needs to increase its resources and invest in long terms solutions. As of today the everyday problems are solved with the use of countermeasures where the problems reappear. The company has to invest time and resources in creating improvement groups among operators to get to the root cause of problems.
7. From the financial analysis, it can be seen that along with losses due to shortage of labor, there also exists losses due to machinery breakdown. Thus if these are eliminated by root cause problem solving the company will be able to make more profit in the long run.
8. For being able to transition into a thorough lean manufacturing company, TPM is an important base.

The company strives hard to satisfy their customer needs but the assembly line faces problem in meeting the output of planned target. I can say that the company is an anorexic organization having a strategy of downsizing with permanent personnel reductions. There is a constant debate going on about the advantages of downsizing (Wilkinson, 2005). A further research study that could be carried out is how organizational effectiveness gets affected in "anorexic organizations" or how to strategically manage a downsizing process.

Finally, my delimitations included not considering the changeover activities but I believe that if they are focused upon it would further help in meeting production targets. If the changeover process is standardized, it might lead to a more consistent production output with improved quality of products. The further research that can be carried out is how the changeover process standardizing influences the quality of products.

References

[1.] T Fujimoto, A Takeishi. Automobiles: Strategy-based lean production system. Automobile statistics for Major foreign countries. 2001,1-33.
[2.] CR Kothari,. Research Methodology: Methods and Techniques. New Delhi: New Age International Publisher 2004.
[3.] J.K Liker & JM Morgan. The Toyota way in services: The case of lean product development. Michigan: Academy of management perspective; 2006.
[4.] Ison, RL. System thinking and practice for action research. The Sage Handbook of Action research Participative Inquiry and Practice. 2008, 139-158.
[5.] Holweg M. The genealogy of lean production. Journal of operations management, 25, 2007, 420-437.
[6.] Hines. P. & Rich, N. The seven value stream mapping tools. International Journal of operations & production management, 17 (1), 1997, 46-64.
[7.] Minda Industries Ltd. Annual Report.