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Productivity Improvement in a Four Wheeler Seat Manufacturing Industry Using Lean Techniques

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Abstract

The industries along with the development of technology became competitive in nature. Moreover globalization made this scenario even worst. The productivity becomes vital element with product variety. The four wheeler seat manufacturing industries are badly affected by productivity issues due to high cycle time, unbalanced workload and improper layout. Our ultimate aim of this paper is to use lean methodology to improve productivity without affecting current working pressure in industry. The problems in the current layout are identified and analyzed through value stream mapping. Then the layout is modified in sub-assembly and workload is balanced in conveyor line. The results are compared with the current layout. The results revealed an improvement of 14% in productivity.

Keywords: line balancing and layout optimization, value stream mapping

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INTRODUCTION

One of the most important characteristics of manufacturing is cycle time. The customers expect their manufacturers to be responsive in delivering products on time. So, they are constantly leaning towards cycle time reduction of all the processes. Cycle time is an interval of time, during which a set of consecutive actions takes place repeatedly which in turn is defined as the time of longest operation in a sub-assembly and assembly line. If the line is balanced properly and sub-assembly layout is optimized it will reduce the cycle time. Value stream mapping is used to identify the NVA activities.

The four wheeler manufacturing industry finds problem in assembly section as cycle time taken by process is irregular and unbalanced. The scope of this paper is to use different lean tools such as line balancing, VSM, layout optimization and kaizen for improving the productivity by eliminating NVA activities and reducing production time.

LITERATURE SURVEY

Line Balancing

Assembly line balancing is the process of dividing the workloads between stations. So that workstations have equal time allotted and less time is wasted.

Santhosh [1] gave an idea about line balancing in truck assembly line, which helps to reduce cycle time of the process. Shamuvel [2] found that with help of line balancing it is possible to improve productivity and better utilization of resources.

Johan [3] identified that there is a less accuracy of standard time and a poor work arrangement. In order to overcome root causes, line balancing is suitable method.

Value Stream Mapping (VSM)
VSM is a method for analyzing the current state and designing a future state for the series of activity that take a product from its beginning through to the customer. At Toyota Inc, Japan it is known as material and information flow mapping.

Manoj [4] examined the process performance against the customer demand and satisfaction to the current state and achieved NVA reduction by 25% of seat assembly line. Vivek [5] gave an overview of elimination of nonvalue added wastes like bottlenecks, setup time, idle time etc., using VSM method. Sundar[6] explained about how the lean manufacturing is implemented in an organization.

Layout Optimization
Layout optimization is done to reduce the material handling costs, improves throughput and minimizes space requirements. Karthik [7] focused on meeting daily demand by improved utilization of man power and material flow in shop floor layout. Mahesh [8] increased layout utilization by changing the position of the existing resources or by introducing the new resources into the layout.

METHODOLOGY
The research methodology starts with detailed process study of firm and after further analysis, problem is selected. The data are collected for constructing current state VSM to identifying opportunities for change. The different lean tools, layout optimization and line balancing, are introduced after finding gap. The lean tools were implemented in firm to improve productivity.

Finally, the future state mapping shows the improvement achieved in process. The flow methodology is plotted in Figure 1.

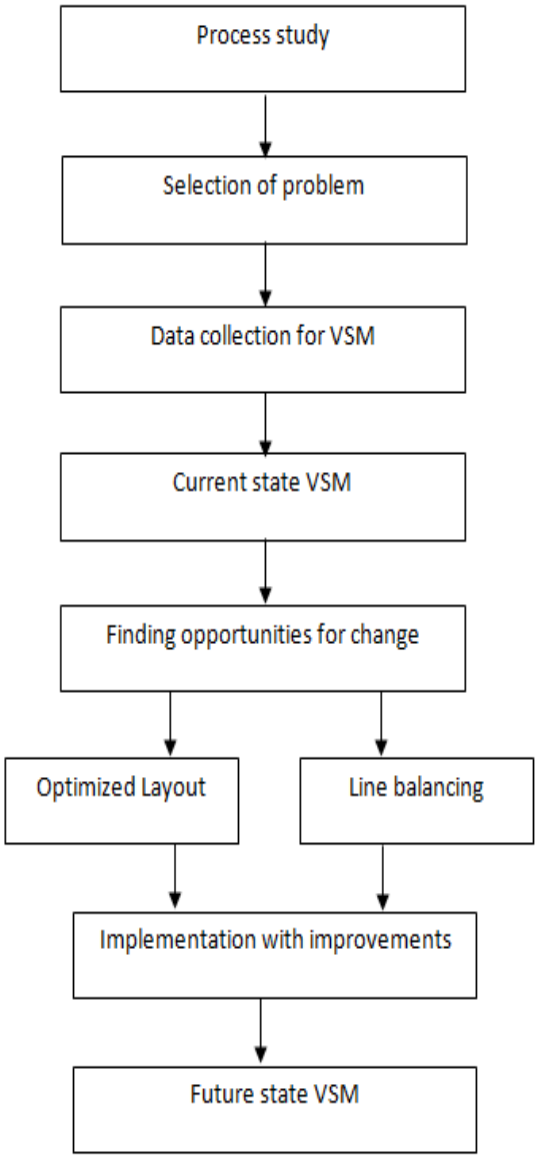

Fig. 1. *Methodology.*

Process Study
The four wheeler seat manufacturing company finds difficulty in competing with other players in market. But industry doesn't know exact reason behind it. For finding out reason, detailed process study of firm is advised by higher official. As a conclusion, some of the problems listed are high cycle time, unbalanced conveyor line and high raw material inventory.

Selection of Problem
Among various factors listed above, high cycle time and unbalanced conveyor line are major cause of lower productivity.

CURRENT STATE VSM

Data Collection for VSM

The value added time and non-value time of the overall seat manufacturing process are collected to create current state VSM and shown in Table 1.

Table 1. *Data for VSM.*

Stations	Value added time (minutes)	Non-value added time (minutes)	Total cycle time (minutes)
Sub-assembly	87	9	96
Conveyor line	88	77	165
Inspection	5	1	6
Rework 2	0	6	6
Packing	4.5	1.5	6
Dispatch	30	15	45

Takt Time

It is the time at which product should be produced to meet the demand of the customer. Industry operates 480 minutes per shift including 50 minutes break and there are 2 shifts per day and the customer demand is 45 sets of seats per day. The available time per day and takt time is calculated.

Available time per day = [2 shifts × {480 min – (50 min)
= 860 min.

$$\text{Takt time} = \frac{\text{Available time per day}}{\text{Customer demand per day}}$$

$$= \frac{860}{45}$$

= 19.11 min (or) 1146 sec

Current State VSM

VSM is a lean technique for analyzing current state and constructing a flow of the system level.

The current VSM is developed using the input parameters such as total cycle time, customer demand, transporting time, forecast, inventory, and takt time and shown in Figure 2.

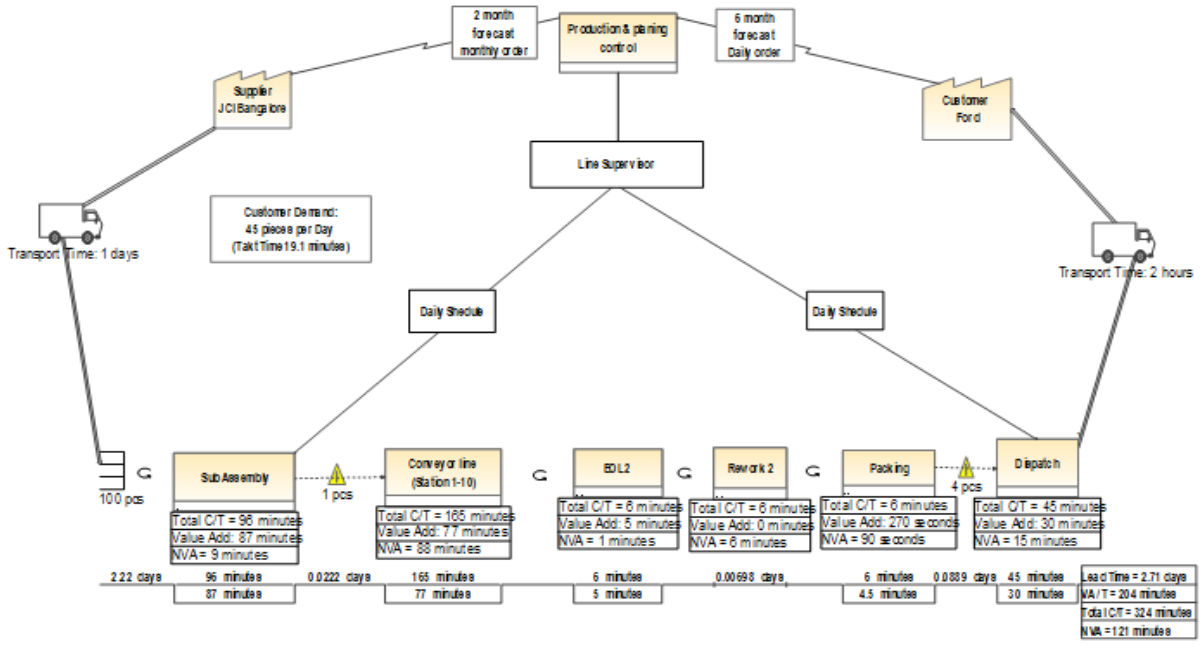

Fig. 2. *Current State VSM.*

Finding Opportunities for Change

From, the current state VSM unnecessary motions in driver seat track sub-assembly, improper workloads in conveyor line activities are identified. These NVA activities should be eliminated by using lean tool to improve the firm productivity. The suitable lean tools are layout optimization and line balancing.

OPTIMIZED LAYOUT

Current Layout

The current layout is having 6 stations and it is shown with operator movement as a spaghetti diagram in Figure 3.

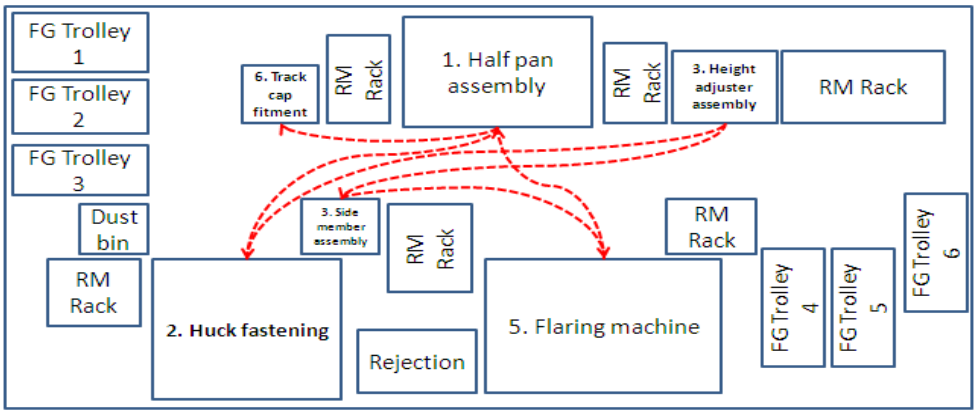

Fig. 3. *Current Layout.*

The total cycle time and operator movement for current layout are collected and is shown in Table 2.

Table 2. *Time Taken for Current Layout.*

Parameters	Driver seat track	Co-driver seat track
Value added time in (secs)	611	259
Non-value time in(secs)	212	127
Total cycle time in (secs)	823	386
Operator movement in (feet)	51	11

Proposed Layout

The proposed layout is having 5 stations. The station 3 and station 4 is combined, rearrangement of machines is done to reduce operator movement and it is shown with operator movement as a spaghetti diagram in Figure 4.

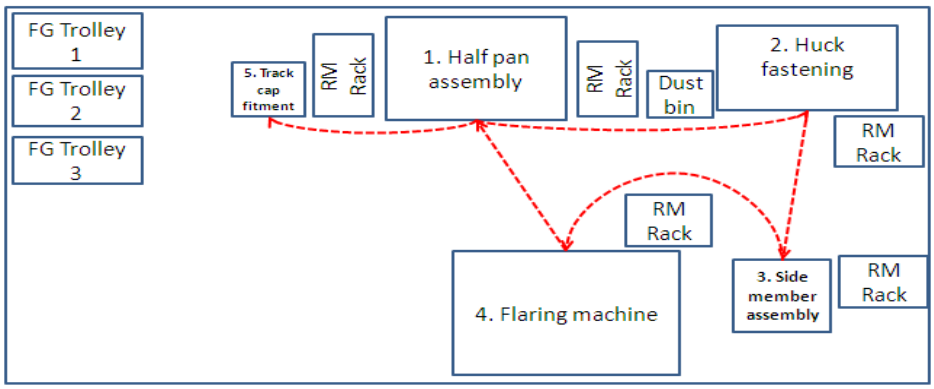

Fig. 4. *Proposal Layout.*

The total cycle time and operator movement for optimized layout is tabulated in Table 3.

Table 3. *Time Taken for Proposed Layout.*

Parameters	Driver seat track	Co-driver seat track
Value added time in (secs)	611	259
Non-value time in(secs)	102	127
Total cycle time in (secs)	713	386
Operator movement in (feet)	30	11

By implementing the proposed layout a firm can reduce cycle time from 823 seconds to 713 seconds and operator movement for driver seat track from 51 feet to 30 feet.

LINE BALANCING

Before Line Balancing

The lean tool, line balancing is used in conveyor line to balance the workloads between operators and reduce NVA activities.

The conveyor line is having 10 workstations and 8 operators. And the operation time of each station and immediate predecessor is shown in Table 4.

Table 4. *Operation Time for Each Station Before Line Balancing.*

Tasks	Station's activities	Operation time (secs)	Immediate predecessor
A	Cushion & part assembly	547	–
B	Scanning barcode	262	A
C	Armrest fitment	606	B
D	Back assembly & zip locking	228	C
E	Track cover & side assembly	22	D
F	Finished assembly	378	D,E
G	Steaming	280	F
H	Headrest assembly	119	F
I	Inspection	455	G,H
J	Rework	522	I
	Total operation time	3419	

Yamazumi chart is used to show the balance of operating time workloads between the operators in an assembly line. The chart is created to show the work load between operators and it is show in Figure 5.

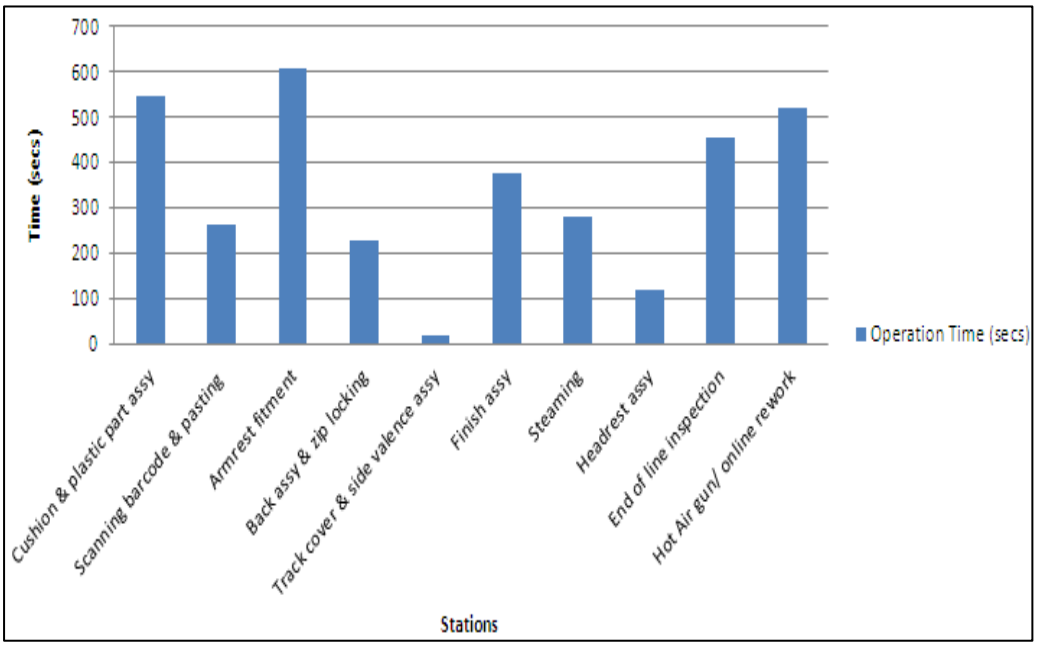

Fig. 5. *Yamazumi Chart Before Line Balancing.*

Efficiency of Line

The production line productivity could be evaluated by the results of the system efficiencies calculation. The efficiency of existing conveyor line is calculated.

$$\text{Efficiencyofline}(\%) = \frac{\text{Total operation time}}{(\text{Total number of work station x takt time})}$$

$$= 3419/(10 \times 1146.6)$$

$$= 0.2985 \times 100$$

$$= 30\%$$

Precedence Diagram

Precedence diagram shows the sequential task and relationships among operators and it shown in Figure 6. Based on precedence diagram, stations E, F and G, H is clubbed into single station shown in Figure 6 and station A, B, C, D, are balanced by dividing the work content between each operators to balance the line and it is reduced to three stations shown in Figure 7.

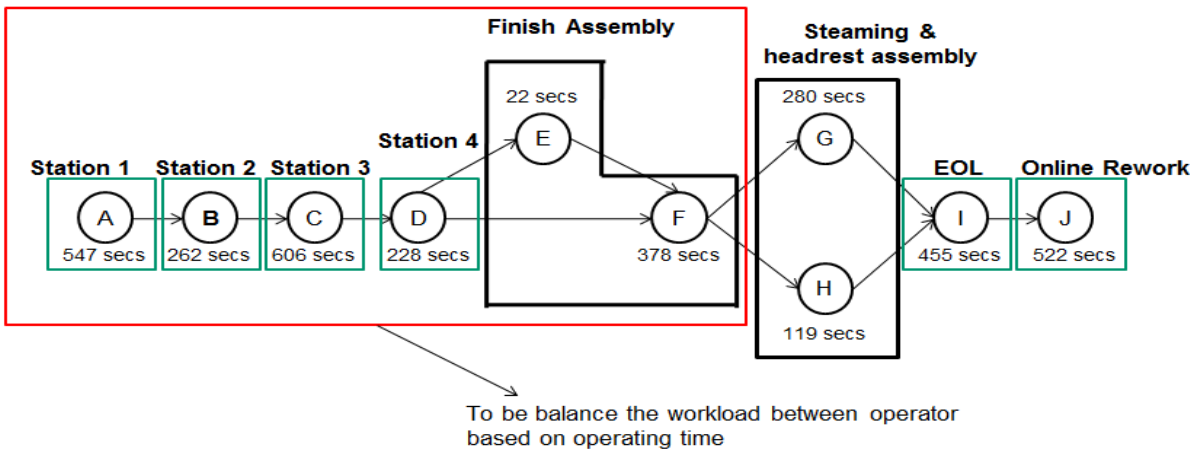

Fig. 6. *Precedence Diagram.*

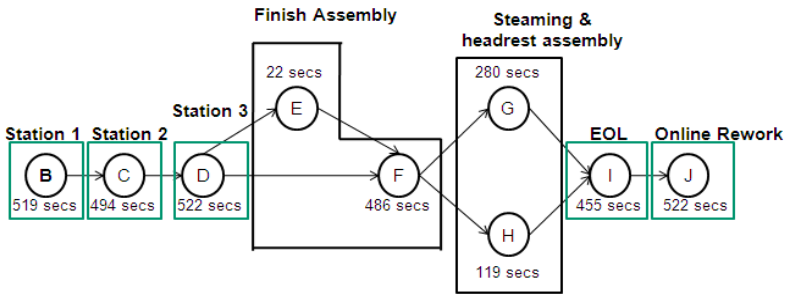

Fig. 7. *Precedence Diagram After Stations Clubbed.*

After Line Balancing

The balanced line with 7 station and operation time of each station is shown in Table 5.

Table 5. *Operation Time for Each Station after Line Balancing.*

Stations	Operation time (secs)
Cushion and part assembly	519
Mat and back assembly	494
Armrest assembly and zip locking	522
Finish assembly	508
Steaming and headrest assembly	399
End of line inspection	455
Hot Air gun/online rework	522

After line is balanced the chart is created to know the work load between operators and it is shown in Figure 8.

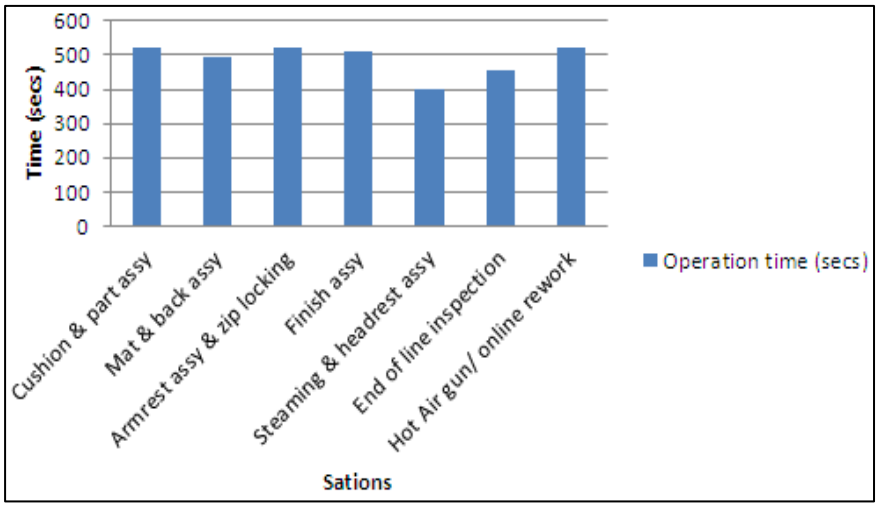

Fig. 8. *Yamazumi Chart After Line Balancing.*

Efficiency of Line – After Line Balancing

The efficiency of the conveyor, after line is balanced

$$\text{Efficiencyofline}(\%) = \frac{\text{Total operation time}}{(\text{number of work station after line balancing x takt time})}$$

$= 3419/(7 \times 1146.6)$

$= 0.4259 \times 100 = 42\%$

By balancing the conveyor line a firm can reduce the workstation from 10 to 7 and increased the efficiency of line from 30% to 42%.

FUTURE STATE VSM

The current layout is optimized and the workload is balanced. After the implementation, the future state VSM is constructed and is shown in Figure 9.

It shows that the total cycle time is reduced from 324 to 243 min.

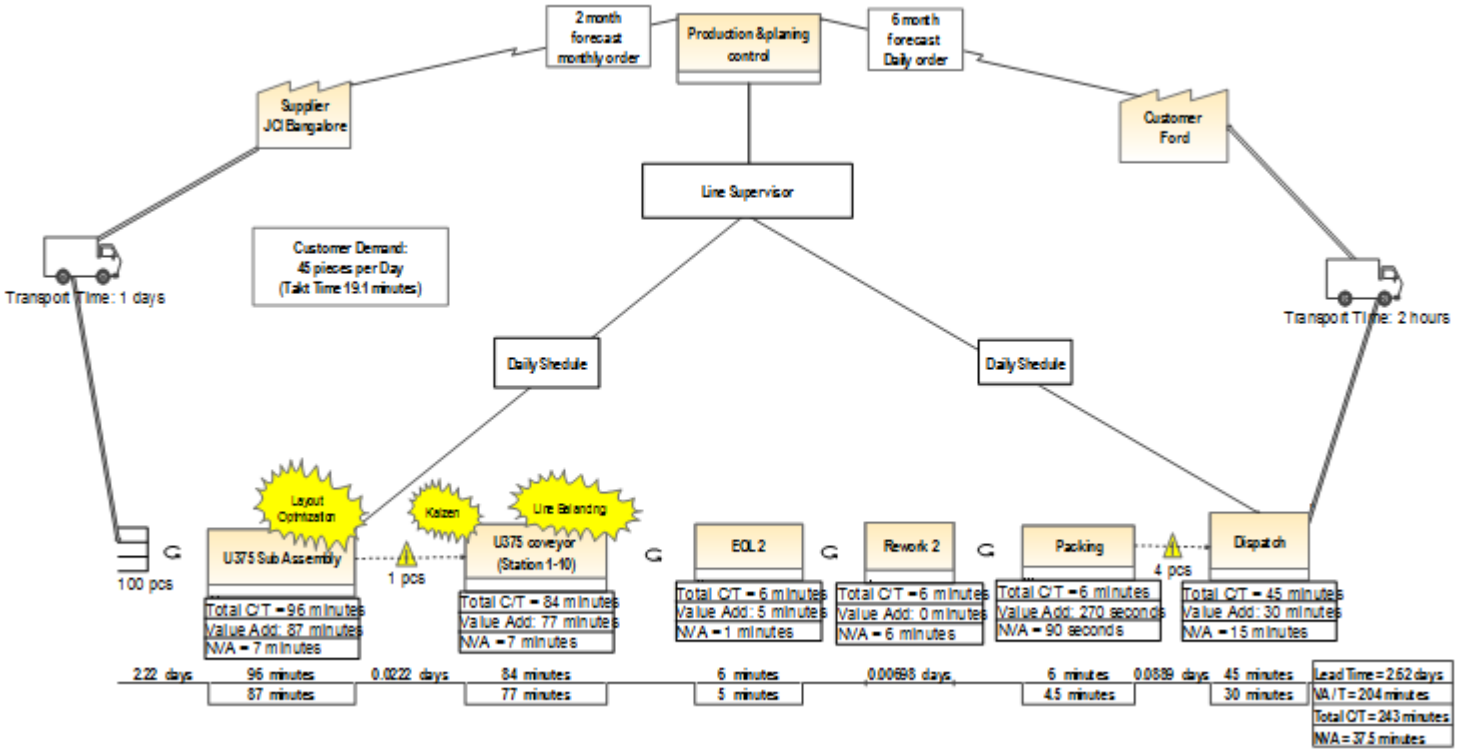

Fig. 9. *Future State VSM.*

CONCLUSION

The assembly process of a four wheeler seat is studied. The critical non-value added activities are identified from the current state VSM. Opportunities for improvement have been identified and future state VSM is constructed. Spaghetti diagram is created for current layout and optimized. Work load is equally divided among the operators in conveyor line. The solutions were implemented and studied, the following results were achieved:

- Total cycle time is reduced by 25%.
- Productivity of a seat manufacturing industry is increased by 14%.

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