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ENHANCING OVERALL LABOUR EFFECTIVENESS OF CSD WAREHOUSE BY ADOPTING LEAN TOOLS IN CONSTRUCTION EQUIPMENT MANUFACTURING PROCESS

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Abstract

Now a days in this fast growing industrial or non - industrial age everyone needs speed in manufacturing to cope up with customer requirement and the customer satisfaction. A sound measurement framework is something every manufacturer would like to have. Yet today most measurement systems focus on machinery effectiveness or production output. Manufacturers measurers time and attendance carefully but beyond that few have a method of understanding the effective use of their workforce. Overall Labour Effectiveness (OLE) is the key to understanding the effect of the workforce has on manufacturing performance and most important it provides a platform that helps diagnose and predict that performance. This paper is based on enhancing the productivity of warehouse through overall labour effectiveness with the help of industrial engineering tools in BULL Machines Private Limited, construction equipment industry. The construction equipment industry is specialize in producing backhoe loaders, smart loaders and skid steers etc. The most challenging issue in construction industry is effective productivity and good labour performance. The objective of this research is in dispatch section of warehouse not meeting the dispatch lead time of 48 hours to customers. Identifying value added activities, non value added activities and necessary non value added activities of labours in warehouse. The major factors considered in warehouse are identified in the pareto chart and implementing kaizen for improvements by applying lean tools like kanban and just in time concept to reduce the lead time. Calculations based on their availability, performance and conformance to requirements of work by labours in warehouse to reduce the lead time.

Keywords: Dispatch, Kaizen, Kanban, Value added, Non value added.

1. INTRODUCTION

Overall Labor Effectiveness (OLE) is a key performance indicator (KPI) that measures the utilization, performance, and conformance to requirements of the workforce and its impact on productivity. Similar to Overall Equipment Effectiveness (OEE), OLE measures availability, performance, and quality. In this paper quality been termed as conformance to requirements by the Crosby principle is applied to this OLE concept.

Availability – The percentage of time labours spend making effective contributions.

Performance – The amount of product delivered by the labour towards actual.

Conformance to Requirements – The percentage of perfect or saleable product produced.

However, OLE helps manufacturers understand the interdependency and trade-offs of shop floor productivity and profitability by measuring the contributions of the workforce. OLE gives manufacturers the ability to analyze the cumulative effect of these three workforce factors on productive output, while considering the impact of both direct and indirect labor. OLE supports Lean and Six Sigma methodologies and applies them to workforce processes, allowing manufacturers to make labor-related activities more efficient, repeatable and impactful.

Measuring Availability

There are many factors that influence workforce availability and therefore the potential output of equipment and the manufacturing plant. OLE can help manufacturers be sure that they have the person with the right skills available at the right time by enabling manufacturers to locate areas where providing and scheduling the right mix of employees can increase the number of productive hours. OLE also accounts for labor utilization. Understanding where downtime losses are coming from and the impact they have on production can reveal root causes - which can include machine downtime, material delays, or absenteeism - that delay a line startup.

Measuring Performance

When employees cannot perform their work within standard times, performance can suffer. Effective training can increase performance by improving the skills that directly impact the quality of output. A skilled operator knows how to measure work, understands the impacts of variability, and knows to stop production for corrective actions when quality falls below specified limits. Accurately measuring this metric with OLE can pinpoint performance improvement opportunities down to the individual level.

Measuring Conformance to Requirements

A number of drivers contribute to quality, but the effort to improve quality can result in a lowering of labor performance. When making the correlation between the workforce and quality it is important to consider factors such as the training and skills of employees, whether they have access to the right tools to follow procedures, and their understanding of how their roles drive and impact quality. OLE can help manufacturers analyze

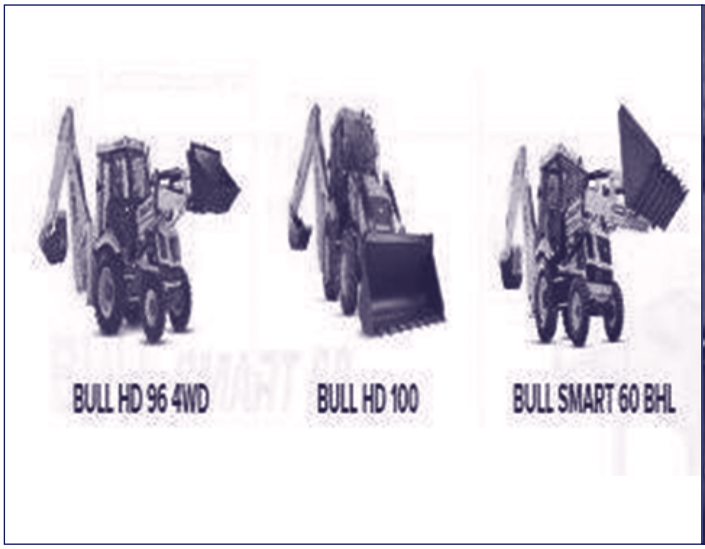
shift productivity down to a single-shift level, and determine which individual workers are most productive, and then identify corrective actions to bring operations up to standards.

1.1 Introduction To Company

This project is carried out in Bull Machines Private Limited Coimbatore. BULL Machines Pvt. Ltd is part of the 50 - year old Sandfits Engineering Group which has a turnover of more than Rs 400 crore. Established in 1998.BULL Machines has already made an impact in the world market by producing world class dedicated construction equipment vehicles, while it continues to remains as India's number 1 tractor attachment manufacturer for more than 16 years. Bull Machines has the capacity of producing 3000 vehicles per annum. Bull Machines worldwide sales and service network of 600 plus dealers and 7 branch offices across India and they sales around 28+ Countries. The Bull machines construction equipment industry is specialize in producing backhoe loaders, smart loaders and skid steers etc.

1.2 About The Warehouse

A warehouse is a building for storing goods. Warehouses are used by manufacturers, importers, exporters, wholesalers, transport businesses, customs, etc. They are usually large plain buildings in industrial parks on the outskirts of cities, towns or villages. They usually have loading docks to load and unload goods from trucks. Sometimes warehouses are designed for the loading and unloading of goods directly from railways, airports, or seaports. They often have cranes and forklifts for moving goods, which are usually placed on ISO standard pallets loaded into pallet racks. Stored goods can include any raw materials, packing materials, spare parts, components, or finished goods associated with agriculture, manufacturing, and production. The warehouse in bull machines are storing the spare parts of construction industry machines like backhoe loaders, smart loaders and skid steers. Bull machines are Original equipment manufacturing (OEM) industry for delivering various spare parts to dealers to the customers. The spare parts are been packed in three types tape pack, transparent pack and box pack. In the top of the spare parts the details of part been listed in sticker and hologram sticker is pasted on the spare parts**ses**



(a) Construction equipments vechicles in Bull machine industry

(b) CSD Warehouse in Bull Machine Industry

1.3 List Of Processes In The Warehouse

The most common operations in the warehouse are as follows

- Picking and Packing the spare parts.
- Stickering the spare parts.
- Placing the spare parts to the required bins in the racks.
- Checking bin cards of available spare parts in the bins.
- Checking sale orders and purchase orders.
- Updating Kanban board based on ROP and ROQ.
- Dispatching spare parts to the dealers of customers/ dealers by transport.

2. PROBLEMS FACED BY THE INDUSTRY

The problems faced by the industry at the dispatch section of warehouse not meeting the dispatch lead time of 48 hours to customers based on customer feedback. Initial causes are

- Ineffective use of time and Lack of training to adapt processes spelt out by method study.
- Time study not done to find standard time.
- Unavailability of required material/spares to pack and dispatch.
- Communication gap between receiving orders and passing on he order related information to dispatch section.
- Software bugs and undefined issues in the computer system.

2.1 Identified Problem

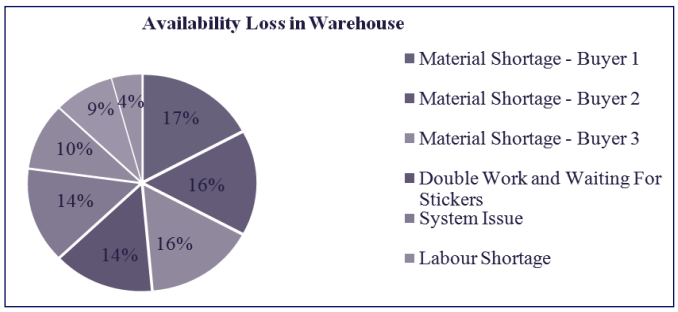
The problem identified in the warehouse by various factors affecting the availability, performance and conformance to requirement are listed below with table.

Table 1 - Factors affecting OLE in warehouse

PARAMETERS	FACTORS
AVAILABILITY	• Material Shortage Buyer - 1 • Material Shortage Buyer - 2 • Material Shortage Buyer - 3 • Double Work and Waiting for Stickers • System Issue • Labour Shortage • Insufficient Work Area • Packing Machine Issue Breakdown
PERFORMANCE	• Lack of Training • Instruction Delay 1 • Layout Issue • Bin Card Checking Issue • Instruction Delay 2 • Fatigue of workers
CONFORMANCE TO REQUIREMENTS	• Package Issue • Short Supply • Wrong Supply • Component Mixing Issue • Improper Placing of Bin Cards • Barcode Issue from Scanners

2.2 Availability Loss In Warehouse

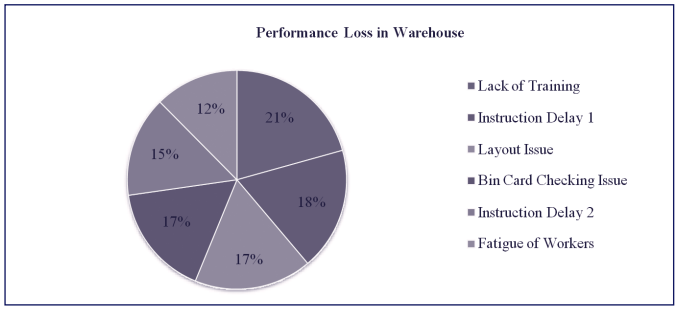
The availability loss data been collected for one month based on the factors affecting in warehouse of labour been listed in the pie charts.



(c) Available Loss in Warehouse

2.3 Performance Loss In Warehouse

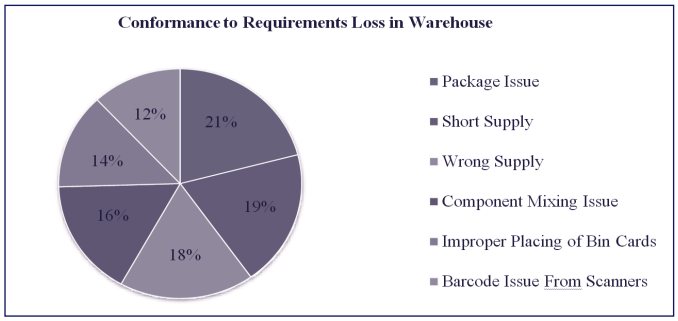
The performance loss data in warehouse has been collected for one month the various percentages of factors affects the performance of warehouse been listed in pie chart.



(d) Performance Loss in Warehouse

2.4 Conformance To Requirements Loss In Warehouse

The conformance to requirements loss in warehouse data been collected for one month the various factors affecting are listed in pie chart with percentages.



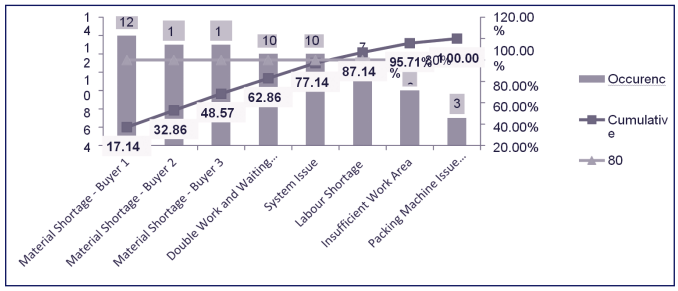
(e) Conformance to Requirements Loss in Warehouse

2.5 Determining Existing Ole Of Warehouse

The various factors affecting OLE of warehouse based on the losses of availability, performance and conformance to requirements are shown on pareto chart.

2.6 Availability Issues Of Ole In Warehouse

In availability of various issues of OLE in warehouse are listed in the pareto chart. By using the 80/20 rule.

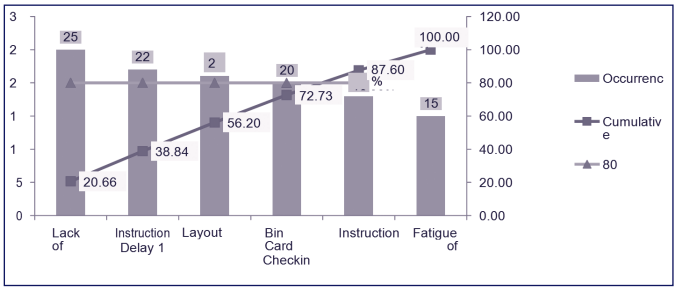


(f) Availability Issues of OLE in Warehouse

In this pareto chart describes that describes that below the cutoff point and the major issues occurred in the factors like Material shortage - Buyer 1 and Material shortage - Buyer 2 and Material shortage - Buyer 3 and double work and waiting for stickers and system issue are the main losses factors that affects availability issues in OLE of warehouse.

2.7 Performance Issues Of Ole In Warehouse

The losses in performance by various factors been listed in pareto chart and major factors been considered for the performance issue in warehouse.

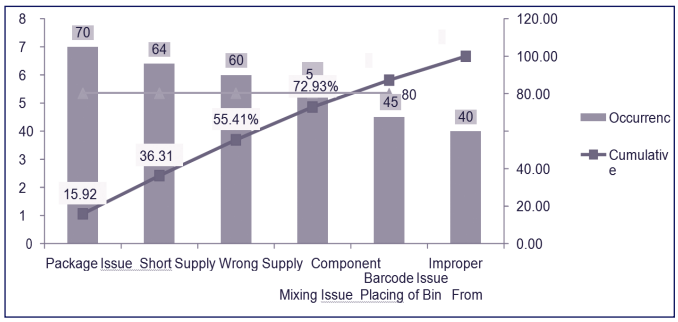


(g) Performance Issues of OLE in Warehouse

In this performance issue has a major factors like lack of training and instruction delay 1 and layout issue and bin card checking issue are all the major issues that affects the performance of OLE in warehouse.

2.8 Conformance To Requirements Issues Of Ole In Warehouse

The losses in conformance to requirements issues of OLE in warehouse by various factors are listed in the pareto chart.



(h) Conformance to Requirements Issues of OLE in Warehouse

In conformance to requirement major losses occurred in package issue and short supply and wrong supply and component mixing issue are the major issues that affects the quality of conformance to requirement in the warehouse.

2.9 Ole Calculation

The OLE calculation of warehouse based on their availability, performance and conformance to requirements for one month data been calculated are given below.

2.10 Availability Of Ole In Warehouse (Availability)

The formula for calculating availability of OLE in warehouse is Availability = [Planned Production Time of Labour] - [Unplanned Downtime of Labour] Planned Production Time of Labour

Planned Production Time of Labour = [Plant Operating Time of Labour] - [Planned Downtime of Labour] Plant Operating Time of Labour = 12750minutes

Planned Downtime of Labour = 2250minutes

Unplanned Downtime of Labour= 2135minutes

Planned Production Time of Labour = 12750 - 2250 = 10500minutes Availability = 10500 - 2135 = 0.7966 x 100 = 79.66%

10500

Availability of OLE in Warehouse = 79.66%

2.11 Performance Of Ole In Warehouse (Performance)

The formula for calculating performance of OLE in warehouse by the job card data of labours.

Performance = Actual Produced by Labour

Target achieved by Labour

Performance of Labour 1 = 161 / 236 = 0.6822 x 100 = 68.22%

Performance of Labour 2 = 180 / 285 = 0.6315 x 100 = 63.15%

Performance of Labour 3 = 3030 / 4279 = 0.7081 x 100 = 70.81%

Performance of Labour 4 = 2600 / 3993 = 0.6511 x 100 = 65.11%

Cumulative Performance of Labour =

$$\frac{0.6822 + 0.6315 + 0.7081 + 0.6511}{4} = \frac{2.6729}{4}$$

= 0.6682 x 100 = 66.82%

Performance of OLE in Warehouse = 66.82%

2.12 Conformance To Requirements Of Ole In Warehouse (Conformance To Requirements)

The formula for calculating conformance to requirements of OLE in warehouse is based on the wrong supply and short supply data of warehouse.

Conformance to Requirements =

[Total Units Started by Labour] - [Defective Units Produced by Labour]

Total Units Started by Labour

Total Units Started by Labour = 6748 Defective Units Produced by Labour = 96

Conformance to Requirements =

$$\frac{6748 - 96}{6748} = \frac{6652}{6748} = 0.9857 \times 100 = 98.57\%$$

Conformance to Requirements of OLE in Warehouse = 98.57%

2.13 Overall Labour Effectiveness (Ole) Of Warehouse

The Overall Labour Effectiveness (OLE) be calculated as by the formula is OLE = Availability x Performance x Conformance To Requirements

= 0.7966 x 0.6682 x 0.9857

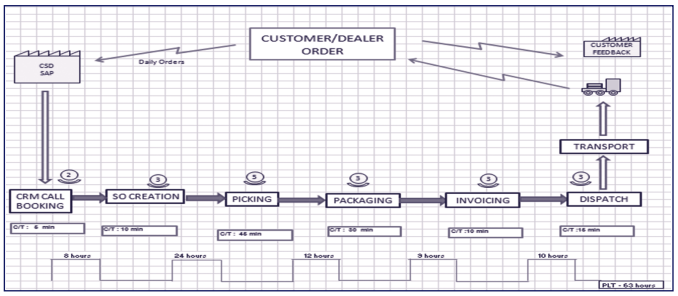
= 0.5246 x 100 = 52.46%

Overall Labour Effectiveness (OLE) of Warehouse = 52.46%

2.14 Value Stream Mapping

Value-stream mapping (VSM) also known as “material- and information-flow mapping”, is a lean management method for analyzing the current state and designing a future state for the series of events that take a product or service from the beginning of the specific process until it reaches the customer. A value stream map is a visual tool that displays all critical steps in a specific process and quantifies easily the time and volume taken at each stage. The purpose of value-stream mapping is

to identify and remove or reduce "waste" in value streams, thereby increasing the efficiency of a given value stream. The before state of VSM for CSD warehouse is done by VSM software is given below. Based on the pie chart and pareto chart losses are been identify for the scope of improvement based on implementing the lean tools to reduce the lead time.

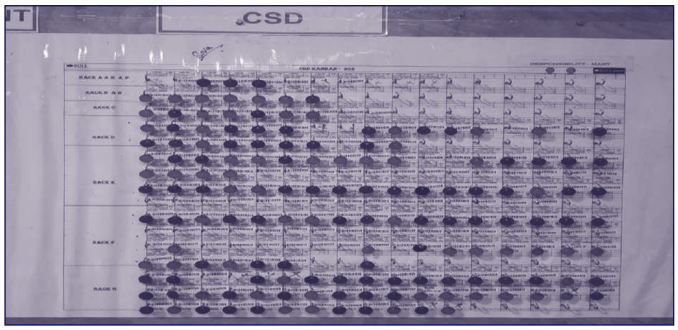


(i) Before State Vsm of Csd Warehouse

3. IMPLEMENTATION OF LEAN TOOLS

3.1 Kanban

Kanban is a lean method to manage and improve work across human systems. This approach aims to manage work by balancing demands with available capacity, and by improving the handling of system- level bottlenecks. Work items are visualized to give participants a view of progress and process, from start to finish usually via a Kanban board. Work is pulled as capacity permits, rather than work being pushed into the process when requested.Kanban is a method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed. Eliminates waste from inventory and overproduction. The Kanban board in CSD warehouse is given below.



(j) Kanban Board in CSD Warehouse

Kanban board signal cards been changed based on the ROP and blue token values of runner, repeater, stranger items are determined as follows:

- 8-12 Months = Runner
- 4-8 Months = Repeater
- 1-4 Months = Stranger

The 8-12 months are runner items it is also called as an fast moving items. And 4-8 months are repeater items it is also called as medium moving items. Then 1-4 months are stranger items it is also called as slow moving items.

- **Blue Token -** If an items inventory quantity exceeds beyond its inventory defined level then the blue colour token should be updated on the kanban board.
- **Green Token –** If an items inventory quantity is in between defined ROP and blue token level then the green colour token should be updated on the kanban board.
- **Red Token –** If an items inventory quantity when goes below defined ROP level then the red colour token should be updated on the kanban board.

Advantages of Kanban

- Better managed inventory levels.
- Smoother manufacturing flow.
- Work Life Balance.
- Overproduction elimination.
- Increased productivity & efficiency.
- Ability to focus.

3.2 Barcode Scanner

A barcode reader (or barcode scanner) is an optical scanner that can read printed barcodes, decode the data contained in the barcode and send the data to a computer. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating for optical impulses into electrical signals. Additionally, nearly all barcode readers contain *decoder* circuitry that can analyze the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.

(k) Barcode Scanner Implementation in CSD Warehouse

The barcode sticker been pasted in the bins and the spare parts items and in the racks. Then easily identifying the required spare parts in the bin by detecting the barcode based on the sale order by the labours.

Advantages of Barcode Scanner

- Barcodes eliminate the possibility of human error.
- Barcodes eliminate the possibility of human error.
- Barcodes are inexpensive to design and print.
- Inventory control improves.
- Data obtained through barcodes is available rapidly.
- Barcodes promote better decision making.

3.3 Kaizen

The Japanese word *kaizen* means "change for better", without inherent meaning of either "continuous" or "philosophy" in

Japanese dictionaries and in everyday use. The word refers to any improvement, one-time or continuous, large or small, in the same sense as the English word "improvement". However, given the common practice in Japan of labeling industrial or business improvement techniques with the word "kaizen", particularly the practices spearheaded by Toyota, the word "kaizen" in English is typically applied to measures for implementing continuous improvement, especially those with a "Japanese philosophy". Kaizen is a strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing process. Kaizen strategy applied in the CSD warehouse after implementing the barcode process are given below

(l) Before Barcode Implementation

(m) After Barcode Implementation

3.4 Kaizen Process Applied In Packing

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use. The package of spare parts made in three types they are tape, transparent and box pack. They are given below.

(n) Tape Pack

(o) Transparent Pack

(p) Box Pack

These are all the kaizen process applied in the CSD warehouse. In spare part item the barcode sticker and hologram sticker are pasted in all the individual spare part item in the CSD warehouse. Inside of barcode sticker part number of spare part and their quantity and price and the address are been printed in the sticker for identification.

Advantages of Kaizen

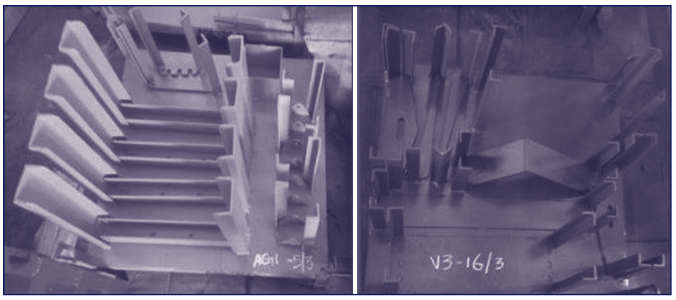
- Advantages of Kaizen:
- Waste reduction.
- Better safety.
- Improved employee satisfaction.
- Improved standard work document.
- Improved efficiency and teamwork.
- Kaizen builds leadership skills.

3.5 Just In Time

Just-in-time (JIT) manufacturing, also known as just-in-time production or the Toyota Production System (TPS), is a methodology aimed primarily at reducing times within the production system as well as response times from suppliers and to customers. Its origin and development was in Japan, largely in the 1960s and 1970s and particularly at Toyota. Pull parts through production based on customer demand instead of pushing parts through production based on projected demand. Relies on many lean tools, such as Continuous Flow, Heijunka, Kanban, Standardized Work and Takt Time.

1. Right Material - When needed
2. Right Place - Where needed
3. Right time - How much needed

By creating standard bins for CSD warehouse so that items from inside manufacturing parts will come as right material at right place in right time.



(q) Standard Bins for CSD Warehouse

The three bin concept been made first bin from cutting area second bin from welding area and third bin from assembly or

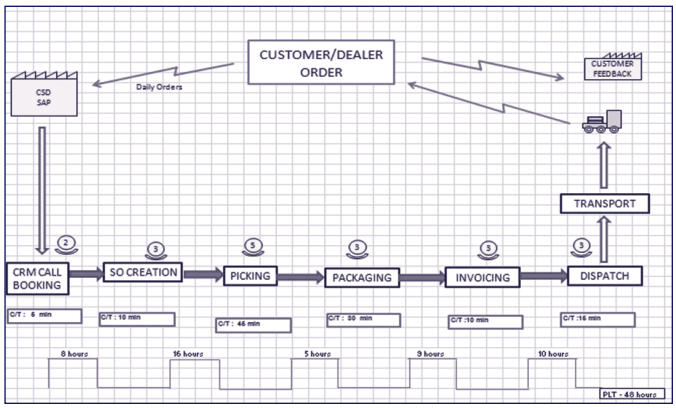
CSD warehouse area to achieve the lead time.

Advantages of JIT

- Reduced space needed.
- Smaller investments.
- Waste elimination/reduction.

4. AFTER STATE OF VSM

By applying all the above lean tools in CSD warehouse after state of value stream mapping been achieve the lead time. The after state of VSM is done by VSM software is given below. The major loss been taken from one month data of VSM software as CRM call booking and sale order creation and picking and packing and invoicing and dispatch sections areas been taken for implementing the lean tools to reduce the lead time.



(r) After State VSM of CSD Warehouse

The process lead time are reduced from 63 hours to 48 hours by reducing the lead time in all the areas. The main areas for reducing lead time are given below

- The lead time are reduced from SO creation to Picking in that picking area by applying kanban board and barcode system and just in time concept been used to reduce the lead time from 24 hours to 16 hours.
- Then the lead time reduced from Picking to Packaging area in that packaging area the packing system are been split into tape, transparent and box pack by a kaizen process to reduce the lead time from 12 hours to 5 hours.

4.1 Ole Calculation

After implementing lean tools OLE calculation of CSD warehouse based on their availability, performance and conformance to requirements for one month data been calculated are given below.

4.2 Availability Of Ole In Warehouse (Availability)

The formula for calculating availability of OLE in warehouse is Availability = [Planned Production Time of Labour] - [Unplanned Downtime of Labour] Planned Production Time of Labour

Planned Production Time of Labour = [Plant Operating Time of Labour] - [Planned Downtime of Labour] Plant Operating Time of Labour = 12750minutes

Planned Downtime of Labour = 2250minutes Unplanned Downtime of Labour= 1500minutes

Planned Production Time of Labour = 12750 - 2250 = 10500minutes Availability = $\frac{10500 - 1500}{10500} = 0.8571 \times 100 = 85.71\%$

Availability of OLE in Warehouse = 85.71%

4.3 Performance Of Ole In Warehouse (Performance)

The formula for calculating performance of OLE in warehouse by taking one month data from the job card data of labours in warehouse.

Performance = $\frac{\text{Actual Produced by Labour}}{\text{Target achieved by Labour}}$

Performance of Labour 1 = $\frac{216}{280} = 0.7714 \times 100 = 77.14\%$

Performance of Labour 2 = $\frac{290}{350} = 0.8286 \times 100 = 82.86\%$

Performance of Labour 3 = $\frac{3800}{4426} = 0.8586 \times 100 = 85.86\%$

Performance of Labour 4 = $\frac{3100}{3800} = 0.8158 \times 100 = 81.58\%$

Cumulative Performance of Labour =

$\frac{0.7714+0.8286+0.8586+0.8158}{4} = \frac{3.2744}{4}$

= 0.8186 x 100 = 81.86%

Performance of OLE in Warehouse = 81.86%

4.4 Conformance To Requirements Of Ole In Warehouse (Conformance To Requirements)

The formula for calculating conformance to requirements of OLE in warehouse is based on the wrong supply and short supply data of warehouse.

Conformance to Requirements = [Total Units Started by Labour] –

[Defective Units Produced by Labour]

Total Units Started by Labour

Total Units Started by Labour =

6800 Defective Units Produced by Labour = 50

Conformance to Requirements =

$\frac{6800-50}{6800} = \frac{6750}{6800} = 0.9926 \times 100 = 99.26\%$

Conformance to Requirements of OLE in Warehouse = 99.26%

4.5 Overall Labour Effectiveness (Ole) Of Warehouse

The Overall Labour Effectiveness (OLE) be calculated as by the formula is OLE = Availability x Performance x Conformance

To Requirements

= 0.8571 x 0.8186 x 0.9926

= 0.6964 x 100 = 69.64%

Overall Labour Effectiveness (OLE) of Warehouse = 69.64%

After results of OLE in warehouse

PARAMETERS	AFTER RESULTS OF OLE IN WAREHOUSE (%)
Availability	85.71
Performance	81.86
Conformance to Requirements	99.26
Overall Labour Effectiveness (OLE)	69.64

4.6 Financial Statement

The Financial statement of warehouse is before financial statement man power cost and transportation cost of wrong and short supply loss is Rs. 45000 per month and after implementing lean tools cost been reduced to Rs. 2000 loss per month. The loss of Rs. 2000 be the packing loss of spare items delivered to the customer/dealers.

Before & After Loss of Financial Statement

Parameter	Before loss of financial statement in csd warehouse (rs)	After loss of financial statement in csd warehouse (rs)
❑ Man Power Cost ❑ Transportation Cost of Wrong Supply & Short Supply	45000	2000

The spare parts items are send to the customer/dealer within 48 hours of lead time of work in CSD warehouse. The cost saving for one month been calculated after implementing lean tools like kanaban and barcode scanner and kaizen and just in time concept Rs. 43000 as a profit for the company.

5. CONCLUSIONS

OLE method are been used for achieving the lead time of CSD warehouse based on the availability of all the spare item are available in the warehouse by updating in the kanban board and performance of labours been calculated by the job card basis on daily task towards actual vs target and conformance to requirement been calculated based on the total good parts produced by the defective parts by the labours. And by combining all the values of availability and performance and conformance to requirement the overall labour effectiveness of CSD warehouse been identified. At finally lead time been achieved based on applying the lean tools in CSD warehouse. And the transportation cost of wrong supply and short supply to customer/dealer are been reduced. So OLE of CSD warehouse increased from 52.26 to 69.64 and the lead time are reduced by 63 hours to 48 hours by implementing the lean tools in CSD warehouse.

REFERENCES

[1] *Aynur Kazaz, Serdar Ulubeyli, Turgut Acikara and Bayram ER. (2016), "Factors Afecting Labour Productivity : Perspective of Craft Workers" science direct Procedia Engineering 164 (2016) 28 – 34.*

[2] *Ashok Sarkar , Arup Ranjan Mukhopadhyay and Sadhan Kumar Ghosh (2012), "Issues in Pareto analysis and their Resolution" Total Quality Management, 2013 Vol. 24, No. 5, 641–651.*

[3] *Abraham Grosfeld-Nir, Boazronen and Nir Kozlovsky, (2007) "The Pareto managerial principle: when does it apply?" International Journal of Production Research,Vol. 45, No. 10, 15 May 2007, 2317–2325.*

[4] *Bhimasen Soragaon, Nagaraj L Hiregoudar and S B Mallur. (2012), "Development of a Conceptual Model for the Measurement of Overall Worker Effectiveness (OWE) In Discrete Manufacturing SMES" (IJEIT) Volume 2, Issue 3, September 2012.*

[5] *Chris Ajila and Awonusi Abiola. (2004), "Influence of Rewards on Workers Performance in an Organization" J. Soc. Sci., 8(1): 7-12 (2004).*

[6] *Chetan Patel and Vivek Deshpande. (2016), "A Review on Improvement in Overall Equipment Effectiveness" IJRASET Volume 4 Issue XI, November 2016, ISSN:2321-9653.*

[7] *Himanshu Agarwal, Sohit Agrawal and Dr.Mukesh Pandey. (2013), "A Case Study on Labour Productivity" IRJET Volume: 03 Issue: 12 | Dec -2016.*

[8] *Hari Supriyanto and Mokh Suef. (2018), "Performance Evaluation Using Lean Six Sigma And Overall Equipment Effectiveness: An Analyzing Tool" Volume 9, Issue 8, August 2018, pp. 487–495, Article ID: IJMET-09-08-053.*

[9] *KRONOS. (2007), "Overall Labour Effectiveness (OLE)" incorporated in US based workforce management software and service company.*

[10] *Mohammadreza Salehi and Hadi Shirouyehzad. (2013), "Labour Productivity Measurement Through Classification and Standardisation of Products" Int. J. Productivity and Quality Management, Vol. 11, No. 1, 2013.*

[11] *Mr.A .A. Attar, Prof. A.K. Gupta and Prof.D.B.Desai. (2012), "A Study of Various Factors Affecting Labour Productivity and Methods to Improve It" (IOSR-JMCE) ISSN: 2278-1684, PP: 11-14.*

[12] *Mayur M Mhamunkar, Prof. Arun Kumar. (2017), "A Review on Employment of TPM to Improve OEE in Manufacturing Industry" DOI:10.15680/ IJIRSET.2016.0608155 Vol.6, Issue 8, August 2017.*

[13] *Pradeep Kumar, Raviraj Shetty and Lewlyn L.R. Rodrigues. (2016), "Optimizing a Production System using Tools of Total Productive Maintenance" (ICMMAE'2016) Dec. 14-15, 2016 at Pattaya (Thailand).*

[14] *Prachi R. Ghate, Prof. Pravin R. Minde. (2016), "Importance of Measurement of Labour Productivity in Construction " Reasearchgate 307138481.*

[15] *Ryad Tuma Hazem and Pramila Adavi. (2015), "Impact of External and Human Factors on Labour Productivity ofConstruction Projects in IRAQ" IJESRT SSN: 2277-9655 Scientific Journal Impact Factor: 3.449 (ISRA), Impact Factor: 2.114.*

[16] *Sivaraj. S and Dr.Vidivelli B. (2018), "Effective Productivity in Construction through LabourManagement" IRJES Volume 7, Issue 4 Ver. I (April 2018), PP. 46-55.*

[17] *Shree Raja Gopal T G and Murali K. (2016), "Analysis of Factors Affecting Labour Productivity in Construction" IJRSR Vol. 7, Issue, 6, pp. 11744-11747, June, 2016.*

[18] *Sachit Vardhan, Pardeep Gupta and Vaibhav Gangwar. (2015), "The Impact of Quality Maintenance Pillar of TPM on Manufacturing Performance" Proceedings of the 2015 International Conference on Industrial Engineering and Operations Management Dubai, United Arab Emirates (UAE), March 3 – 5, 2015.*

[19] *Samuel. H. Huang, John P. Dismukes, J. Shiqsu, Mousalam A. Razzak, Rohit Bodhale and D. Eugene Robinson. (2003), "Manufacturing Productivity Improvement Using Effectiveness Metrics and Simulation Analysis" INT.J. PROD. RES., 2003, VOL.41, No.3, 513-527.*

[20] *Zeeshan Ahmed, Sarwat Sabir, Mishal Khosa, Imam Ahmad, Muhammad Amjad Bilal. (2016), "Impact of Employee Turnover on Organisational Effectiveness in Tele Communication Sector of Pakistan" (IOSR- JBM) e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 18, Issue 11. Ver. V (November. 2016), PP 88-96*

[21] *Zahra Ehsanbakhsh Mostahsan and Seyedeh Somaiye Mirzaee. (2013), "Labour Productivity (Sagacity in Production and Consumption)" Singaporean journal of business economics, and management studies vol.1, no.6, 2013.*

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