Manufacturing Excellence Model To Solve Operational Risks Due To Product Demand Variations

Rohit Kenge*& Zafar Khan
Sandip University, Nashik, India
rohit.kenge@gmail.com

DoI:10.23862/kiit-parikalpana/2020/v16/i1-2/204565

Abstract

The dynamic product demand impacts the manufacturing supply cycle by creating some operational risks like high inventories, excess manpower, and underutilization of machines, etc. Business firms or companies get impacted financially due to the dynamic product demand with issues like rising finish goods, raw material, and in-process stocks or inventories, inefficient usage of resources like machines, water, and people, and excess or less manpower or job cuts.

We studied the lean manufacturing principle in a literature survey to understand the concept of the manufacturing excellence at the product manufacturing and its deployment to solve the above-listed issues due to product demand variations. Further, in research methodology, we considered the independent variable as dynamic product demand and the dependent variable as operational risks like high inventories, excess manpower, and underutilization of machines. We plotted the value stream map for the selected product manufacturing with daily demand 25 and 40 numbers to understand the operation risks that occur after changing the demands.

We proposed consolidated manufacturing excellence models for solving the operational risks and after deployment of them; we again plotted the value stream map for the selected product manufacturing with daily demand 25 and 40 numbers. We got gain of in the case of the daily 25 demand, total lead time reduced from 14.6 to 7.82 days that is 46.44% for in-house product manufacturing and in the case of the daily 40 demand, total lead time reduced from 26.18 to 15.18 days that is 42.01%. Total lead time in both cases is reduced by +40% that helped product manufacturing.

We conclude this research study as our manufacturing excellence models are successful in delivering the expected results at our selected product manufacturing.

Keywords: - VSM, Lean, Manufacturing Excellence Model, Inventory, Operational Risks.

Introduction

Background

The dynamic product demand impacts the manufacturing supply cycle by creating some operational risks like high inventories, excess manpower, and underutilization of machines, etc. Business firms or companies get impacted financially due to the dynamic product demand with issues like rising finish goods, raw material, and in-process stocks or inventories, inefficient usage of resources like machines, water, and people, and excess or less manpower or job cuts (Kenge, Rohit. & Khan, Zafar, 2020). We are addressing this statement of the problem by finding a consolidated business development model for manufacturing operation scope and standardizing it.

Definition

An actual manufacturing process consists of four parts that are man, machine, material, and method. Lean manufacturing is focused on detecting, preventing, or reducing, and eliminating waste in the process. The standard lean tools application at the manufacturing process involves five steps that are,

a. Defining customer value or requirement.

b. Value stream mapping for the defined value by considering all the steps, further identify and eliminate the non-value-added process in it.

c. Designing the value stream by eliminating all the waste in the process which will reduce the overall lead time (James P Womack and Daniel T Jones. March 1, 2003).

d. Customer Pull deployment in the complete value stream.

e. Standardize all the improvements done in the process.

Six Sigma, Lean manufacturing, and TQM that is total quality management are some of the tools used to manage manufacturing operations (D. Rizzardo and R. Brooks, 2003); (Hoyle, David, 2007). While each tool has a distinct set of actions, they all try to remove the wastage from the manufacturing process by optimizing the resources availed (Kokemuller, Neil, 2020).

Objective

To analyse the different operational risks caused by the product demand variations and provide a consolidated business excellence model for manufacturing to reduce it.

Literature Review

The framework of the customer to customer manufacturing operation

A framework of the customer to customer manufacturing operation is explained in figure 1 as below,

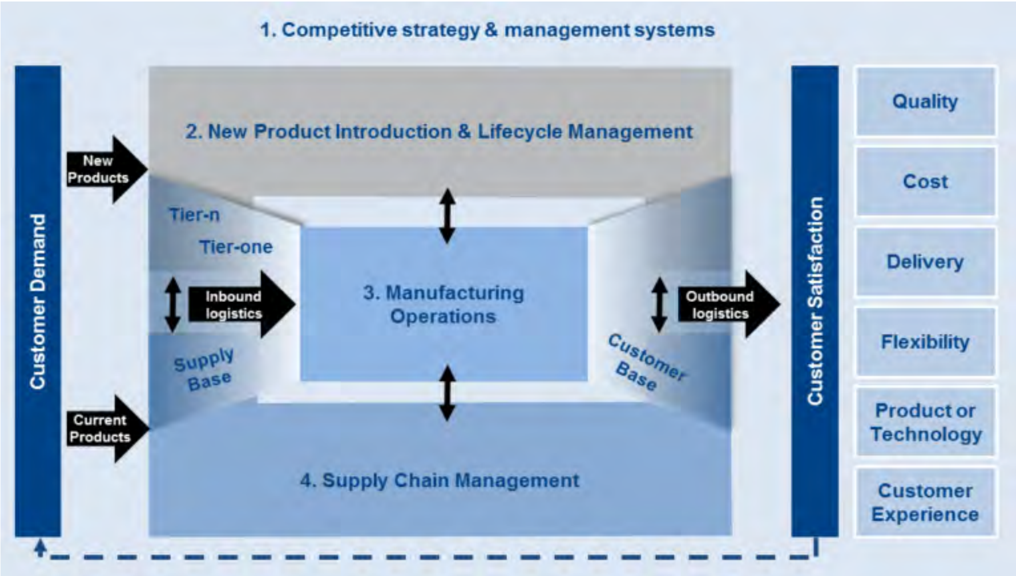

Figure 1: Manufacturing Operation Cycle (Industry forum, 2020)

Lean Manufacturing implementation

Lean manufacturing implementation involves key techniques namely Waste Elimination in the complete value chain (Merrill Douglas, June 2013), Continuous improvement i.e. Kaizen, Human respect, Production levelling i.e. Heijunka, Just in Time i.e. JIT, Single piece flow, Built-in quality, Mistake proofing i.e. Poka-Yoke, and Detecting defects through automation i.e. Jidoka (Page, Julian, 2003). . Let us discuss the nine Lean manufacturing tools in detail as below,

Waste Elimination

Lean can be termed as "with as little waste". Common Waste in the product manufacturing process is high inventory, not required resources, big size workstations, as it requires higher travel time between the workstations, Bottleneck operations, Excess manpower is deployed at a limited task, and process automation lacking (Christine Wheeler, Feb 17, 2014). The workflow is tracked from station to station and each work station is analyzed to reduce the above-mentioned types of wastage. Total process waste elimination is difficult in one go, however continuous improvement can be deployed to eliminate most of it (Tanya, February 12, 2019).

Kaizen that is Continuous Improvement

The process improvement first step is tracking and documenting the complete station to station of the production process. We need to identify wastage, gaps, and inefficiency in our documented production processes and continuously improve it. Hence, continuous improvement and waste elimination work together (Rever team, January 29, 2019). An employee who is working at the analyzed station tells problems and possible improvement solutions for continuous improvement (Mika, Geoffrey L, 1999).

Human respect

The third lean technique is human respect that ensures a provision of the best work experience to employees for getting a consistent performance. Some examples of best practice provision are No overwork allocation to any of the employee, proper work training to all employees, allocation of the work targets aligned with their work purpose, targets review should be practiced for accountability, target achievements and gaps in it need to be found out with probable causes, also communicate individually to each employee for the closing of the gap with fewer disputes and to perform their work easily, further allocate challenge in their allocated work by rotating them to have variety in work. If we give our employees respect, they will give the best quality work output.

Heijunka that is Production Levelling

Production levelling states that every day our output will be the same. Based on our regular order booking status, every day we need to produce 80% the same output of the total booked order plan. On a day if excess quantity produced over the levelling plan, it can be moved to "fluctuation stocks", and on a day if we produce lesser quantity, we can utilize this fluctuation stock (Villanovau, Feb 6, 2018). Stock is considered as waste in the lean principle, but "fluctuation stock" reduces the in-process WIP by a big amount. The production rate must balance the dispatch rate to prevent the high FG inventory. Heijunka that is production levelling is applied to the products having a longer lead time of production and delivery or complex in sizes, also for the make-to-stock products. In make to stock case our "fluctuation stock" allow us to cater to the sudden booked orders (Jamie R. Friddle, 2020).

JIT that is Just in Time

JIT means no excess production. The final goal of JIT is minimum raw material inventory, WIP, and FG inventory. Production managers must plan a strategy to fight with sudden problems namely machine breakdown, absenteeism of manpower, and late raw material supply (Martin Murray, October 12, 2020). Make to order product suites to JIT than production levelling, as "fluctuation stock" in levelling immediate consumption is not predictable (Cleartax, Jun 05, 2020).

Single Piece Flow

Single piece flow is an action to reduce the in-process WIP and bottlenecks in the production. As a single piece flow itself is one WIP at a time that eliminates the in-process WIP and improves the product quality as the focus is increasingly on a single piece (Ottomotors, Aug 24, 2017). Travel time gets reduced between stations to the station as the distance is zero (Ben Mulholland, January 5, 2018).

Built-in Quality:

The process must be capable of producing defects less and built-in quality products. Process defect types are manual error, machine breakdown, or wrong product supplied on an assembly line (Kanbanize, 2020). These defects may be prevented or eliminated by either Poka-Yoke or Jidoka that is automatic detection of defects on the line.

Poka-Yoke that is error proofing

Error proofing is the prevention of errors in three systematic ways (RNA Automation, 2020) at source error identification, prevention, and elimination.

Jidoka that is the automatic detection of defects on the line

The machine is checking the product to detect or prevent the occurrence or passing of the defect to the next station without a manual check. After detecting the error machine alarms the worker who is working at that machine, further, he gets to know that some error has happened.

Methodology

An Empirical Hypothesis statement three

The dynamic product demand impacts the manufacturing supply cycle by creating some operational risks like high inventories, excess manpower, and underutilization of machines, etc. We assumed the above condition in the following way,

- Independent Variable: Dynamic Product Demand
- Dependent Variable: Operational risks like high inventories, excess manpower, and underutilization of machines, etc.

Primary Data Collection

We are going to plot the Value stream map (Manos, Tony, June 2006) for the complete product manufacturing cycle for the sample original electrical products manufactured at the Nasik District to understand the different operational risks caused by the dynamic product demand. We plotted a value stream map for in-house Product manufacturing with the daily demand of 25 Numbers as shown below in Figure2,

Next, we plotted a value stream map for complete Customer to Customer Product delivery with the daily demand of 40 Numbers with as shown below in Figure3,

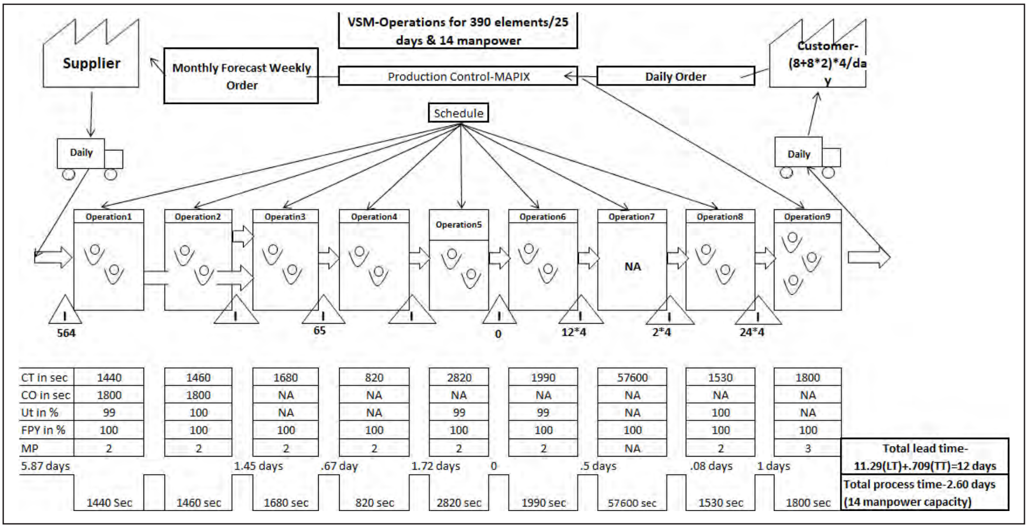

Figure2: Value Stream Map for Product with the daily demand of 25 Numbers

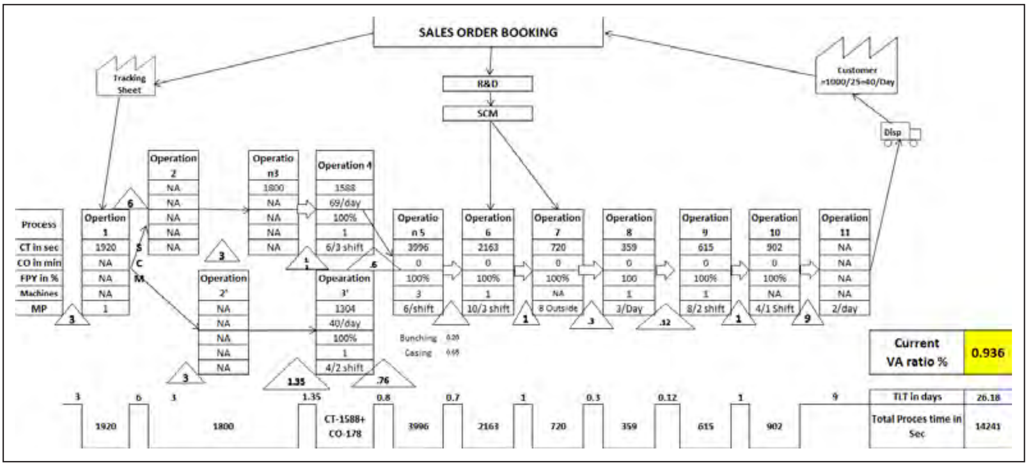

Figure3: Value Stream Map for Product with the daily demand of 40 Numbers

Analysis of the collected Primary VSM data

We analysed the following key operational risks from the above two Value Stream Mapping data for the same product with daily demand 25 and 40 numbers,

1. Inventory level increases for the lower daily demand for the same product manufacturing.
2. Total lead time increases as the inventory between station to station increases in days.
3. Higher inventory's results in higher space consumption, it may

further lead to safety issues for the operator's working at the work stations within reduced space than earlier.

4. Raw Material quality may degrade as waiting time is higher in case of the lower daily demand.
5. Manpower excess issue occurs for lower daily demand if demand changes suddenly.
6. Machines utilization or overall equipment efficiency for lower demand is not good.

The solution to answer the above operational risks due to changing demand

1. Industry 4.0 improves employee work-life, their productivity, and reduces the operation cost in mass manufacturing processes (Padovano et al, January 1, 2018). Industry 4.0 may be a boon in the CORONA pandemic by the deployment of its key principles like digitization, networking, and internet use. It also tries to deploy automation that communicates in real-time (Kenge, Rohit. & Khan, Zafar, 2020).
2. SCM 4.0 is the consolidation of big data, IoT, and AI by deploying internet networks, sensors, and data analysing tools at the process for consumer satisfaction (Mckinsey, October 27, 2016). The Supply chain overall efficiency improves by eliminating digital waste in the process. SCM 4.0 try's a granular, faster, efficient, flexible, and digitized manufacturing process. The SCM 4.0 principles create a change in manufacturing agility, capital cost, and service (Kenge, Rohit. & Khan, Zafar, 2020).

From the above data, we proposed the following model number 1 and model number 2 for deployment at the product manufacturing to answer the operational risks we listed,

Market Support-Customized Business	Objective-Reduction of response time @15% in 1st attempt
	Key focus area Identified-FMS Implementation
	Flexible Manufacturing system application strategy
	Develop customer response system (IT solution)
	Implementation of FMS to improve response Time

⇩

Product Quality	Objective-Quality defect reduction
	Analysis of Existing process
	Identifying the actions for each Workstation improvement and Plan for Implementation of action defined

	Organization post Go-live (Responsibilities/escalation)
	Six Sigma deployment
Lean knowledge platform	Objective-Lean Six Sigma deployment at internal stakeholders
	Selection of stakeholder
	Study and make a proposal
	Workshop for Implementation
	Lean platform-Preparation of Knowledge database
	Lean Platform database ready online
Digitization under Industry 4.0 and SCM 4.0	VSM
	Flow Levelling
	Standardization
Supplier Portal	Define Team
	Group strategy on SRM tool
	Finalization of potential vendors from the purchase side
	Group SRM functionality availability & assessment
	Alternate at the local level to be explored

Table1: Manufacturing excellence model1

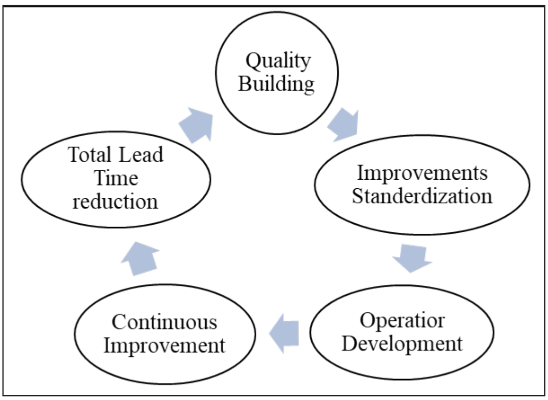

Figure4: Manufacturing excellence model2

We deployed both these manufacturing excellence models at our product manufacturing as per the sequence proposed and redrawn the value stream map for our selected product manufacturing for comparing the results with earlier VSM plotted.

Results

We are going to plot the Value stream map for the in-house and the complete product manufacturing cycle for the sample original electrical products manufactured at the Nasik District to understand the different operational risks caused by the dynamic product demand.

We plotted a value stream map for in-house product manufacturing with the daily demand of 25 Numbers as shown below in Figure5,

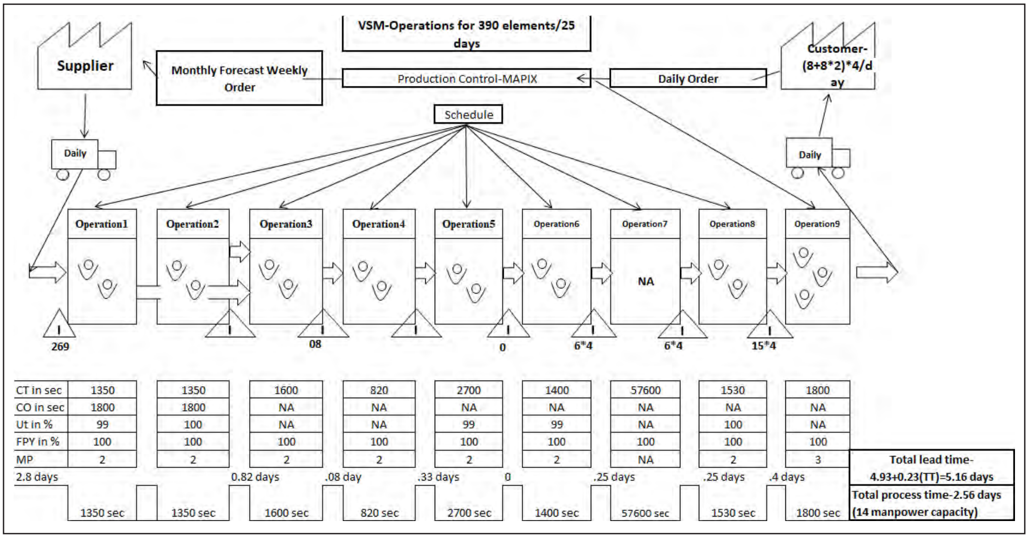

Figure6: Value Stream Map for Product with the daily demand of 25 Numbers after improvements

Next, we plotted a value stream map for complete Customer to Customer Product delivery with the daily demand of 40 Numbers with as shown below in Figure7,

After deployment of both the manufacturing excellence models, we quantified the gains from the above value stream mapping as below,

1. In the case of the daily 25 demand, total lead time reduced from 14.6 to 7.82 days that is 46.44% for in-house product manufacturing.
2. In the case of the daily 40 demand, the total lead time reduced from 26.18 to 15.18 days that is 42.01%.

Total lead time in both cases is reduced by +40% that helped the product manufacturing by following ways,

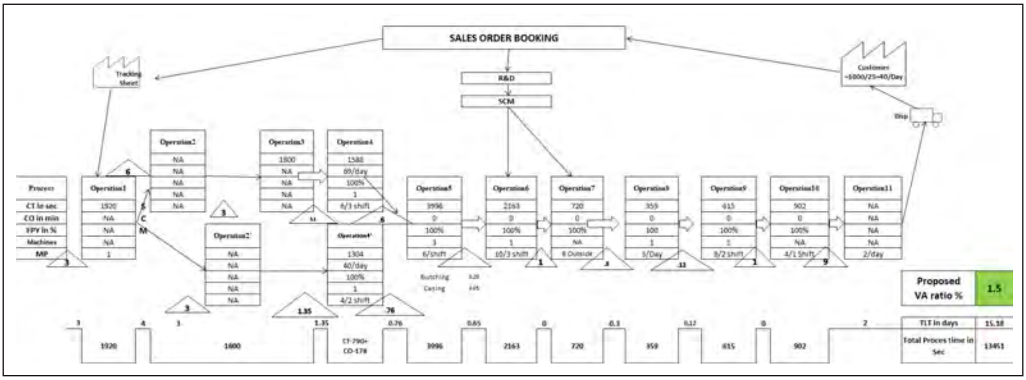

Figure7: Value Stream Map for Product with the daily demand of 40 Numbers after improvements

1. Inventory level between stations to the station is reduced drastically.
2. Total lead time was reduced by half.
3. Space consumption is reduced, which may prevent the probable safety issues for the operator's working at the workstations within reduced space than earlier.
4. Raw Material quality rises as the shelf life of inventory on the shop floor is reduced.

Conclusion

The dynamic product demand impacts the manufacturing supply cycle by creating some operational risks like high inventories, excess manpower, and underutilization of machines, etc. Business firms or companies get impacted financially due to the dynamic product demand with issues like rising finish goods, raw material, and in-process stocks or inventories, inefficient usage of resources like machines, water, and people, and excess or less manpower or job cuts. We addressed this statement of the problem by finding two consolidated business development models for manufacturing operation excellence. After deployment of these two models at selected product manufacturing, we got gain of in the case of the daily 25 demand, total lead time reduced from 14.6 to 7.82 days that is 46.44% for in-house product manufacturing and in the case of the daily 40 demand, total lead time reduced from 26.18 to 15.18 days that is 42.01%. Total lead time in both cases is reduced by +40% that helped product manufacturing.

We conclude this research study as our manufacturing excellence models are successful in delivering the expected results at our selected product manufacturing.

REFERENCES

D. Rizzardo and R. Brooks. (2003). *Understanding Lean Manufacturing*, Maryland Technology Enterprise Institute.

Hoyle, David (2007), *Quality Management Essentials*, Oxford, United Kingdom: Butterworth-Heinemann, p. 200, ISBN 9780750667869.

Industry forum, (2020). Manufacturing Operations is where people, and produce goods for sale. Retrieved from, https://www.industryforum.co.uk/consultancy/manufacturing-operations/#:~:text=ManufacturingOperationsiswherepeople,andproducegoodsforsale.

Jamie R. Friddle. (2020). *Heijunka the art of levelling production*. Retrieved from https://www.isixsigma.com/methodology/lean-methodology/heijunka-the-art-of-leveling-production/.

Kanbanize. (2020). *The built in quality management of continuous improvement*. Retrieved from https://kanbanize.com/lean-management/improvement/continuous-quality-improvement.

Kenge, Rohit. & Khan, Zafar. (2020). THE RECESSION, ITS IMPACT AND INDIA'S RESPONSE. *World Affairs*. 24(3). 98-109.

Kenge, Rohit & Khan, Zafar. (2020). A CONCEPTUAL STUDY OF THE SUPPLY CHAIN MANAGEMENT 4.0 IMPLEMENTATION PROCESS. *GSTF Journal of Engineering Technology*. 10(2). 12-16. 10.46360/cosmos.

Mika, Geoffrey L. (1999). *Kaizen Event Implementation Manual.*

Neil Kokemuller, (2020). Manufacturing operations management.Retrieved from, https://smallbusiness.chron.com/manufacturing-operations-management-69293.html.

Padovano, Antonio; Longo, Francesco; Nicoletti, Letizia; Mirabelli, Giovanni (January 1, 2018). "A Digital Twin based Service Oriented Application for a 4.0 Knowledge Navigation in the Smart Factory". *IFAC-PapersOnLine*. 16th IFAC Symposium on Information Control Problems in Manufacturing INCOM 2018. 51 (11): PP 631–636.

Page, Julian. (2003). *Implementing Lean Manufacturing Techniques*.

RNA Automation. (2020). *Poka-Yoke in Manufacturing*. Retrieved from https://www.rnaautomation.com/blog/poka-yoke-in-manufacturing/.

James P Womack and Daniel T Jones. (March 1, 2003) *Lean Thinking*, 2nd Edition, ISBN 978-0-7432-4927-0.

Manos, Tony (June 2006). "Value Stream Mapping-an Introduction" (PDF). *Quality Progress*. American Society for Quality. p. 64.

Merrill Douglas (June 2013). "The Lean Supply Chain: Watch Your Waste Line". Inbound logistics.

Christine Wheeler. (Feb 17, 2014). *Eliminating 7 types of waste with 5s methodology*. Retrieved from https://www.newcastlesys.com/blog/

bid/336185/eliminating-7-types-of-waste-with-5s-methodology.

Mckinsey. (October 27, 2016). *Supply chain 4.0-the next generation digital supply chain*. Retrieved from https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-40--the-next-generation-digital-supply-chain.

Ottomotors. (Aug 24, 2017). *Advantages of one piece flow manufacturing*. Retrieved from https://ottomotors.com/blog/advantages-of-one-piece-flow-manufacturing.

Ben Mulholland. (January 5, 2018). *How one piece flow can reduce your operation time by 96%?* Retrieved from https://www.process.st/one-piece-flow/.

Villanovau. (Feb 6, 2018). *Heijunka*. Retrieved from https://www.villanovau.com/resources/six-sigma/heijunka/.

Rever team. (January 29, 2019). *What is kaizen definition?* Retrieved from https://reverscore.com/what-is-kaizen-definition/.

Tanya. (February 12, 2019). *Lean systems and waste elimination*. Retrieved from https://www.setpointusa.com/blog/lean-systems-waste-elimination/#:~:text=Waste%20elimination%20is%20one%20of,is%20and%20where%20it%20exists.

Cleartax. (Jun 05, 2020). *Just in time jit inventory management*. Retrieved from https://cleartax.in/s/just-in-time-jit-inventory-management.

Martin Murray. (October12, 2020). *What is just in time supply chain?* Retrieved from https://www.thebalancesmb.com/just-in-time-jit-2221262.

Kenge, Rohit. & Khan, Zafar. (2020). A case study of industry 4.0 implementation in manufacturing industry. *The Clarion- International Multidisciplinary Journal*. 9(2). 6-11. 10.5958/2277-937X.2020.00010.6.