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ENHANCING DELIVERY PERFORMANCE USING 8D METHODOLOGY

R. Jayachitra*[1], K. Punitharani[1], V. Vijay Anand[1]

[1*]Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Tamil Nadu, India.

ABSTRACT

In this article, eight disciplines problem solving method is used to continuously improve quality by eliminating the causes and prevent their reoccurrence. The Latch assembly line at an aerospace industry reported that "Customer is not happy with the order fulfillment of center guide assembly". The statistical data collected also revealed that delivery performance is observed to be 78.14% instead of 100%. A visual control analysis was done by implementing a visual control board and it was inferred that center guide assembly has some inherent capacity issues and can be improved by adding additional resources. Time study was carried out to validate the corrective actions performed. Then Ranked Positional Weight (RPW) method, a theoretical line balancing technique was adopted to balance the work element. Improvements were assessed and a Preventive Maintenance check list was developed to prevent recurrence of all similar problems. Finally, the team members were felicitated certificates for their efforts.

KEYWORDS

Delivery performance, Visual control analysis and Preventive maintenance.

Author for Correspondence:

Jayachitra R,
Department of Mechanical Engineering,
PSG College of Technology, Coimbatore,
Tamil Nadu, India.

Email: jayachitrapsg@gmail.com

INTRODUCTION

Cost and delivery are the key terms of any business enterprise. Each and every company in the world has its own motto but everything converges into a single motto "Customer Satisfaction". Customer expects more than satisfaction. Customer satisfaction is more important for sustenance and growth of an industry. This can be achieved by reducing the cost by maintaining the quality and on-time delivery of products and services. In this case study, delivery performance of center guide assembly used in aircraft was improved based on 8D approach, a versatile problem solving technique which emphasizes more on Quality enhancement. By adopting lean principles in the 8D approach which results in enhanced performance. 8D problem solving methodology was started by Ford Motor Company which takes 8 Disciplines and uses them to tackle engineering problems. 8D methodology is most commonly used to identify product and process improvements in larger organizations.

Literature Review

Hiroshi Katayama and David Bennett[1] examined the relationship between agility, adaptability and leanness in terms of their overall purpose and characteristics. Performance measures such as set up time, operational cycle time, variety of products that can be offered, procurement lead time, on-time delivery to customers, delivery lead time and speed of new product development have been analyzed under four process categories: operational processes, supply processes, order fulfillment processes and product development processes. Kushwaha[2] suggests that,throughout the time, the organization has continuously being upgrading the 8D method in terms of methodology and information technology. Since 2005. Mahamani[3] proposedabout an integrated supply chain, coordination of logistical activities is effectively extended to encompass source, make and deliver processes in collaboration with channel partners and suppliers.

Anthony[4] (2000) suggests that supply chain collaboration occurs when "two or more companies share the responsibility of exchanging common planning, management, execution, and performance measurement information" and that "collaborative relationships transform how information is shared between companies and drive change to the underlying business processes". Bowersox[5] proposed the use of collaborative and coordinated supply relationships was a crucial means by which Japanese companies were able to enhance their operational efficiency and effectiveness and, thereby, maintain a competitive edge. Willis[6] (1998) a successful partnership will not only lead to improved customer service but also to better utilization of resources, a reduction in inventory investment, and a reduction in emergencies, better working relationships, and increased profit for all links in the supply chain.

Carlos A Riesenberger and Sergio D Sousa[7], for the response time rules data already existed, however, to validate the measurement system it was somehow important to understand if all the customer assistants were measuring in the same way that is if they considered the correct time for the rules which were defined and report accurate measures to the file to track them. When each customer assistant was interviewed about the perception of the definition of each rule, their opinions seemed to be diverging and originate controversy among them.

8D Methodology

To improve the delivery performance of center guide assembly, the 8D approach of problem solving was considered. This methodology places an emphasis on the problem, the team members who have the appropriate skill sets, tools and tactics and results. It consists of the following eight steps as shown in Figure No.1.

Background of the problem

Better understanding of the problem is required to find the right solution for a problem. In this case study, as shown in Figure No.2, problem can be understood from the Voice of Customer (VOC) statement.

Voice of the customer (VOC)

Is a term used in business to describe the in-depth process of capturing a customer's expectations, preferences and aversions. In this case study, VOC was captured to understand the importance of the problem. VOC statements obtained converge to a specific VOC theme statement.

Critical to Quality (CTQ)

Statement is interpreted from the customer statement to an actionable, quantitative business specification. It should be in the form of measurable terms. In this case study, from the VOC theme statement obtained, CTQ statement has been framed which says that "All customer orders placed before 24 hours of the shift beginning are to be delivered 100% by the shift end of center guide assembly".

To analyze the statement obtained from the customer, statistical data of Demands Vs Supply rate was collected for the period of 3 months and was shown in Figure No.3. Based on Demand Vs Supply analysis, the delivery performance was observed to be 78.14% against the customer expectation of 100%. Hence to improve the delivery performance 8D methodology of problem solving could be utilized.

Discipline 1: Define the problem

From VOC and from Figure No.3, it was observed that delivery performance was poor. To identify the specific reason for the problem, capacity and management issues in the workstation has to be analyzed and identified (if any) as that may be the reason for the poor deliver performance.

Checking for the capacity constraint

Capacity constraint is a fundamental constraint that governs all planning activity. By comparing the takt time and standard time taken for assembly, theoretical constraint in the capacity can be identified. A graph is drawn between standard time and Takt time as shown in Figure No.4. Standard time taken for assembly (4.43 minutes) is less than the Takt time (4.6 minutes) and it can be clearly understood that there is no theoretical capacity constraint.

Standard Time Taken per Assembly=4.43 min

Takt Time = 4.6 minutes

Checking for the management losses

The management losses could be tracked by visual control analysis that contains a visual control board and a card which gives the details of working of a Manufacturing Order, its priority and reason for delay in the shipment. According to priority, the cards will be hanged in the board. As the operator starts the work, he will note down the start time and displays the card as per the work in progress. After the inspection is over, the card will be sent back to the supervisor for further analysis and tracking of the assembly details. The similar procedure was repeated for 21 orders.

Visual control board

SAP (Systems, Applications and Products in Data Processing) which is an enterprise software to manage business operations and customer relations indicates the date and time for the release of Manufacturing Orders (M.O). Similarly as indicated by the SAP, required no of M.O's will be released. Since the operators are not aware of the priority of the M.O (priority is estimated based on the shipment date) and as they are not instructed well before regarding the shipment date, they prefer to work with the M.O which is easier for them to assemble or to work with. Sometimes this leads to delay in shipment. The priority of M.O's will be displayed in the visual control board by means of color codes like RED color for high priority, BLUE color for medium priority and GREEN color for low priority.

Visual control card

Visual control card system tracks the reason for delay in release of M.O and delay in shipment. Also it gives information about the management issues like material shortage, man power shortage, equipment break down and power failure and its impact over the delay in shipment. Table No.1, shows the sample visual control card in the industry.

Results of VCA

Latch Assembly is a mixed model line for manufacturing Pallet Lock Assembly, Container Lock Assembly, Side Lock Assembly and Center Guide Assembly in a single shift.

It was observed that,

Manufacturing Order Release Date and Plan Shipment Date are same. It clearly indicates that high priority is given to the center guide assembly.

There is no problem due to other reasons like material shortage, man power shortage, and equipment breakdown and power failure.

Problem Definition

The poor delivery performance of center guide assembly line is due to some inherent capacity issues which indicate that wastes are hidden inside the process. The process can be improved by Adding additional resources and by continuous improvement

Discipline 2: Build a team

A three-member team was formed which included a member with process knowledge, a member who is an expertise in lean and problem-solving technique and a member to implement the improvements made.

Discipline 3: Interim Containment action

Interim plan is a temporary action made until a permanent action is done. As an interim action additional resources has been provided i.e., extended shift was operated or over time was given to compensate the delay in shipment and to satisfy the customer demand. Providing over time hours leads to increase in labor cost which increases the manufacturing cost and also increases the energy consumption. A permanent solution can be obtained by continuous improvement which is a lean technique adopted to identify and eliminate 7 types of wastes.

Discipline 4: Determine the root cause and Escape points

To determine the root cause, a brainstorming was conducted. It isolates the problem in future by standardizing the procedure to meet the requirements.

The flow chart in Figure No.5, represents the sequence of operation to be carried out to eliminate the problem and to meet the required delivery performance. First visual control analysis was conducted to check whether the problem is due to any capacity constraint. As a result of VCA, it was found that the problem was due to some inherent capacity issues. Video analysis was conducted to identify the inherent capacity issues i.e. hidden wastes. Improvements were assessed and a standard Preventive Maintenance check list was developed to prevent the reoccurrence of the problem by standardize the procedures.

Video analysis

Video analysis is done to identify the inherent capacity

Issues in the center guide assembly by permanently recording it. No of cycles is obtained using statistical approach.

$$n = \left(\frac{40\sqrt{n'\sum x^2 - (\sum x)^2}}{\sum x}\right)^2$$

From Video analysis, It was observed that the cycle time taken for center guide assembly is 939 seconds. It included 3 stations and in each station individual time required for assembly was obtained. Station 1 is the bush pressing station and it took 272 seconds for the assembly. Station 2 is the Pawl sub assembly station and it took 375 seconds for the assembly and the station 3 is the Pawl final assembly and functional test station and it took 292 seconds for the assembly. The time taken in individual stations and its comparison with the takt time has been shown below in the Figure No.6.

Balanced Delay = [3 (375) - 939] / [3 (375)]

= 0.1653 * 100 % = 16.53%

Line Efficiency=100%-Balanced Delay = 83.5%

The graph plotted between stations and task time showed that the station 1 which takes 272 seconds of task time lies within the takt time (276 seconds) whereas station 2 and 3 which takes 375 seconds and 292 seconds of task time exceeds the takt time by 99 seconds and 16 seconds respectively. Therefore stations 2 and 3 are considered to be the bottle neck processes.

Fish Bone diagram or Cause and Effect Diagram or Ishikawa diagram

It is one of the methods of identifying the root cause for the problem. It focuses on a specific issue without resorting to complaints and irrelevant discussions. It organizes and displays graphically the various theories about what the root causes of a problem may be. As an example, the problem of repetitive strain for the operator during bush pressing was studied using fish bone diagram and its root cause was identified as shown in Figure No.7.

Brainstorming

Brainstorming works by focusing on a problem, and then deliberately coming up with as many solutions as possible and by pushing the ideas as far as possible. It is a group or individual creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its member(s). Here, Brainstorming was done for a list of problems and corrective actions are carried out as given in Table No.2.

Discipline 5: Verify the Corrective Actions

Escape points were implemented in the workstation and was verified. For example, for the bush pressing operation, manual hand press was replaced by the pneumatic press which made it a comfortable operation for the operators from the ergonomics point of view. This eliminated the potential for the strain injury for the operators. Similarly other problems and its root causes were also verified.

Discipline 6: Validation of Corrective Actions

Corrective actions suggested or implemented are to be validated by making an analysis. Analysis is done by using a stop watch for 8 cycles. It is done with all the 3 stations as in Figure No.8.

It was observed that, after improvement task time taken for assembly was reduced in each station. In Station 1, task time was reduced from 272 seconds to 192 seconds i.e. reduced by 80 seconds. In Station 2, task time was reduced from 375 seconds to 355 seconds i.e. reduced by 20 seconds. In Station 3, task time was reduced from 292 seconds to 272 seconds i.e. reduced by 20 seconds. Also it can be seen that, 1 of 2 bottle neck processes has been eliminated. Since tasks are unevenly distributed among stations, line balancing can be done to balance the tasks between the stations.

Line Balancing

The objective in line balancing is to distribute the total workload on the assembly line as evenly as possible among the stations. The following are the methods to solve line balancing problem.

- Largest Candidate Rule
- Kilbridge and Westers method
- Ranked Positional Weight (RPW) method

Among the 3 methods, RPW is the best method as it takes into account both the Te(Element time) value and its position in the precedence diagram. In this method, a ranked positional weight value (call it RPW for short) is computed for each element. Specifically, RPW is calculated by summing Te and all other times for elements that follow Te in the arrow chain of the precedence diagram. Elements are compiled into a list according to their RPW value.

Line Balancing using RPW Method

From Figure No.9, we observe that, Station 2 only has the bottle neck process. Stations 1 and 3 have lot of unused time and the task of Station 2 can be distributed among the stations 1 and 3. For this, we use line balancing method to equally distribute the task among operators and to maximize line efficiency. Figure No.9 represents the process flow chart and listed in Table No.3.

Construction of table in order of RPW

Reassignment of work to different stations

From Figure No.10, it was observed that, all the stations are balanced and task times corresponding to stations 1, 2 and 3 are 271 seconds, 276 seconds and 272 seconds respectively. In all the stations task time is found to be within the takt time (276 seconds). No bottle neck processes are seen.

Balanced Delay = $\frac{3(276) - 819}{3(276)}$ x 100 % = 1.1%

Line Efficiency =100%- Balanced Delay =98.9%

The line efficiency before improvement was observed to be 83.5% and after improvement it was observed to be 98.9%. The line efficiency has been increased by 15.4% and shown in Figure No.11.

Improvement assessments

The number of components assembled per day has been increased from 78 to 100 which have met the requirement per day. The data is shown in Figure No.12.

Statistical data collected after improvements

After improvements are made, to assess the improvements, once again Demand Vs Supply rate data was collected for the period of 3 months. A Graph was plotted from the obtained data as shown in Figure No.13.

Based on Demand Vs Supply analysis, the delivery performance was observed to be 99.79% against the customer expectation of 100%

Discipline 7: Preventive Measures

Preventive measures are the procedures to prevent reoccurrence of this and all similar problems. A Preventive Maintenance check list was developed to standardize the procedures to prevent the reoccurrence of the problems which is shown in Table No.4.

Preventive Maintenance check list contains the tasks to be done by the operator on a daily basis or as advised by the line supervisor. The tasks to be done by the operator includes Cleaning the workstation and removing the unwanted materials, Checking for the tools and fixtures to be arranged in its place, To-Do list review and checking for the maintenance of the pneumatic press. The line supervisor reviews the station and acknowledges in the PM check list.

Discipline 8: Congratulate the team

The team members were congratulated for their efforts and they were felicitated with certificates.

Table No.1: Sample Visual control card

S.No	Sample Visual Control Card			
	Part No	**7718140-5**	**Qty per day**	**100 units**
1	Standard ime(Hrs)/ Assembly/Operator	0.22	Total Hrs (Min)	13.3
2	Plan M.O Release Date	02/06/2018	Reason for delay	-
3	Actual M.O Release Date	02/06/2018		
4	M.O received (shop) Date	02/06/2018	Time	8:00 am
5	Plan Shipment Date	02/06/2018		
6	Actual Shipment Date	03/06/2018		
Reason for delay (if any)				
7	i) Material Shortage Yes /No		No	
8	ii) Man Power Shortage Yes /No		No	
9	iii) Equipment Breakdown Yes/ No		No	
10	iv) Power Failure Yes /No		No	

Table No.2: Brainstorming observation, Root cause anaysis and corrective actions

S.No	Observation/Problem	Root Cause	Corrective/Preventive Action Taken
1	Tools are not found in specific place	No dedicated place for tools	Tools were mounted on the station and named separately.
2	Solvent containers are misused.	Solvent containers are not labeled and no dedicated place.	Solvent containers were labeled and a separate place was identified.
3	Hand press not positioned properly	No proper work area specified	Yellow mark mentioning the work area was specified around the hand press
4	Fixtures are not found in place	No dedicated place for fixtures	Fixtures were placed on a separate rack.
5	Manufacturing Order sheet was found to be kept on the 2 Bin box	No dedicated place for placing the Manufacturing order sheet	A separate place for placing the M.O sheet was identified
6	Operators were found searching for drawing files during assembly hours	Drawing Files and instruction sheets were not seen near the workstation	A separate place in the workstation was identified and kept in an easy to access area.
7	Work table found unclean as paint from the paint jar was spilled outside.	No dedicated place for paint jars	A separate place for paint jars were identified in workstation
8	Bins are not used for its specific purpose	Bins are not labelled	Bins were labeled and required 2 bin and other materials were kept.
9	Unwanted materials were seen in	No proper 5S was seen in	5S improvement was made

	the workstation	the workstation	and unwanted materials were removed.
10	Nitrogen jar was handled without safety precautions	No safety handling sheet was located in the workstation	Safety handling instruction sheet was kept near the nitrogen jar
11	Components for curing are kept in the workstation itself	No dedicated place for curing components	Curing components were kept in a separate place.
12	Potential for repetitive strain injury for the operator during bush pressing	Manual hand press is used	Manual hand press is replaced by pneumatic press.
13	If there is a problem in the station, each time operator seems to search for the line supervisor.	No Andon Lights available	Andon Lights are placed in the station.

Table No.3: Construction of table in order of RPW

Element	Task Description	RPW
1	Packing Removal	819
2	Referring to Drawings and Assembly Procedures – I	769
3	Bush Pressing	729
4	Grease Application and Spring insertion	669
5	Referring to Drawings and Assembly Procedures – II	627
6	Lock Lever, Roller, Pawl and Housing Assembly	588
7	Plate pin fixing and staking	549
8	Spring insertion and Assembly	475
9	Base and lever sub assembly	412
10	Referring to Drawings and Assembly Procedures – III	272
11	Base with lever and housing assembly	232
12	Ball insertion and Functional test	162
13	Cleaning, Label cutting and Pasting	92

Table No.4: Preventive measures

	Preventive Maintenance Check list				
Operator Name: ________ PM Date: ________ Next PM Due On: ________		Unit: ________ Last PM Date: ________			
S.No	**Tasks To be Done**	**Status**		**Problem if any**	**Sign of the Supervisor**
		Yes	**No**		
1	Clean the worksstation and remove the unwanted materials				
2	Check for tools are arranged in its place				
3	Check for fixtures are arranged in its place				
4	Check for drawing files to be kept near the worksstation				
5	To do list review				
6	Check for manitenance date of the pneumatic press				

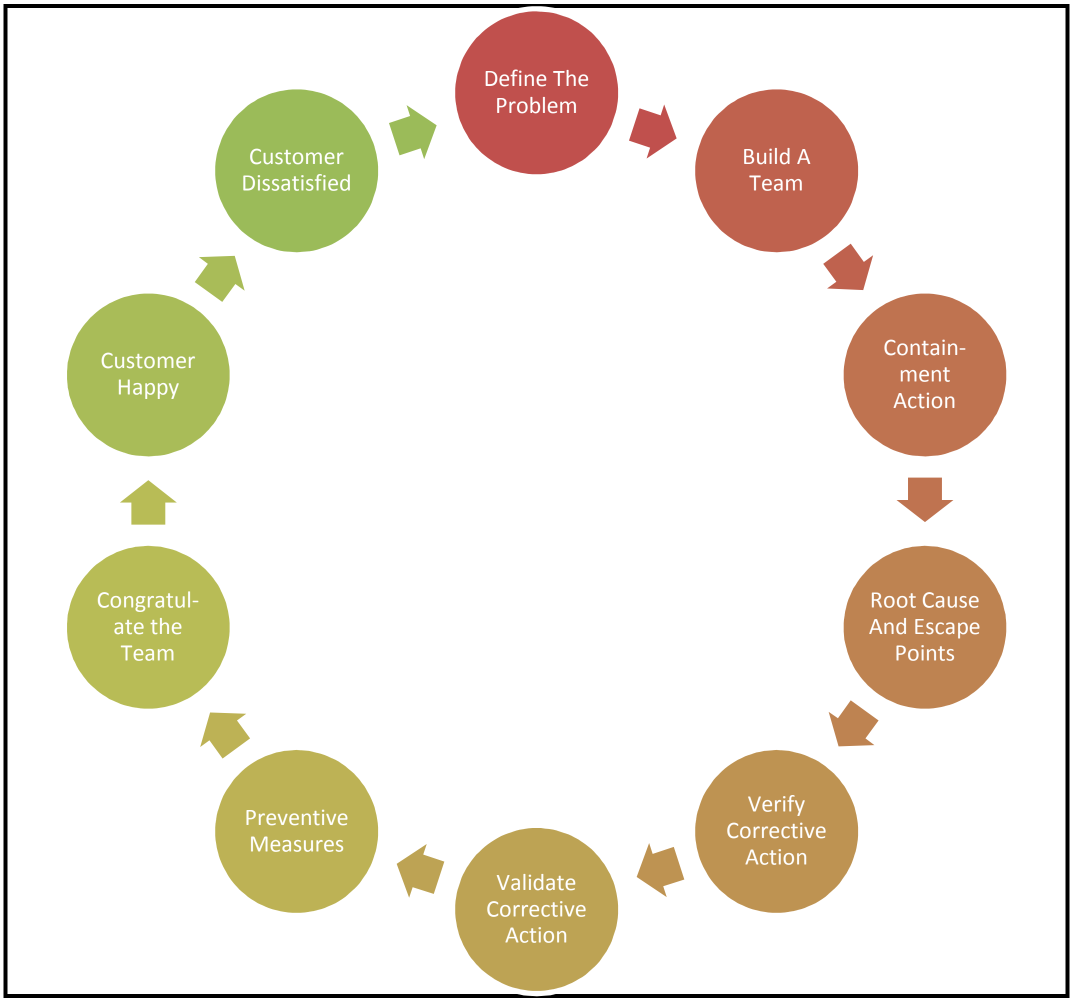

Figure No.1: 8 Steps of 8D Approach

VOICE OF CUSTOMERS

- "Orders placed on center guide assembly are not fulfilled"
- "Delivery performance is not good"
- "Shipment is delayed"

VOC THEME STATEMENT

"Customer is not satisfied with the order fulfillment of center guide assembly"

CRITICAL TO QUALITY STATEMENT

"All customer orders placed before 24 hours of the shift beginning are to be delivered 100% by the shift end in center guide assembly"

Figure No.2: Background of the problem

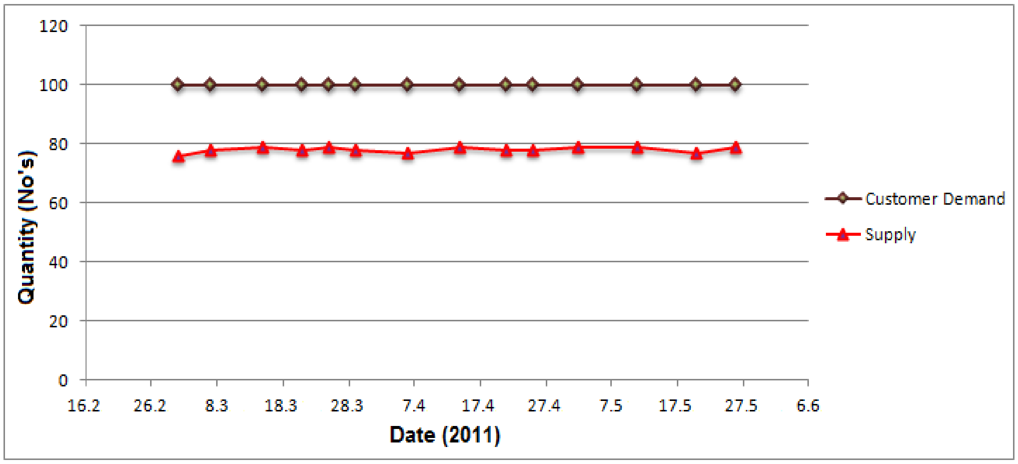

Figure No.3: Statistical data of demands Vs supply rate

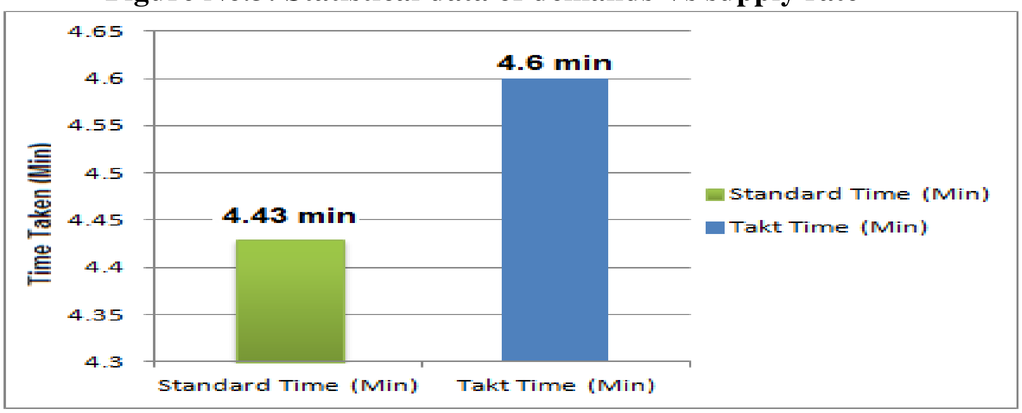

Figure No.4: Standard Time and takt time

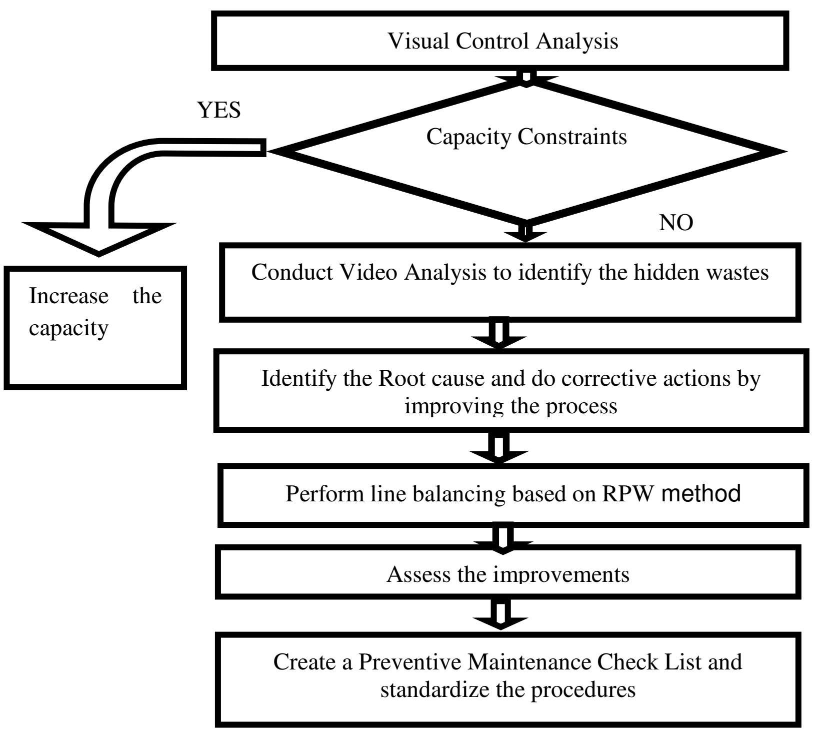

Figure No.5: Flow chart of process

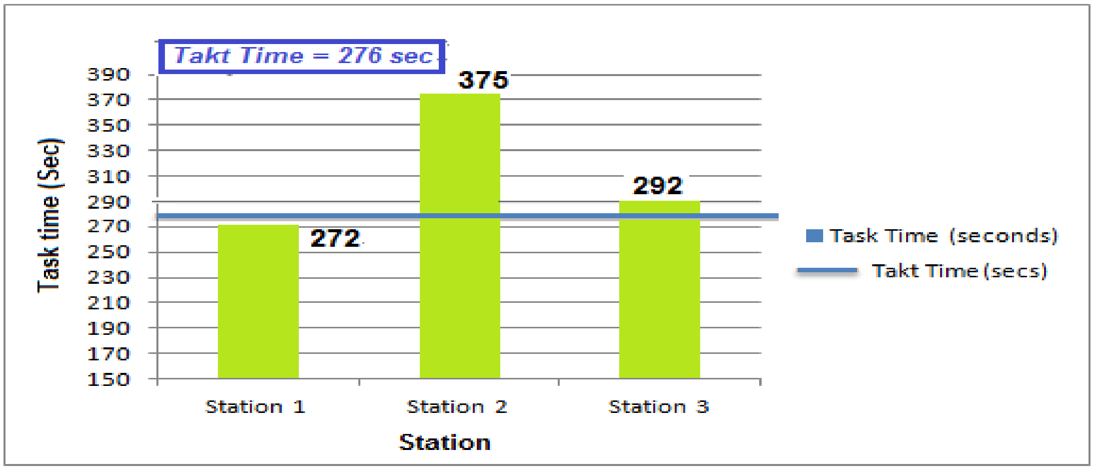

Figure No.6: Takt time comparison

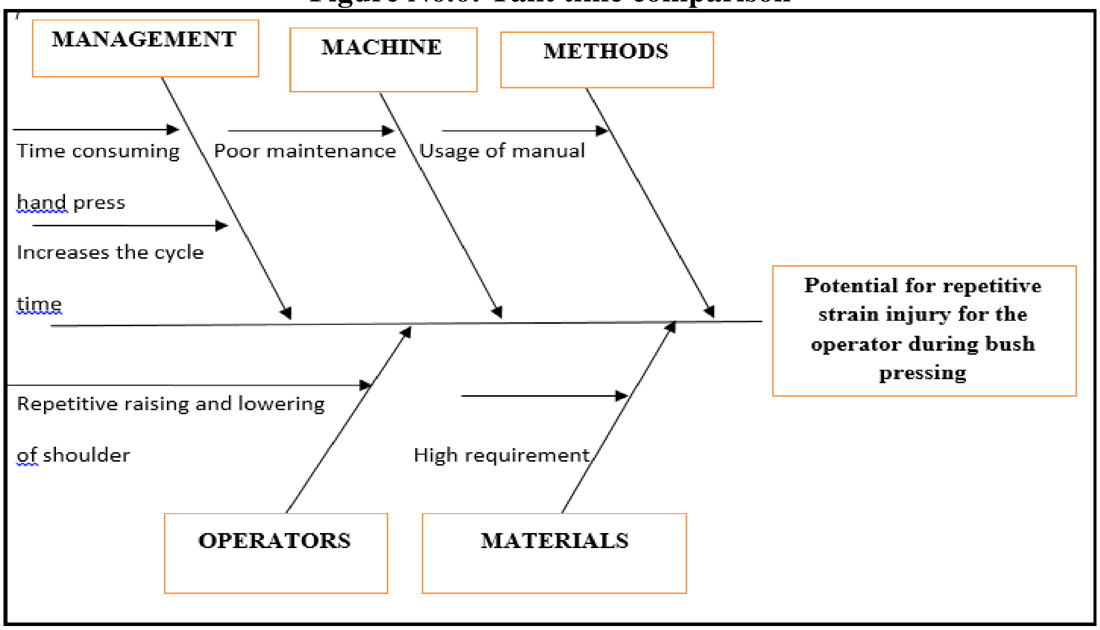

Figure No.7: Fish bone diagram

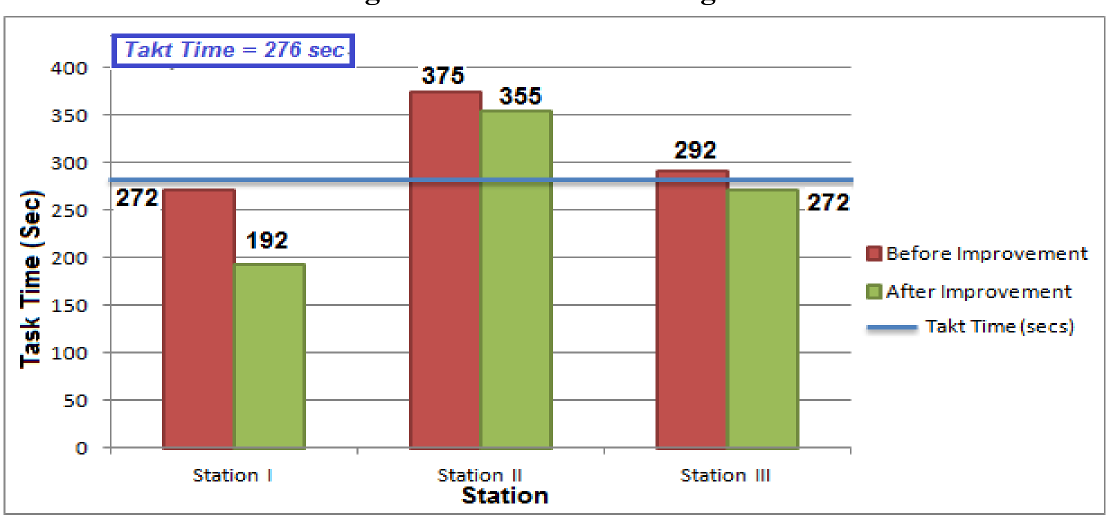

Figure No.8: Validation of corrective actions

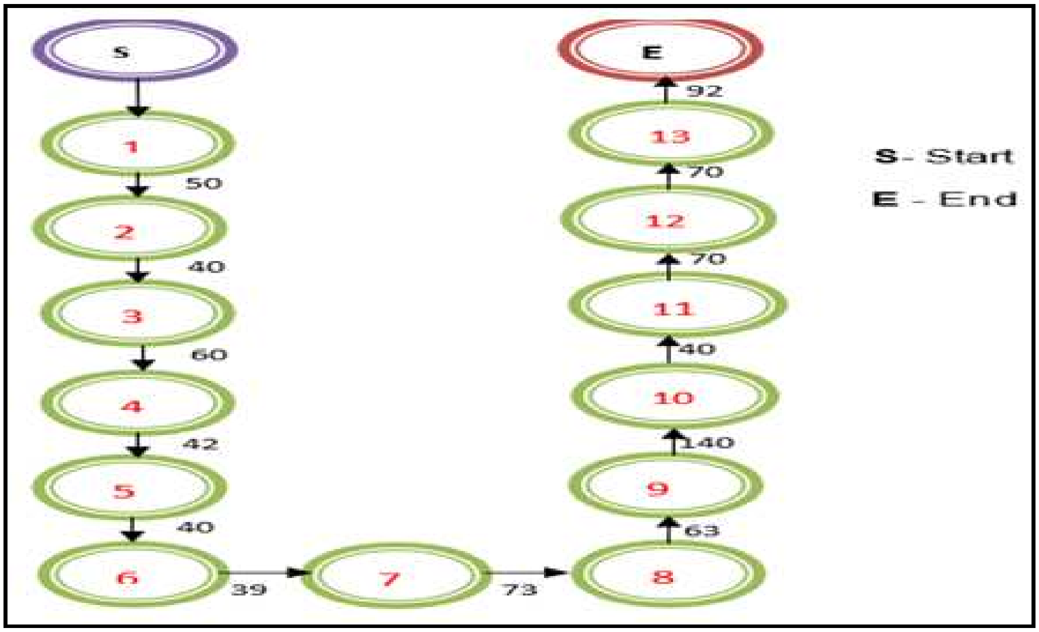

Figure No.9: Line Balancing

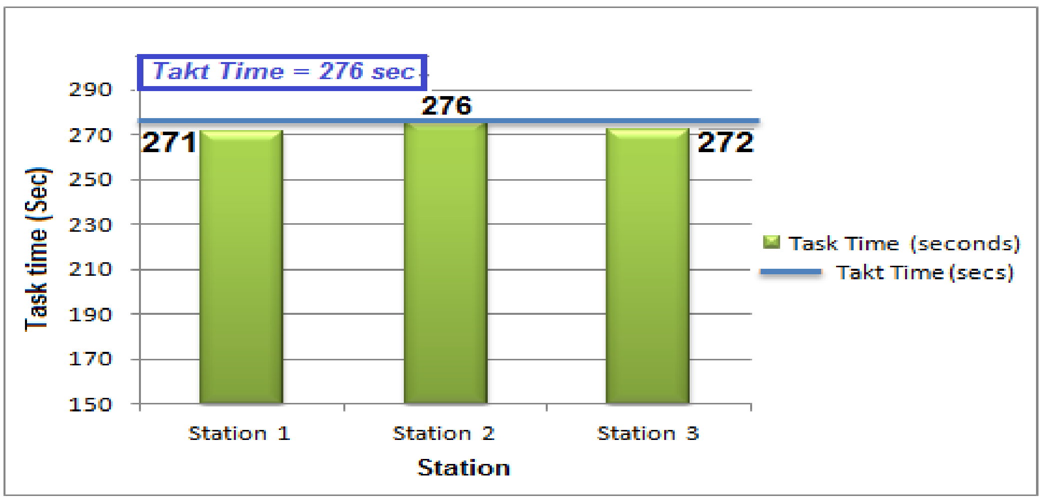

Figure No.10: Reassigning of work

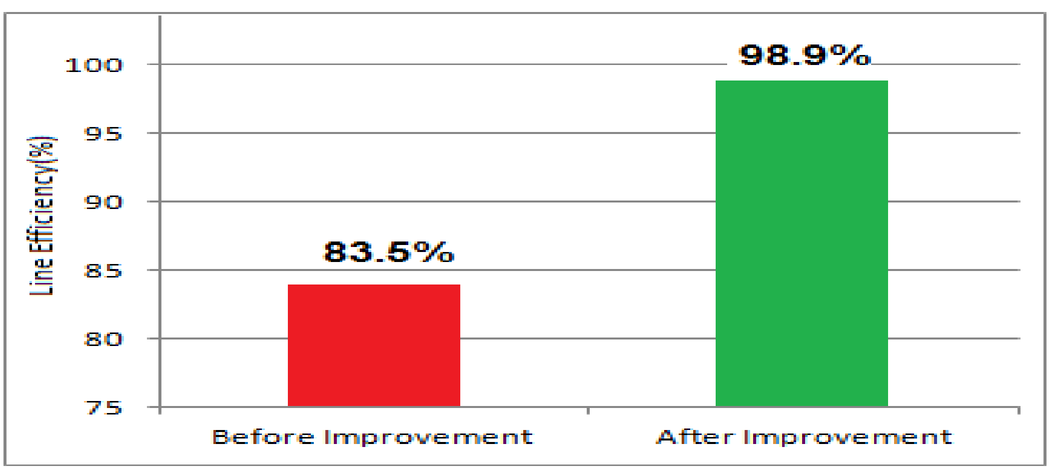

Figure No.11: Line Efficiency Results

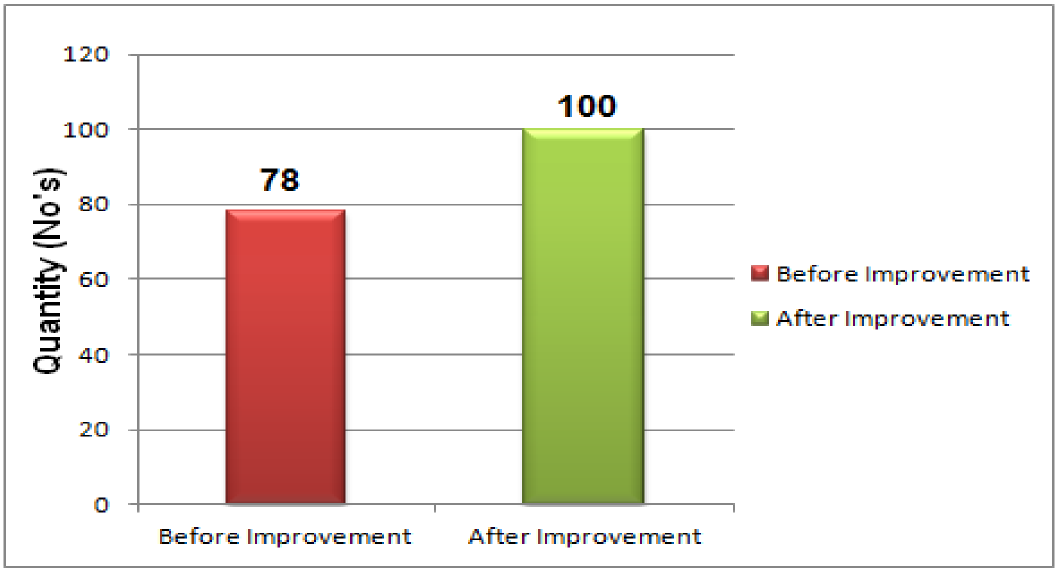

Figure No.12: Improvements in number of components

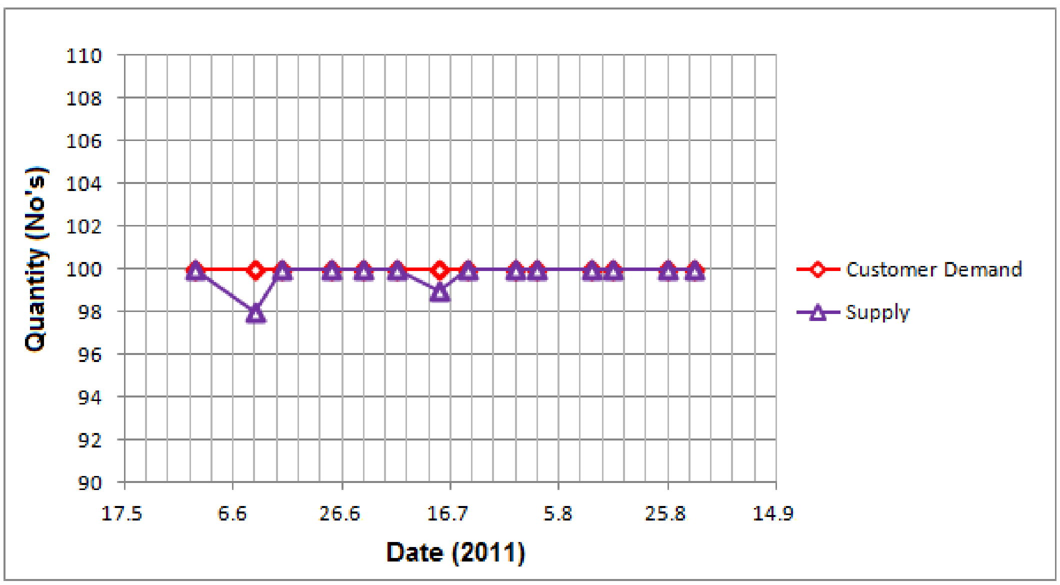

Figure No.13: Demand Vs Supply rate

CONCLUSION

The limitations in the delivery performance is obtained from the voice of the customers (VOC) and with the help of effective implementation of 8D methodology in the latch assembly line thereby altering the cycle time of three different stations within the take time. Hence the delivery performance is improved from 78.14% to 98.9%. Due to this, it is possible to satisfy most of the customers. Systematic approach combined with lean has eliminated the waste in the process.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

BIBLIOGRAPHY

1. Katayama H, Bennett D. Agility, Adaptibility and Leanness: A comparison of concepts and a study of practice, *International Journal of Production Economics,* 60-61, 1999, 43-51.
2. Kushwaha G S, Barman D. Development of a theoretical framework of supply chain quality management, *Serbian Journal of Management,* 5(1), 2010, 127-142.
3. Mahamani A, Rao K. Development of a spreadsheet based vendor inventory model for a single echelon supply chain: a case study, *Serbian Journal of Management,* 5(2), 2010, 199-211.
4. Anthony T. Supply chain collaboration: success in the new internet economy, *Achieving Supply Chain Excellence Through Technology, Montgomery Research Inc, San Francisco, CA,* 2, 2000, 41-43.
5. Bowersox D J, Closs D J and Stank T P. 21st Century Logistics: Making supply chain ıntegration a reality, *Council of Logistics Management, Oak Brook, IL,* 1st Edition, 1999, 264.
6. Willis A K. Creating win-win customer-supplier partnerships, *Hospital Materiel Management Quarterly,* 19(3), 1998, 15-22.
7. Carlos A. Riesenberger and Sergio D. Sousa. The 8D Methodology: An Effective Way to Reduce Recurrence of Customer Complaints? *Proceedings of the World Congress on Engineering 2010 vol III WCE 2010, June 30 - July 2, 2010, London, U.K,* 3, 2010, 1-6.

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