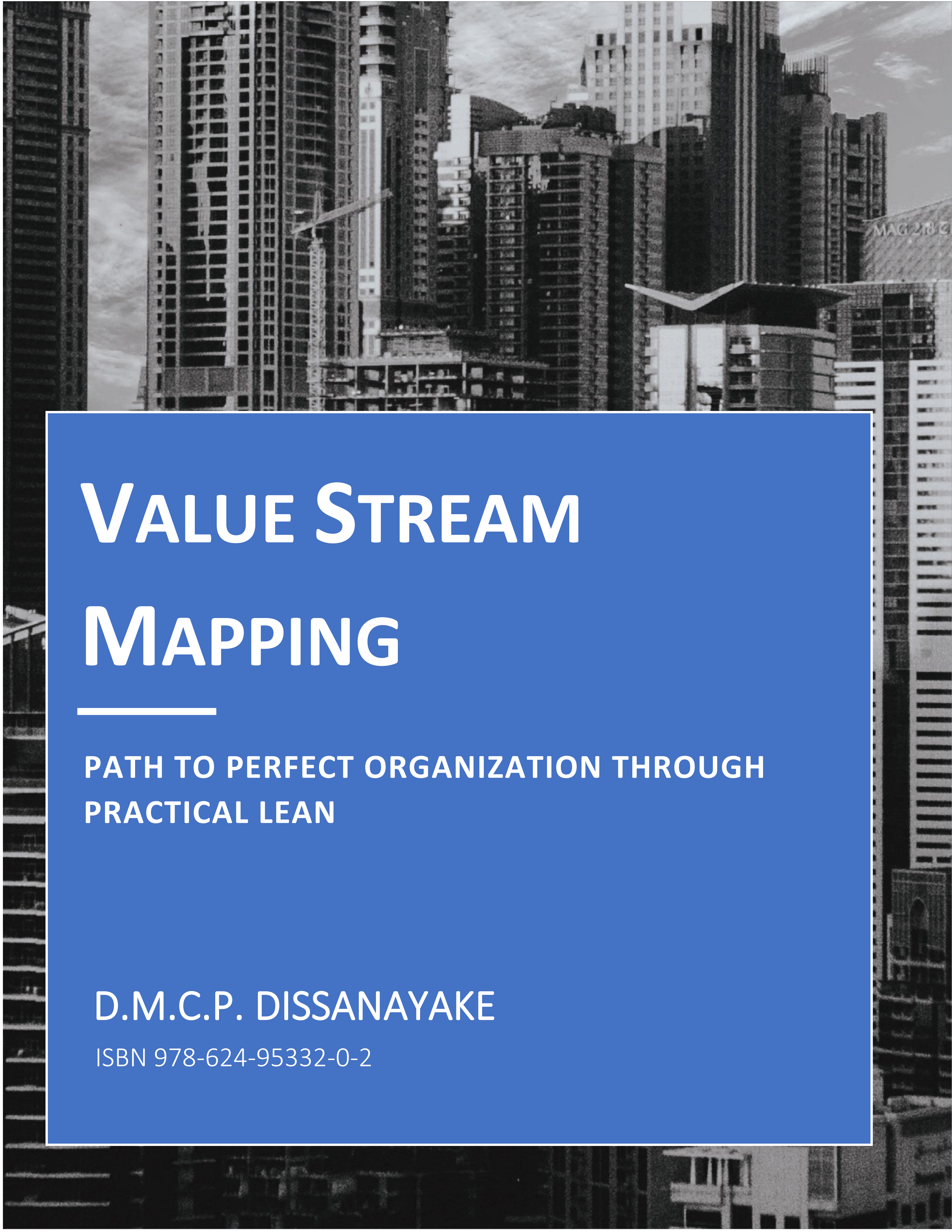

Value Stream Mapping

PATH TO PERFECT ORGANIZATION THROUGH PRACTICAL LEAN

D.M.C.P. DISSANAYAKE

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ABBREVIATIONS

VSM	Value Stream Map
BPM	Business Process Map
DT	Downtime
UT	Uptime
LT	Lead Time
CT	Cycle Time
PT	Process Time
JIT	Just in Time
CO	Change Over
MR	Machine Reliability

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I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. Special thanks to leading multinational lean organization to get the practical understanding with the implementation as part of the organization. And thanks for providing the necessary training to enhance the lean concepts and apply them within the organization.

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Special thanks to the institutes that enhanced my knowledge on Lean, Lean Six Sigma to get the knowledge to write this book.

PREFACE

Continuous improvement is a key success factor for the survival of profit-making organizations in the current revolutionized world. Cost is continuously increasing, and selling prices may decline, increasing the phase of increasing the cost. Therefore, cost reduction is essential, and most organizations are still struggling in those areas. The lean management concept is a proven concept to enhance the profitability through waste minimization. Lean is talking about systematically identifying the waste and minimizing the waste. Continuous improvement should minimize the waste and keep the objectives to reduce lead time, achieve best quality with lowest operating cost. There are several tools to achieve this at the enterprise level.

A value stream map is one tool that is used to identify improvement areas in a systematic way. Mainly, this activity gives a 30,000 feet height view (helicopter/macro view) and large level improvements. The main objective of this activity is to reduce manufacturing lead time and improve the value adding functions. Generally, this activity gives the current lead time, process times, inventory levels, cycle times, changeover time, downtime, defect and scrap rate, number of operators, etc. and their improvement areas. Consequently, it helps to enhance the process by reducing lead time and other related areas and drive towards profitability.

In an organization, material flows are categorized into five stages: push, pull, sequence pull, first in first out and continuous flow. To make the optimum material flow, all in-between processes must run with one-piece flow. However, most organizations are still in push, and a few are on the pull process. Therefore, to maximize the profit, those material flows must convert into one-piece flow. Low inventory quickly highlights the problems, less damage, real time problem solving, etc. are key benefits to help the one-piece flow or continuous flow.

In this book, the main focus is on the value stream map and process maps, flow charts are used to further drill down the process. However, this book is talking about the macro level view and value stream mapping.

When we move on to the value stream mapping, there are two key flows in the value stream: material flow and information flow. Standard pre-defined symbols and pre-defined data categories are used to complete the value stream map ,and details are discussed in more detail in Chapter 3.

To complete the value stream map activity, the following process steps should be completed sequentially.

Product family analysis	To identify the focus product. Generally, next 3-6-month volume/revenue and number of process steps consider when selecting the product family.
Current state mapping	Draw the current state map with the team. All data / inventories need to be collected process wise with understanding the material flow and information flow.
Identify the improvements	Identify the improvement when mapping the current state map.
Future state mapping	Develop the future state with the targets according to the identified improvement.
Improvement plan and implementation	This is the most important part - set up the improvement plan and execution to achieve the future level targets.
Management reviews	Monthly review by senior management is very important. This is the driving force of the project, and the project team also need some mentoring. This is a good opportunity, and no project will be successful without management support and drive.

CHAPTER 01:

1. INTRODUCTION

1.1. OVERVIEW

Continuous improvement is a key success factor to focus for industries to survive in a revolutionized world. Cost is continuously increasing, and selling prices may decline, increasing the phase of increasing the cost. Therefore, cost reduction is essential, and most organizations are still struggling on those areas. The lean management concept is a proven concept to enhance profitability through waste minimization.

As per the definition and objectives, lean manufacturing is talking about reducing lead time, producing best quality products, and reducing cost. Consequently, expects to enhance the profitability. In other words, achieving minimum possible lead time, best quality, lowest cost by eliminating waste to achieve strategic operational goals.

Tools called value stream maps and business process maps are mainly used to identify waste systematically and help to understand the improvement areas on a high level. This is considered as a helicopter view or 30,000 feet above where you can see the large level focus areas and large-scale improvements. The key focus towards value stream mapping is lead-time reduction, which in manufacturing, is focusing through value stream mapping while business process mapping is used for service industries and service areas. This tool permits the factory to determine the current lead time, process times, inventory levels, cycle times, changeover time, downtime, defect and scrap rate, number of operators, etc. There are two key flows in a value stream: material flow and information flow. Generally, materials flow according to the information given by information flow, and those two flows cannot flow isolated. The value adding and non-value adding processes are highlighted in the value stream mapping activity with the improvements. This provides the information required to create future state by creating an ideal value flow. The mapping is not enough, and the most important part is executing to get into the future state. Therefore, this is a systematic tool and method to identify process improvements, define new processes and establishment. But executing the driving belongs to the management.

Most organizations tend to do the value stream map using middle management or below. But that is useless. The most important thing is the involvement of senior leadership/ department heads/ supporting functional head. The middle management can be a part of this team, but leadership need to have ownership to achieve success in this event.

1.2. WHAT IS LEAN MANUFACTURING?

In simple terms, lean manufacturing can be defined as ***"Identify the waste in a systematic way and eliminate them from the process using the concept of continuous improvement to optimize(reduce) lead-time with achieving best quality towards the lowest cost."***

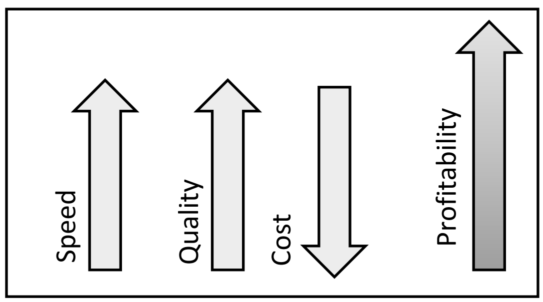


Figure 1 ;Objectives of lean

There are key work types discussed in the manufacturing environment, and they are value adding works, waste or non-value adding activities.

Table 1 Work types in the manufacturing environment

Work type	Definition
Value Adding	Any product that changes the form, shape or function in line with the customer needs. Basically, the customer is willing to pay for the changes; otherwise, it becomes waste.
Waste/Non-Value Adding	Anything that does not add value to the product or service can be considered waste or non-value adding activities.

Anything that does not add value to the product, or a service can be considered as waste to manufacturing. That is the simple definition under lean manufacturing for waste, and Toyota has identified seven major types of non-value adding waste in manufacturing processes, and an eighth has been added. They are:

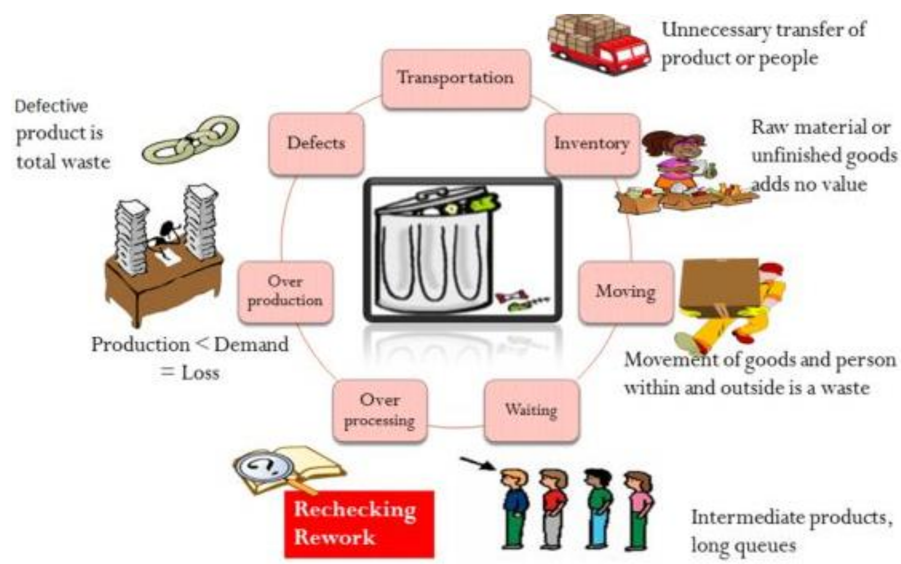


Figure 2 ; Seven waste

Table 2 Explanation of seven wastes

No	Waste type	Explanation
01	Overproduction	Producing items, but there are no orders which generates overstaffing, storage, and transportation costs due to excess inventory. Overproduction is considered as the fundamental waste (largest waste) because it causes most of the other wastes.
02	Waiting	Workers are merely watching an automated machine or having to stand around waiting for the next processing step, tool, supply, part, etc., or have no work because of stock outs, lots of processing delays, equipment downtime, or capacity bottlenecks.
03	Transport	Carrying work in process (WIP) for long distances, creating inefficient transport, or moving materials, parts or finished goods into or out of storage or between processes.

04	Over processing	Taking unneeded steps to process parts. Inefficient processing due to poor tool and product design, causing unnecessary motion and producing defects.
05	Inventory	Excess inventory, excess raw material, WIP, or finished goods causing longer lead times, uselessness, damaged goods, transportation and storage costs, and delay. Also, extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long setup times.
06	Motion	Unnecessary movement. Any wasted motion employees should perform during the course of their work, such as looking for, reaching for, or stacking parts, tools, etc. Also, walking is waste.
07	Defect	Production of defective parts or correction. Repair or rework, scrap, replacement production, and inspection mean wasteful handling, time and effort.
08	Unused employee creativity	Losing time, ideas, skills, improvements, and learning opportunities by not engaging or listening to your employees.

CHAPTER 02:

2. INTRODUCTION TO VALUE STREAM MAPPING

2.1. WHAT IS VALUE STREAM?

Value stream is defined as a collection of processes in the manufacturing process throughout the dock to dock. Value adding processes and non-value adding processes are part of a value stream. The visualization of value stream can be considered as a value stream map.

In value stream mapping, we talk about helicopter view, and focus improvements are large and might be breakthrough initiatives. The core objective is to minimize the lead time and create continuous flow by minimizing the in-processes inventories. Several organizations are currently in different stages with current standardized processes, and waste is also hidden inside the standardization. The image below expresses the stages of manufacturing organization relay in terms of material movement.

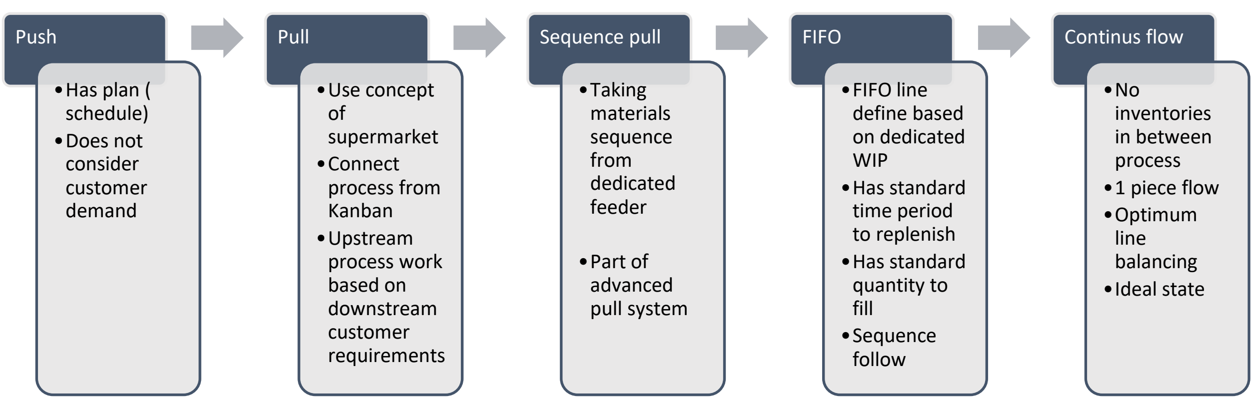


Figure 3 ; Material flow types

Special note:

The mapping is done for core material movement and other sub material movements are not considered.

Examples.

In an engine oil company, the main product is oil, and cans are needed to store oil. We draw the value stream to consider the movement of oil. Not the cans.

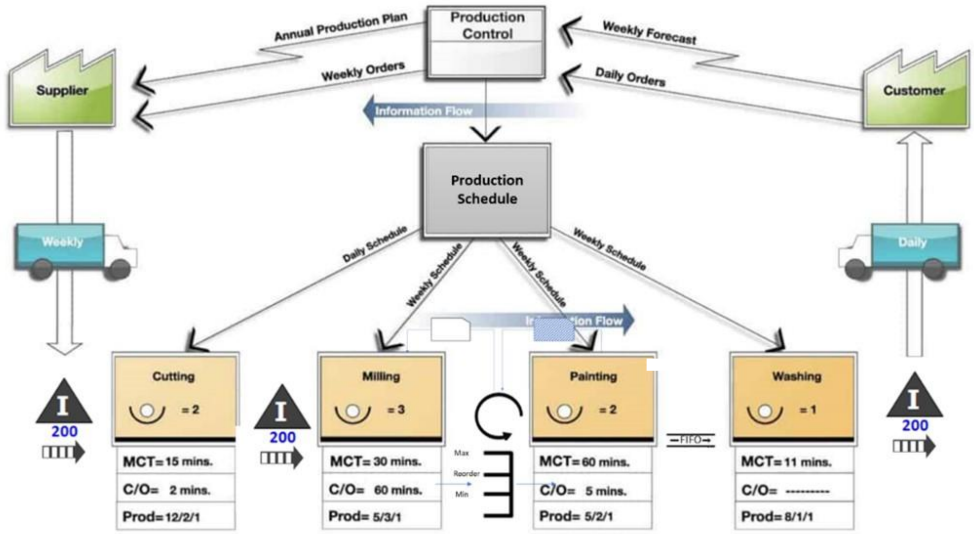


Figure 4 Standard sketch of value stream map

2.2. KEY BENEFITS OF USING VSM

Mainly, this mapping is focusing on converting business processes into different states.

- Can easily understand the entire material movement.
- Helps to understand the information flow that is supporting to flow the materials.
- Can identify the value adding percentage from the entire process.
- High level improvements can be easily identified.
- Improvements can focus into areas such as lead-time /change over times/ defect rates /Downtimes/in process WIP/,etc.

2.3. WHY DOES THE COMPANY REQUIRE VSM?

The main objective of an organization is to maximize profitability. The lean concept maximizes profitability through waste minimization. Consequently, this affects lead time and helps to maximize profitability. By doing the value stream mapping activity, highly impactable improvements surface and then help to re-engineer with improvements. That is why companies are required to do the value stream mapping activity.

2.4. TOOLS RELATED TO VSM

As discussed above, the ideal state of an organization's material flow is continuous flow (one-piece flow), and currently, most organizations are in the stage of push or scheduled with batch movements. The stages are discussed under this topic.

2.4.1. PUSH SYSTEM

In simple terms, push is "make to stock." In this concept, there is no consideration for customer demand, and the stock is made and stored at the warehouse. Therefore, this creates more waste through unnecessary inventories and has high impact on lead times and cash holdings.

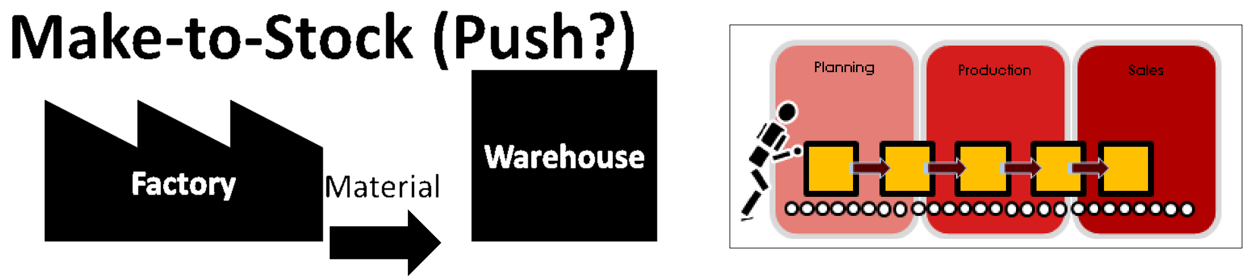


Figure 5 Push system

2.4.2. PULL SYSTEM

This is functioning with demand from the next process. Therefore, this is simply called "Make to Order."

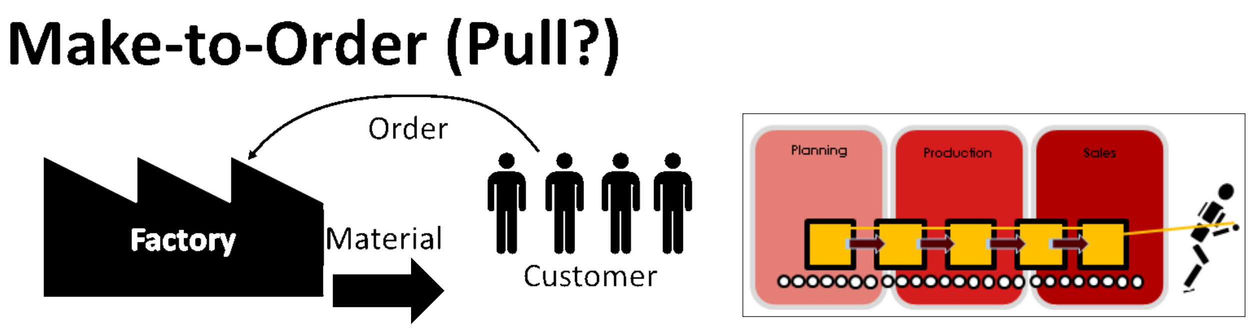


Figure 6 ; Pull system

2.4.3. JUST IN TIME

Manufacturers focus on maintaining less volume of production for cost effectiveness. The required materials are receiving at the manufacturing point when required without delay or waiting. This concept gradually industrialized with the factory and suppliers aiming for continuous improvement through waste reduction and inventory reduction. However in-house processes must be aligned to avoid the downtimes. Internal supplies and customers within the manufacturing units also use this concept which helps to optimize the manufacturing processes. Therefore, JIT is a very important theory in cost minimization through lead time reduction.

2.4.4. KANBAN (PULL SIGNAL)

The Kanban tool is used to achieve the JIT concept in terms of passing the signal into the supplier from customers as well as to control supermarkets. Generally, this can be a card system, electronic system through emails, some signal lights, alarming, etc. This signal type is usually used to control WIP in the process, smooth the production and in process inventory flow. Generally, Kanban flow happens in the reverse direction of material flow as follows.

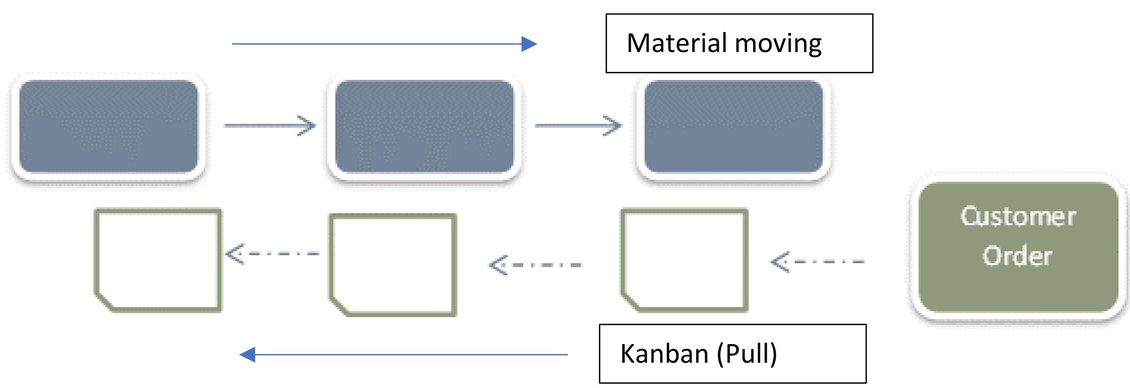


Figure 7 Kanban and material moving directions

Toyota initially developed the Kanban concept to accomplish their goals to minimize the process and product costs by eliminating or minimizing waste. Workplace organization for quick response to abnormalities, built in quality, creating the mutual trust, and ergonomically supporting health and safety environment. Allowing this to maximize the human potential in the production process. Supermarket is the essential thing to function Kanban in-between processes.

2.4.5. SUPERMARKET AND PULL SYSTEM FUNCTIONING

This concept also directly links with the JIT and Kanban. Production smoothness is essential, and the establishment of a Kanban system helps to reduce downtime of the process, equipment, human capacity and WIP. All are used to smooth the material flow for optimization and quick problem-solving.

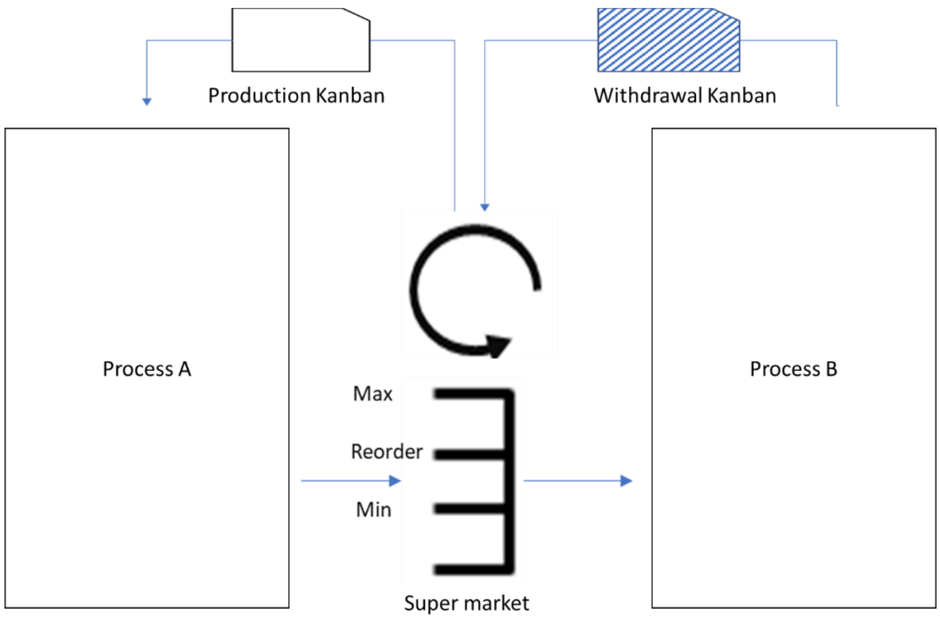


Figure 8 Function of supermarket

<u>Process of a supermarket</u>

There are two types of Kanban functioning around supermarket. In the above case, based on Process B consumption, they send the withdrawal Kanban to the supermarket to fill their process. Generally, the supermarket issues goods based on that Kanban. After a few Kanban and issuing reaches the supermarket inventory down and once it reaches the reorder level, the supermarket sends the Kanban call production Kanban to fill the supermarket. Once the production Kanban is sent from the supermarket, the supplier to the supermarket starts to produce and fill the supermarket. That is the process behind supermarket and consists of the following 5 elements:

- Min
- Max
- Reorder
- Function on Withdrawal Kanban

- Function on Production Kanban

However, all signals to order the goods by the customer is not a Kanban. To accept as Kanban, there are 6 rules behind the Kanban. Those are considered golden Kanban rules.

Table 3 6 rules of Kanban

Rule	Description
Rule 01	The later process goes to the earlier process to pick up products
Rule 02	Upstream process produces only the amount withdrawn by the downstream process
Rule 03	Kanban prohibits picking up or producing goods without Kanban
Rule 04	Kanban should always attach to the goods
Rule 05	Free of defects from the upstream process (100% FTT)
Rule 06	Reduce number of Kanban as much as possible and function with minimum Kanban

2.4.6. SEQUENCE PULL

Setting up the sequence to the next process with considering maximum stock in-between process can be defined as sequence pull. Taking sequence from a dedicated feeder.

Example. This is sequence and pull in sequence.

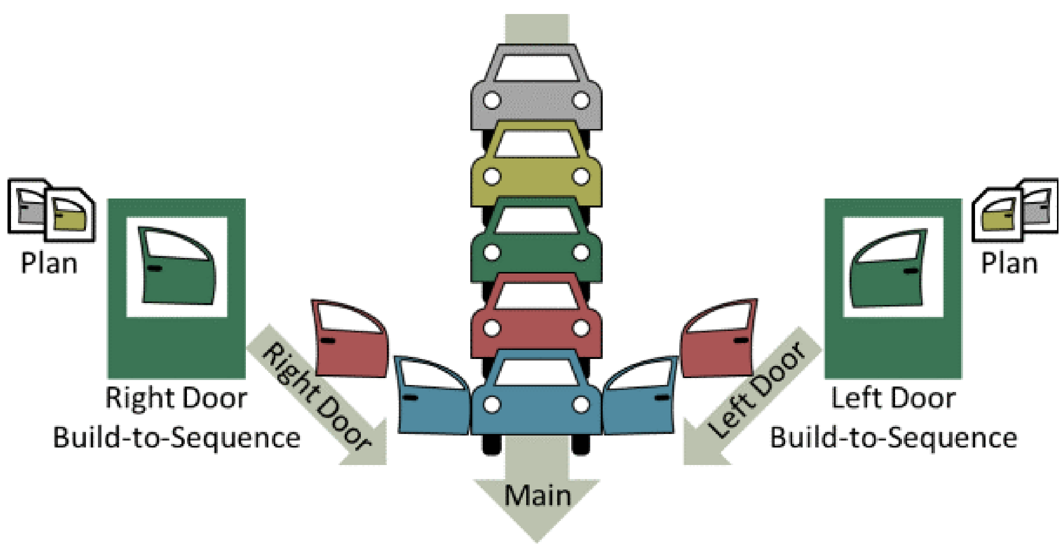


Figure 9 ; Sequence pull

2.4.7. FIFO (FIRST-IN-FIRST-OUT)

This is the next step of material flow and has pre-defined dedicated line with a defined size. The size of the line is defined based on the consumer rate and replenishment cycle. And the replenishing quantity is also defined based on the above two criteria.

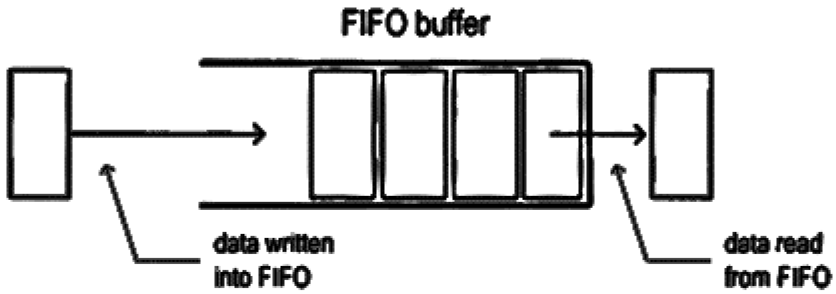


Figure 10 ; FIFO concept

2.4.8. CONTINUOUS FLOW (ONE-PIECE FLOW)

Continuous flow is the best flow type, and this does not create inventories in-between processes. Flow as one piece until the downstream process is finished; then the upstream process starts. Simply, no inventory in between two processes.

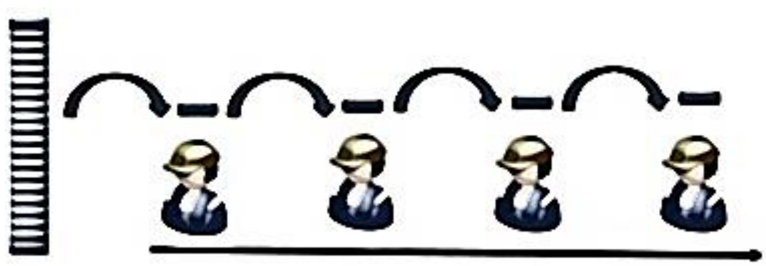


Figure 11 One-piece flow

CHAPTER 03:

3. PROCESS OF VALUE STREAM MAPPING

Here is the high-level discussion on value stream mapping which will be discuss in further detail in this chapter.

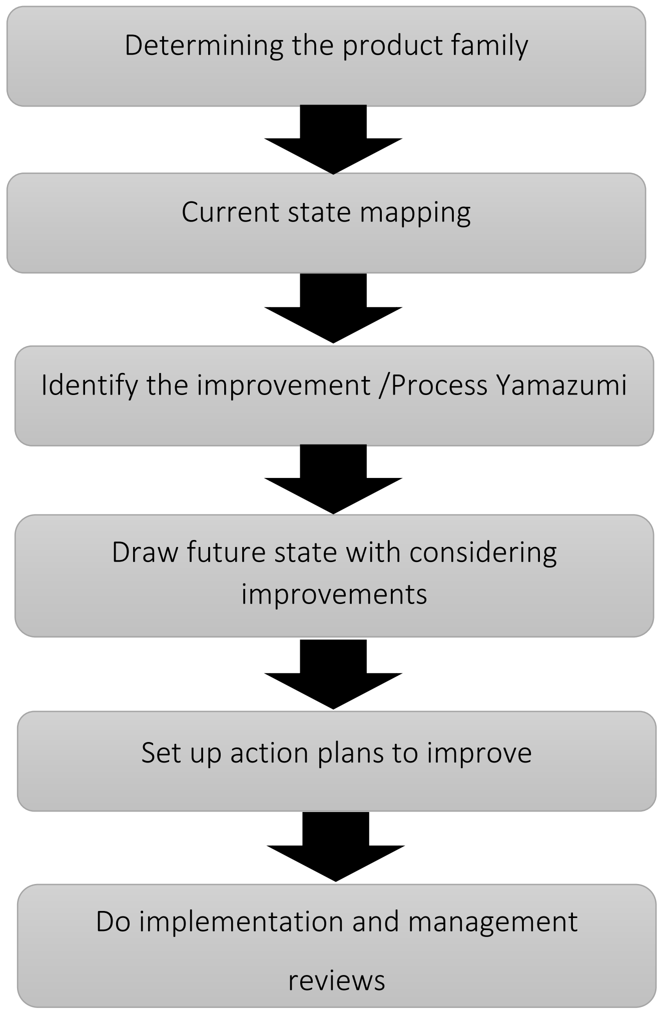


Figure 12 Value stream mapping process

This is the cycle of value stream mapping and generally, this activity needs to be done annually. However, it can be defined by the team, and it may be drawn every 6 months depending on the execution plan. After one cycle, if the action plan is executed well, the future state becomes the current state for the new year. However, the most important thing is driving to execute the action plan.

3.1. DETERMINING THE PRODUCT FAMILY

Activity starts with identifying the focus product family for the value stream mapping. Activity initiates to understand and follow what processes need to be considered when mapping the value stream. Most of the organization is running with more than one product covering the same processes or different processes. Therefore, this activity is very important, and it shows the process to go forward with value stream mapping. If there are several product families in the manufacturing process, then there is a need to draw value stream maps for each product family. However, it is not essential, and you can start with selecting a product family with the highest number of processes covering. This is the priority. However, in practice, when determining this, it's better to analyze customer demand at least the previous 3 months and the next 3-6 months. If the demand is low, then the improvement has less impact and consequently, there's no point in implementing since it is useless.

See the example given below relating to selecting the product family for value stream mapping. In addition, some products follow through the same processes and are consider the same product family. Generally, this activity can be done by visiting the actual places or doing brainstorming and collecting the relevant data from the planning function of the organization.

	Process A	**Process B**	**Process C**	**Process D**	**Process E**	**Process F**	**Process G**	**Next 3-6-month Volume**	**Product Family**
Product 1	X	X	X		X		X	7,000	P
Product 2	X	X		X	X	X	X	5,000	Q
Product 3	X		X		X	X	X	5,000	R
Product 4	X	X	X		X		X	3,000	U
Product 5	X	X		X	X		X	4,500	S
Product 6	X	X		X	X	X	X	8,000	Q
Product 7	X	X	X		X		X	9,000	P

Table 4 ; Product family identification

If we read this, product 1 is running through Process A, Process B, Process C, Process E, Process G and has 7,000 order quantity for the next 3-6 months. Then that is taken as Product family "P." Likewise, product families can identify as per the above table, Product 1, Product 4, Product 7 is going through the same processes (Please see the table). Then they are in the same product family. According to that concept, Product family "Q" has two while "R" and "S" have one each. Therefore, this table shows 5 product families as P, Q, R, S, U. As mentioned above, it is better to have 5 value streams covering all processes, but, in general, select one product family based on the highest number of processes in the product family and the next 3 -6-month quantity/revenue.

There are a few steps to consider when selecting the product family. By considering business impact (Revenue/Volume), you can shortlist 'what are the more focused products' for value stream mapping. Generally, Parato analysis is used to do this prioritization, and this concept is running around the 80-20 rule. That means if there are 100 types of products, out of 20 will represent the 80% of impact. According to that, we will consider the following Parato analysis to shortlist the products.

Product Family	Volume or Revenue (next 3 - 6 months)	Cumulative Percentage %
P	**16,000**	**38.5%**
Q	**13,000**	**70%**
R	5,000	82%
S	4,500	93%
U	3,000	100%

Table 5 Product family prioritization on volume or revenue

According to the business impact analysis through the Parato concept, there are 2 products shortlisted as hugely contributing to the business. Then out of 5 product families, we can focus on only P and Q. Thereafter, the next step is to consider the maximum number of processes to finish the product (dock to dock).

Note:

Revenue needs to consider than the volume since volume does not always provide the biggest revenue. Therefore, keep revenue as priority since business focuses on profitability.

	Process A	Process B	Process C	Process D	Process E	Process F	Process G	Next 3-6-month Volume	Product Family
Product 1	X	X	X		X		X	7,000	P
Product 2	**X**	**X**		**X**	**X**	**X**	**X**	**5,000**	**Q**
Product 3	X		X		X	X	X	5,000	R
Product 4	X	X	X		X		X	3,000	U
Product 5	X	X		X	X		X	4,500	S
Product 6	X	X		X	X	X	X	8,000	Q
Product 7	X	X	X		X		X	9,000	P

Table 6 Prioritize product families

The next step is to concentrate the number of processes in selected product families. According to that, P is going through 5 processes, and Q is going through 6 steps. Based on that, we can select the final product family as Q to go forward. *(Note: let's think: one product family is contributing 70 points out of 80 and low number of processes than the 10 points contributing product family with high number of processes when doing the Parato prioritization, then it is your call to pick the most impact one).*

	Process A	Process B	Process C	Process D	Process E	Process F	Process G	Next 3-6-month Volume	Product Family
Product 1	X	X	X		X		X	7,000	P
Product 2	**X**	**X**		**X**	**X**	**X**	**X**	**5,000**	**Q**
Product 3	X		X		X	X	X	5,000	R
Product 4	X	X	X		X		X	3,000	U
Product 5	X	X		X	X		X	4,500	S
Product 6	X	X		X	X	X	X	8,000	Q
Product 7	X	X	X		X		X	9,000	P

Table 7 Select product family

3.2. CURRENT STATE MAPPING

This is the most important step to think about future and base for improvements. Before the improvements, understanding the current state is important. This happens with a few steps, and they are as follows:

Step 01

Do a 15 – 20-minute quick walk with the team through the entire process according to the identified product family. According to the above analysis, the need to walk through the process is identified in product family 'Q'. This is to understand the areas on which to focus and draft drawing.

Step 02

Then as a sub team or entire team, collect the data in each process by identifying the improvement areas. (Data will be discussed later)

Step 03

Draw the current state by using standard symbols.

As discussed in Step 2, the data needs to be collected from each point and also requires general data to calculate lead times, takt time (Takt time = Available time / Customer demand). Collect data as follows.

Data type	Definition	Data collection
Cycle time (CT)	Time for one cycle in the process	Real time data
Throughput Time (TPT)	Time taken for product in and out per particular product	Real time data
Down Time (DT) per shift	Process down time (Shift/Daily/Weekly)	Average of past 1-2 weeks

Change Over time (C/O) per shift	Time difference between new product 1st piece/unit out and previous product last piece/unit out from assembly line.	Real time data or Average of past 1-2 weeks
No of Change Overs per shift	No of COs per Shift /day/Week	Average of past 1-2 weeks
Process DR% (DR% or FTT%)	Daily/weekly Defect percentage	Average of past 1-2 weeks
Rejects /Scrap per shift	No of rejects per particular period (it may be shift/daily/weekly/monthly)	Average of past 1-2 weeks
Process WIP	WIP in the process at a time	Real time /Average
Inventory for process	Inventory waiting for the process after previous process. (it may be waiting as inventories, supermarkets *(take average of Min/Max),* FIFO racks *(take average of Min/Max)* or ready to pull sequence *(take the standard quantity ready to pull sequence)*)	Real time data is the priority, and if there is no inventory, then consider average inventory in the process on this product family by considering past data (1 -4 weeks).
Up time % Or Machine Reliable time (MR)	(Available time – (Down time + (CO time x no of CO)))/Total time) x 100% If it is machine, then use same calculation with considering machine available time, machine down time and changeover time)	Calculate from above details (downtime/CO time/No of changeovers)
Process takt time	Available time of the process/total demand by next process	Consider average demand per particular period
Batch Size	Batch size, consider capturing the data (process time to batch)	Real time
No of Employees	Employees working on the process	Real time /Standard allocation

No of Shift	Working shift per the considering process	Standard
Information into this process	From / information/frequency need to include in the box	Real time discussions
Information out from this process	To / information/frequency need to include in the box	Real time discussions

Table 8 ; Data box definitions and equations

In addition to the above data, there are some general data required to calculate the takt time, lead time, value adding percentage, etc. This requires gathering the information such as total working time per shift, no of shift, customer demand for a particular period, available time to deliver the order.

3.2.1. TAKT TIME

In simple terms, takt time can be considered as in between time taken to out the products from the process to meet the customer demand. This does not depend on the number of operators in the process. It depends on the available time and customer demand.

Takt time = Available time /Customer Demand

Ex:

There is an order to deliver 6000 caps within 5 days. Let's consider that the assembly line works for 10 hours per day. Then to provide the order on time:

Takt time = Available time /Customer Demand
= (10 hours X 5 days) / 6000 caps
= 50 hours / 6000 caps
= 50 x 60 (to convert into min) / 6000 caps
= 3000/ 6000
= ½ min/cap (30 sec/cap)

Note: Break times are not included in available time.

According to the above example, the assembly line needs to bring out one good product each 30 sec to meet customer demand. Without understanding this time, the processes my take a long time and ultimately, the customer will be dissatisfied without fulfilling their needs. Therefore, takt time is very important.

3.2.2. UP TIME %

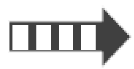
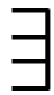
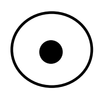
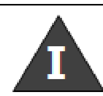
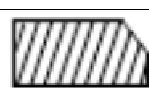
Generally, this is used to check the effective time of the process out of available time.

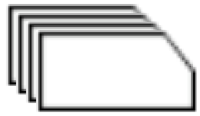
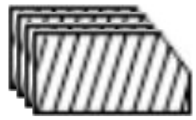
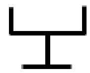
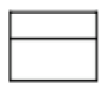
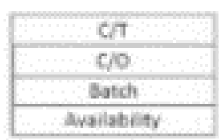
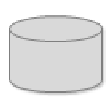
Need to include:

Uptime% = (Available time – (Down time + (CO time x no of CO)))/Total time) x 100%

After collecting the data, the next step is to draw the current state map using the standard symbols. The graph, including symbols is here.

No	Symbol Name	Symbol	Description
1	Customer		Indication of customer
2	Supplier		Indication of Supplier
3	Sea freight		The goods received to factory or sent from factory by sea.
4	Air freight		The goods received to factory or sent from factory by air.
5	Container Transport (Roads)		The goods received to factory or sent from factory by roads by lorries/containers

6	Material from Supplier or to Customer		Indication of material movement from supplier to plant and plant to customer
7	Push		Push system in between two processes
8	Pull		Pull system in between two processes
9	Supermarket		This links with the pull process, and this symbol is used to indicate the supermarkets in-between processes
10	Sequence pull		Sequence pull system in between two processes
11	FIFO		FIFO system in between two processes
12	Level Loading		Level Loading of the processes
13	Inventory		This links with the push process, and this symbol is used to indicate the inventories in-between processes
14	Production Kanban		Symbol for production Kanban to fill supermarket
15	Withdrawal Kanban		Symbol for withdrawal Kanban to send goods from supermarket

16	Batch Production Kanban		Symbol for production Kanban to fill as batches to supermarket
17	Batch withdrawal Kanban		Symbol for withdrawal Kanban to send goods as batch wise from supermarket
18	Kanban Post		Place where Kanban are placing
19	Manual information		Indication of transferring manual information
20	Electronic information		Indication of transferring information electronically
21	Department/Production schedule		To indicate production schedules/production control units
22	Process box		This is to indicate the process/department/machines in the process
23	Data Box		The data captured from processes are included in this box
24	Data base		Data transferred through database/ERP
25	Go and See		This is to show as need further go and see

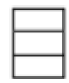
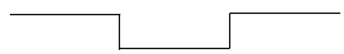
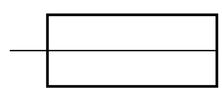
26	Improvement point /Kaizen Burst		To highlight the improvement ideas in the current state
27	Safety Stock		This is to highlight the safety stock in between processes
28	Operators		This symbol indicates the operators in the process (No. of operators are put inside the circle)
29	Timeline Segment		This helps to segment value adding and non-value adding activities. Generally, put details of value adding at the bottom while non-value adding on top
30	Timeline Total		This is used to put a summary of value adding and non-value adding at the end of the VSM

Table 9 ; VSM symbols

The above symbols are used while drawing the value stream map, and it can be arranged as follows onto paper, if you are manually drawing (Some software is available to draw the value stream maps). Then everything is in the document. There are two value streams required: current state map and future state map. Both should be in the same manner. *(Next Page)*

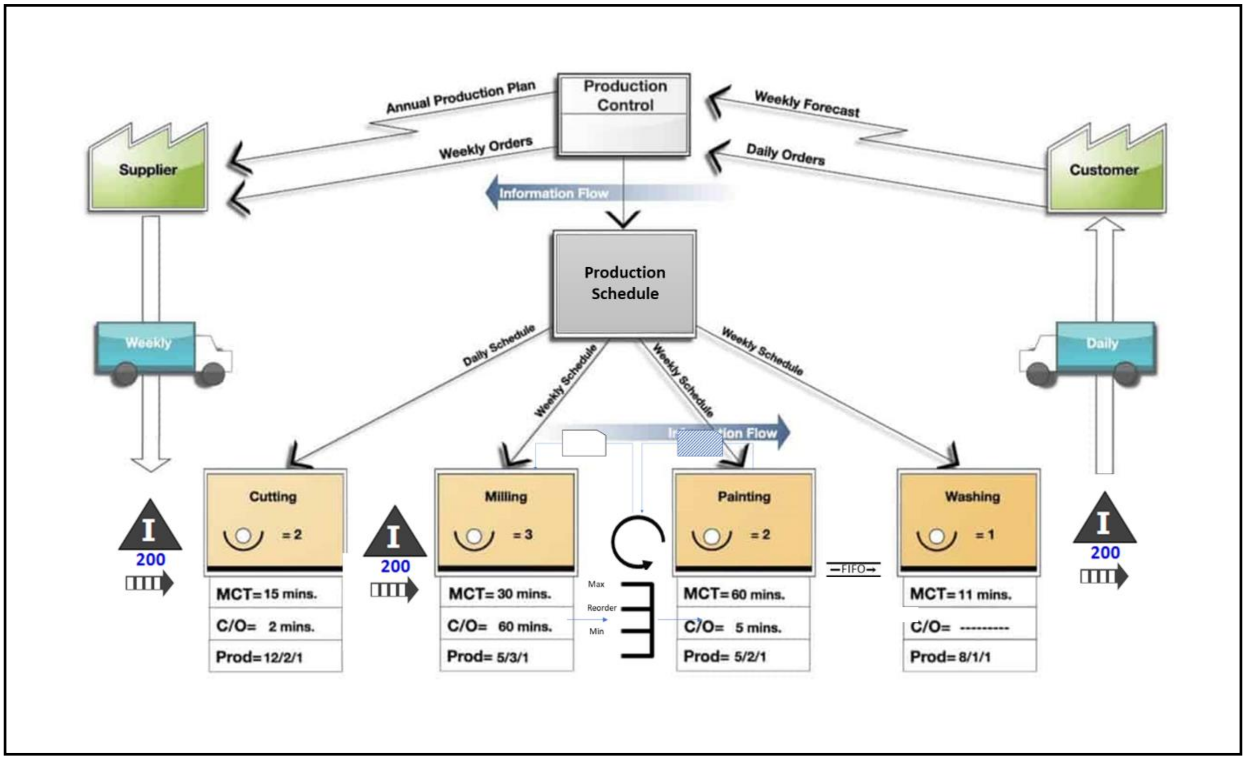


Figure 13 ; Value stream map

The next step is drawing the value stream map. However, this consists of material flow and information flow to material movement. Therefore, information flow is also very important and during the walkthrough or discussing with the relevant experts, the team can figure out information flow.

Before you start drawing, you need to consider the unit of flow which may be pieces /Boxes/batches/, etc. All inventory points need to be converted into the selected unit of flow. Let's think about unit of flow as pcs. However raw materials stay as large aluminum plates. Then take the average consumption of unit of flow (piece) and then convert the raw material into pieces as how many pieces can be produced from the aluminum plate?

Ex: consumption of piece (unit of flow) : 2.5 sq. ft.

Aluminum raw material plate size : 80 sq. ft.

Then inventory put as : 80 /2.5

: 32 pcs

Then put as 32 pcs, not as 80 sq. ft,

Drawing starts with mapping the material flow from dock to dock. Then move on to the information flow. Information flow is mapping on top of material flow. Generally, material flow consists of Process box, data box, Push, pull, sequence pull, FIFO, Level loading, Supermarket, Inventory, safety stock symbols. But depending on the process, some symbols are not required. For example, if the process is running with the push and pull system only, then other symbols such as FIFO, Sequence pull, level loading symbols can't be used. And, as discussed above, if there is a push in between processes, then the inventories are building. Therefore, if the push symbol and inventory symbol are used together while pull symbol and supermarket symbol using together. If there is a pull system in place, the process must be linked with the supermarket and should function through withdrawal and production Kanban.

However, it is time to organize the data into the relevant areas with collected data.

The way process includes to process box

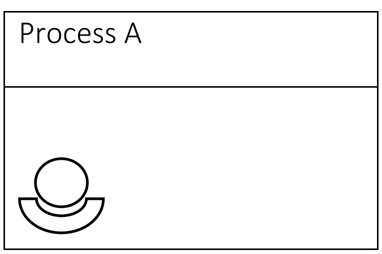


Figure 14 Example of process box and operator

The way that data is organized to data box (data box can be separated in two to put the data)

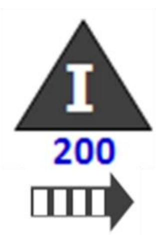
CT	3 min
TPT	150 min
Process Takt time	1 min
DT/day	10 min/day
C/O Time/day	5 min
No of C/O per day	3

UT /MR	85%
FTT% (DR%)	97.5% (2.5%) /day
Process WIP	350 units
Reject	0.05% (Per week)
No of Operators	5
Batch Size	50 units
Days per week	5
Shifts	2
Information into process	Stores /Material request form / hourly
Information out from process	Pasting /finishing doc./daily

Figure 15 Example of data box

Indicate push system in between processes

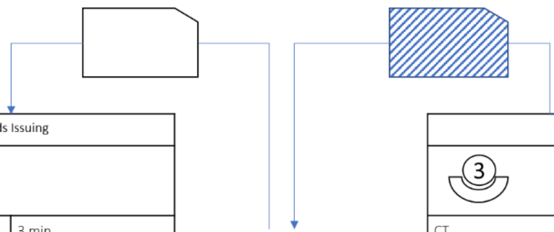
Goods Issuing	
5	
CT	3 min
TPT	150 min
Process Takt time	1 min
DT/day	10 min/day
C/O Time/day	5 min
No of C/O per day	3
UT /MR	85%
FTT% (DR%)	97.5% (2.5%) /day
Process WIP	350 units
Reject	0.05% (Per week)
No of Operators	5
Batch Size	50 units
Days per week	5
Shifts	2
Information into process	Stores /Material request form / hourly
Information out from process	Pasting /finishing doc./daily



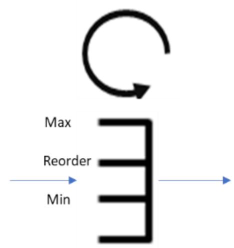
Pasting	
3	
CT	2.5 min
TPT	80 min
Process Takt time	0.8 min
DT/day	15 min/day
C/O Time/day	5 min
No of C/O per day	7
UT /MR	50%
FTT% (DR%)	98.5% (1.5%) /day
Process WIP	340 units
Reject	0.04% (Per week)
No of Operators	3
Batch Size	40 units
Days per week	5
Shifts	3
Information into process	Pasting /finishing doc./daily
Information out from process	Painting /packing list./daily

Figure 16 Example of push process symbol use

Indicate Pull system in between processes



Goods Issuing	
5	
CT	3 min
TPT	150 min
Process Takt time	1 min
DT/day	10 min/day
C/O Time/day	5 min
No of C/O per day	3
UT /MR	85%
FTT% (DR%)	97.5% (2.5%) /day
Process WIP	350 units
Reject	0.05% (Per week)
No of Operators	5
Batch Size	50 units
Days per week	5
Shifts	2
Information into process	Stores /Material request form / hourly
Information out from process	Pasting /finishing doc./daily

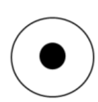


Pasting	
3	
CT	2.5 min
TPT	80 min
Process Takt time	0.8 min
DT/day	15 min/day
C/O Time/day	5 min
No of C/O per day	7
UT /MR	50%
FTT% (DR%)	98.5% (1.5%) /day
Process WIP	340 units
Reject	0.04% (Per week)
No of Operators	3
Batch Size	40 units
Days per week	5
Shifts	3
Information into process	Pasting /finishing doc./daily
Information out from process	Painting /packing list./daily

Figure 17 Example of pull process symbol use

Indicate Sequence pull system in between processes

Goods Issuing	
5	
CT	3 min
TPT	150 min
Process Takt time	1 min
DT/day	10 min/day
C/O Time/day	5 min
No of C/O per day	3
UT /MR	85%
FTT% (DR%)	97.5% (2.5%) /day
Process WIP	350 units
Reject	0.05% (Per week)
No of Operators	5
Batch Size	50 units
Days per week	5
Shifts	2
Information into process	Stores /Material request form / hourly
Information out from process	Pasting /finishing doc./daily



Pasting	
3	
CT	2.5 min
TPT	80 min
Process Takt time	0.8 min
DT/day	15 min/day
C/O Time/day	5 min
No of C/O per day	7
UT /MR	50%
FTT% (DR%)	98.5% (1.5%) /day
Process WIP	340 units
Reject	0.04% (Per week)
No of Operators	3
Batch Size	40 units
Days per week	5
Shifts	3
Information into process	Pasting /finishing doc./daily
Information out from process	Painting /packing list./daily

Figure 18 Example of sequence pull symbol use

Indicate FIFO system in between processes

Goods Issuing	
5	
CT	3 min
TPT	150 min
Process Takt time	1 min
DT/day	10 min/day
C/O Time/day	5 min
No of C/O per day	3
UT /MR	85%
FTT% (DR%)	97.5% (2.5%) /day
Process WIP	350 units
Reject	0.05% (Per week)
No of Operators	5
Batch Size	50 units
Days per week	5
Shifts	2
Information into process	Stores /Material request form / hourly
Information out from process	Pasting /finishing doc./daily

Pasting	
3	
CT	2.5 min
TPT	80 min
Process Takt time	0.8 min
DT/day	15 min/day
C/O Time/day	5 min
No of C/O per day	7
UT /MR	50%
FTT% (DR%)	98.5% (1.5%) /day
Process WIP	340 units
Reject	0.04% (Per week)
No of Operators	3
Batch Size	40 units
Days per week	5
Shifts	3
Information into process	Pasting /finishing doc./daily
Information out from process	Painting /packing list./daily

Figure 19 ; Example of FIFO symbol use

Indicate continuous flow (1 pcs flow) in between processes

Goods Issuing	
5	
CT	3 min
TPT	150 min
Process Takt time	1 min
DT/day	10 min/day
C/O Time/day	5 min
No of C/O per day	3
UT /MR	85%
FTT% (DR%)	97.5% (2.5%) /day
Process WIP	350 units
Reject	0.05% (Per week)
No of Operators	5
Batch Size	50 units
Days per week	5
Shifts	2
Information into process	Stores /Material request form / hourly
Information out from process	Pasting /finishing doc./daily

Pasting	
	3
CT	2.5 min
TPT	80 min
Process Takt time	0.8 min
DT/day	15 min/day
C/O Time/day	5 min
No of C/O per day	7
UT /MR	50%
FTT% (DR%)	98.5% (1.5%) /day
Process WIP	340 units
Reject	0.04% (Per week)
No of Operators	3
Batch Size	40 units
Days per week	5
Shifts	3
Information into process	Pasting /finishing doc./daily
Information out from process	Painting /packing list./daily

Figure 20 Example of continuous flow (one piece)

By using the above, the material flow can be drawn as follows. (Note: It is better to use pencil to draft first and then draw in permanent ink.)

3.2.3. VSM – MATERIAL FLOW

Value stream mapping starts by drawing the material flow. All processes are put into the process boxes and put the data box with merging to process box according to the details discussed above. In between two processes, there should be a stock to run the next process if it is not a one-piece flow. Therefore, based on the types of inventory, the symbols are used as given below.

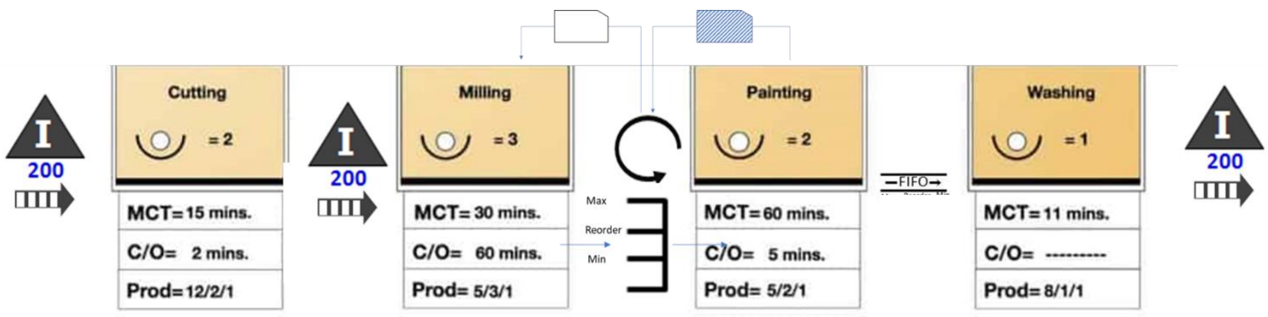


Figure 21 VSM material flow

In plant material, the flow consists of process box, data box, inventories, push, pull, supermarket, FIFO, etc.

3.2.4. VSM – MATERIAL FLOW AND INFORMATION FLOW

The next question is how materials are flowing and what is the relevant information flow in value stream of the plant? Generally, all plants are running with a plan to provide customer demand. Production schedules are used to order materials, manufacturing and delivering. If the processes are running with the separate plans, this means they are producing products without considering the real demand of the next process. Consequently, this creates the inventory, and it belongs to the push system. Likewise, if there is a supermarket, then information is passing through Kanban and the production of particular process depending on the next customer demand.

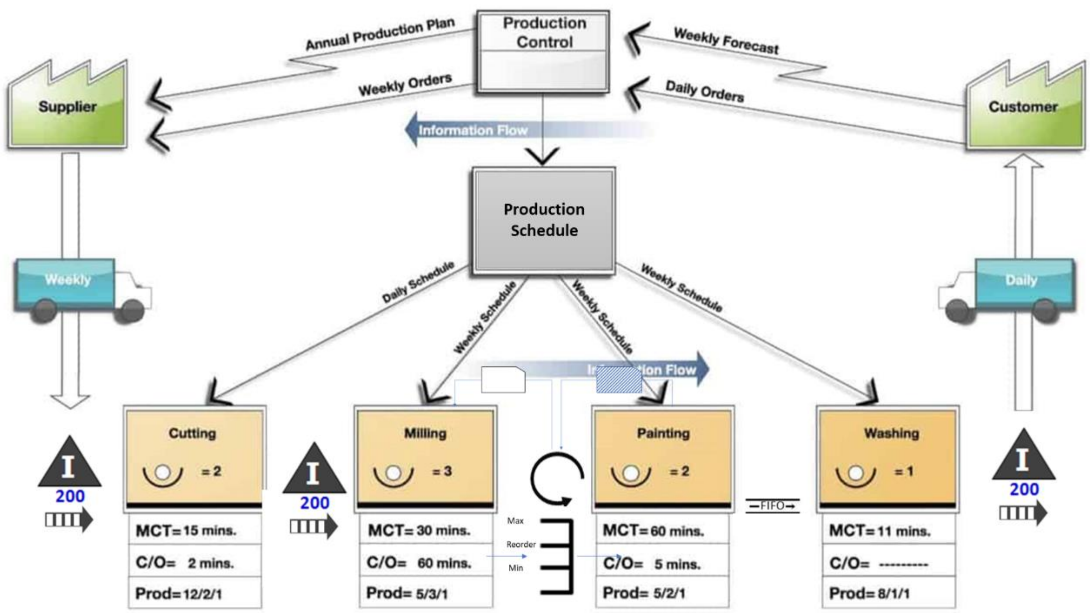


Figure 22 VSM material and information flow

The symbols like production schedules, manual information transferring, electronic information transferring, data base, etc. are consistent in information flow. The material movements from supplier and customer are not part of information flow and are part of material movement. But they are activated based on the information from the production control unit.

Then, the next important point is to determine the takt time of the process based on demand. Therefore, a value stream map should include the following data on the right side of the VSM.

Average demand per day/hour : XXXXX
No of shift (main output process) : XXXX
Working time per shift : XXXXX
Takt time : XXXX

Table 10 Standard VSM summary box

Those details are required to get the overall understanding about the entire process and how the value flow needs to flow to achieve the above demand with available time.

3.2.5. VSM – MATERIAL FLOW, INFORMATION FLOW AND LEADTIME CALCULATION

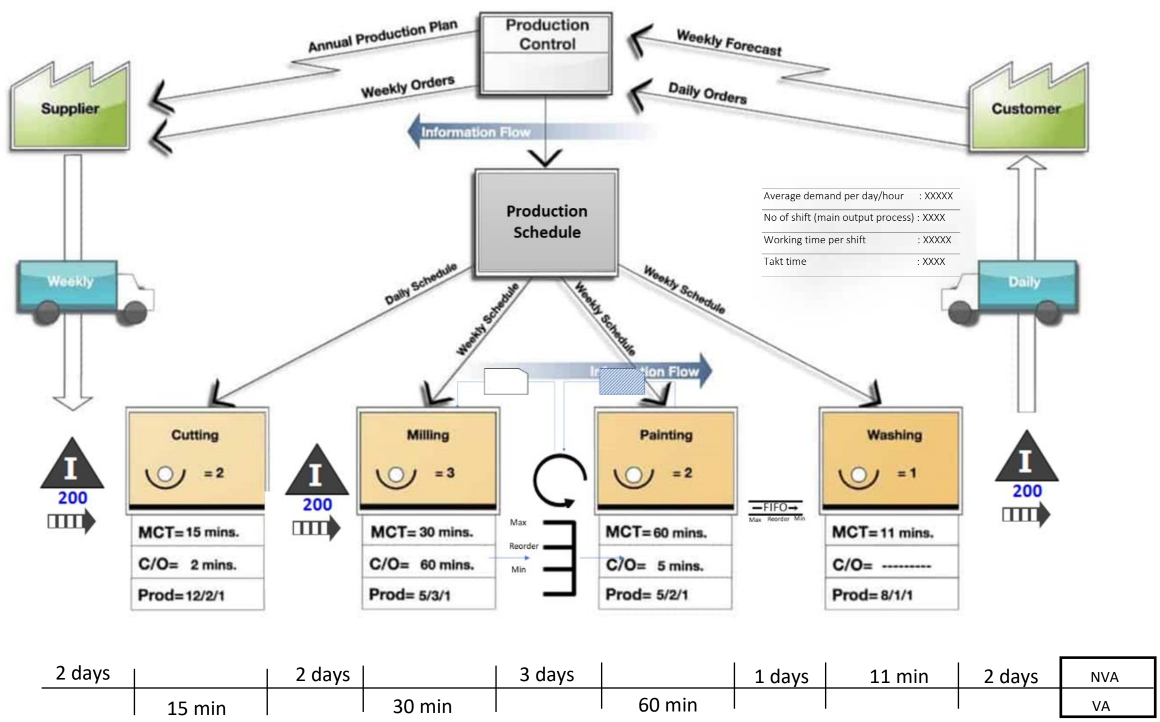


Figure 23 VSM Material, Information flows and timelines

When it comes to the lead time calculation, there are two types of times in the process. Value adding times and non-value adding times. All value adding times are placed on the bottom of the horizontal line, and non-value adding times are put on top of the line. All inventories need to be converted into inventory days/hours/minutes and should be put under non- value adding time. Because inventories are waste and non-value adding to the processes.

The most important thing is calculating what should be put below the timelines. The way of calculation is as follows.

3.2.6. TIMES UNDER PROCESS BOXES

Generally, cycle times of each process is put directly onto the below timeline frame and only consider the process is value adding or non-value adding. Based on that, the time put above or bottom of the line. (i.e. – cutting is value adding, so put it on the bottom, and washing is non- value adding, so put that time above the line)

3.2.7. TIMES UNDER INVENTORIES/SUPERMARKET/FIFO/,ETC.

To calculate the inventory days, initially requires the daily demand of selected product family. Therefore, summary need to fill as follows, and you can see it on the above value stream map.

Ex:

Average Daily demand from selected product family	480 pieces
No. of shifts	2 shifts
Working time per shift (excluding break times)	8 hours
Takt time	= 16 hours /480 pcs = 30 secs

Table 11 VSM summary box - example

Take the average demand considering average production day. *(Make sure to ignore peak production demand and lowest production demand for the calculation)*

Consider the following inventory point.

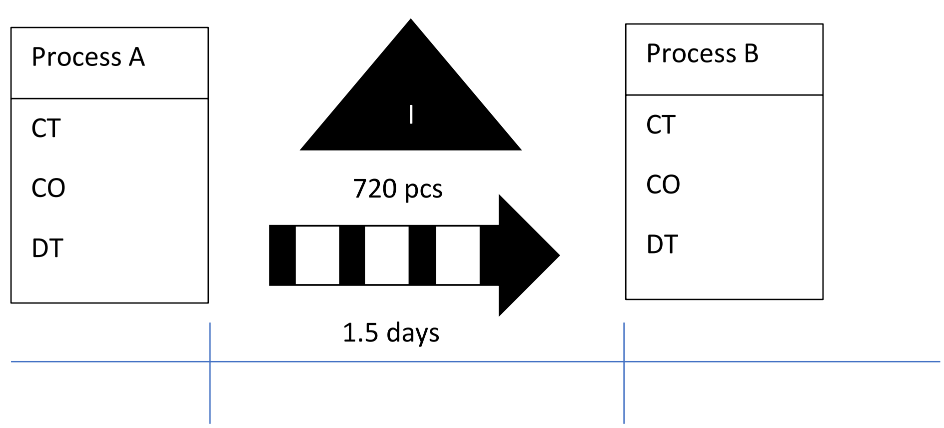


Figure 24 Inventory timeline visualization

Calculation:

Inventory days = pieces held in between two processes / average daily demand

= 720 pcs/ 480 pcs per day

= 1.5 days

If there is inventory at supermarket or linking to pull process /FIFO/Sequence pull

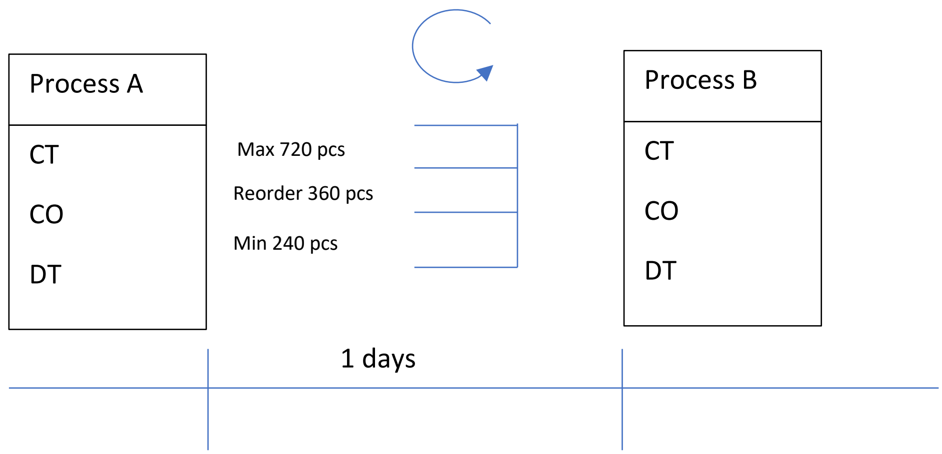


Figure 25 Supermarket timeline visualization

Calculation:

In supermarket or places where has the min, max, reorder, then take the average of min and max

Inventory days = pieces held in between two processes (avg of min-max) / average daily demand

=((720 + 240)/2) pcs/ 480 pcs per day

=480 pcs/480 pcs per days

=1 day

(If the storage is FIFO line, then take the average of full maximum and minimum.

The next part is to sum all non-value adding and put it on the right side of the NVA box while VA is put into the bottom box.

Finally, do the following calculation as the summary of the value stream map and summary; keep on the right-side bottom as the following format.

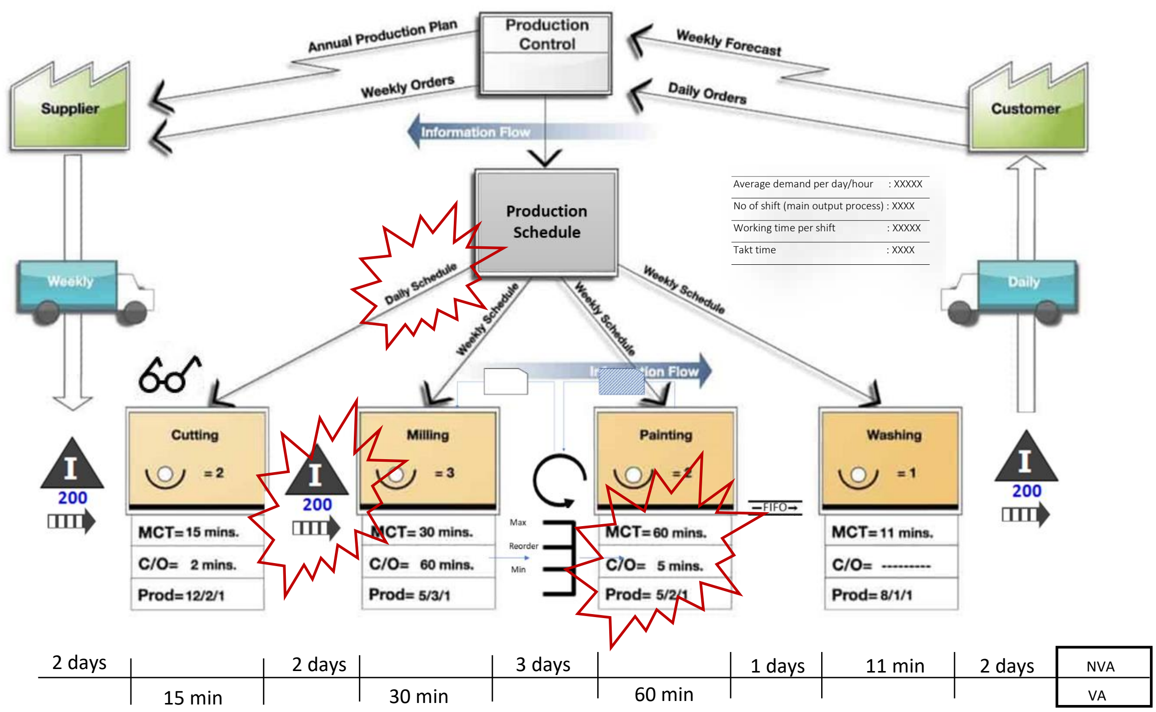
Dock to Dock	Sum of all inventory days
NVA time	Sum of Non-value adding time in process box
VA time	Sum of value adding time in process box
Lead time	VA + NVA
VA %	= (Value adding time /Lead time) x 100%

Table 12 Standard VSM timeline data summary box

The final step of the current state map is to highlight the improvement points and the critical points to go and see for further improvement. Highlight as follows, and it may be from material flow or information flow.

Current State Map (Date)

Product family XXXXXXXXX



Dock to Dock	10 days
NVA time	10.011days (10 days + 11 mins)
VA time	105 min
Lead time	10.12 days
VA %	0.0001%

Figure 26 VSM Current state map

The above visual shows the current state map of the value stream. It's important to have the following things in the VSM:

1. Date of current state map
2. Product family
3. Material flow
4. Information flow
5. Summary with takt time and demand
6. Improvement areas and "go and see" areas
7. Value stream map summary

The next key activity is live the value stream. Then the question is: "What is meant by live the VSM ?" It is just simply capturing the data over a regular period (it may be monthly/weekly) to understand the current state moving with the improvements. It is like checking the improvement initiatives. The same data box can be divided into months/weeks and make the updates. This needs to be reviewed on monthly basis with the senior management and discuss for further improvement.

The data box can be displayed as follows, and this activity is done for the current state map with red, green against the target for more visualization. Target is the future state target level.

i.e. All data must be included here, and those are as examples.

Table 13 VSM live data box

Panting									
	Target	Actual	Jan	Feb	Mar	Apr	…………	Nov	Dec
CT									
PT									
CO time									
UT%									

3.3. IDENTIFY THE IMPROVEMENT

As discussed above, the main purpose of drawing a value stream map is to identify the large level improvements in the process. Improvements highlight in the current state value stream, and it is time to define the future state with the improvements. That is the future expectation and can be with process changes, layout changes in the plant, material movement improvements from traditional push system to pull system, etc. According to the above example, there are three improvements highlighted, and they must be the driving projects to reach the future state. The execution planning must do a thorough project plan with the set of senior teams of the plant.
The highlighted improvements are:

1. Set up pull system with rearranging the process in-between cutting and milling.
2. Improve the changeover process and time of painting process.
3. Redefine information flow.

Based on the above key process improvements, the team is expecting the future state as follows. Further improvements can be taken on the go and see point when developing the project charters.

Apart from that, there are several key processes in the whole value stream, and there is a need to understand the bottleneck process and must level out the bottleneck to set up flow. Otherwise, one process may disturb the entire process and the capacity/potential of other processes may be underutilized. Therefore, the controlling point must identify in a logical way and should balance against other processes to create smooth flow. If there is a process of deciding the speed of the entire process considering as pacemaker of the value stream. Generally, this activity is defined as the Yamazumi process. All the process takt times are put into the bar chart and checked against the entire value stream takt time. To achieve customer demand, all the process cycles takt times must be less than the value stream takt time. Please look at the example below. The data to draw the Yamazumi process is taken from the value stream data box (individual process takt times).

Refer the same example used above for takt time calculation,

Ex:

There is an order to deliver 6000 caps within 5 days. Let's consider, the assembly line works for 10 hours per day. Then to provide the order on time,

Takt time	=	Available time /Customer Demand
	=	(10 hours X 5 days) / 6000 caps
	=	50 hours / 6000 caps
	=	50 x 60 (to convert in to min) / 6000 caps
	=	3000/ 6000
	=	½ min/cap (30 sec/cap)

As per the above calculation, each 30 sec or before process must complete and out a cap to achieve customer demand within a given period. To manufacture a cap, have a few processes such as raw material issuing / cutting / stitching/ packing. If one of the process' takt time is above 30, then the customer demand can't be achieved. Therefore, the objective of this activity is to bring down all the process takt times to VSM takt time or below. This is visualized as follows and identify the pacemaker of the process as well as the improvement areas. Refer to the example data for further understanding.

Material Issuing takt time	-	22s
Cutting takt time	-	33s
Stitching takt time	-	25s
Packing takt time	-	18s

VSM takt time	-	30s

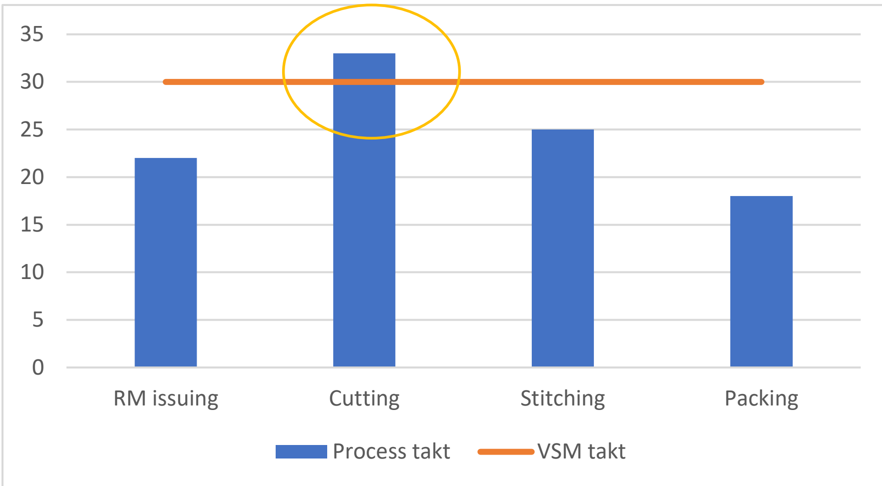


Figure 27 ; Process Yamazumi

As per the above graph, the cutting takt time has gone up than the VSM takt time. That means there is a bottleneck to achieve the customer demand. As a first step, that bar must be reduced to 30 or below to achieve the customer demand. This is the point where the management can decide temporary, find extra capacity to achieve that level by sub-contracting or change shift patterns, overtime, etc. However, long- term this needs to be viewed as an improvement area and do the improvement to bring down the takt to balance with the other processes. And cutting is the pacemaker and that is the process deciding the speed of the entire process.

Note:

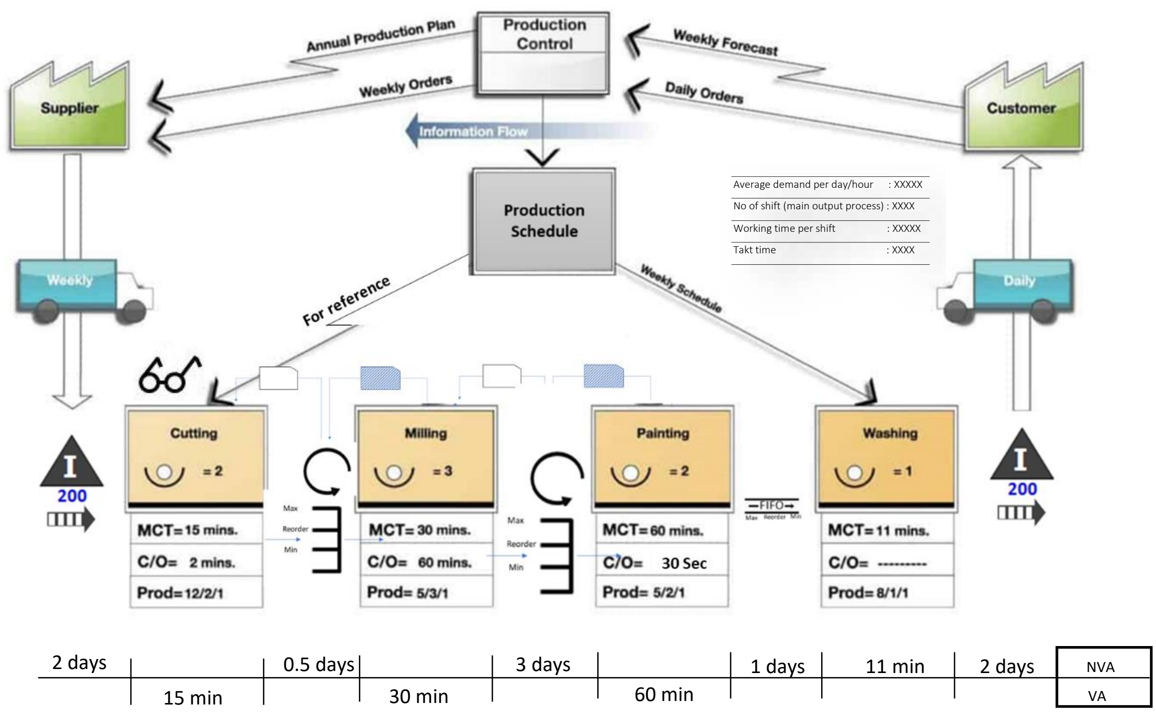
Ideally, in one piece flow, all bars must equal.

3.4. FUTURE STATE MAPPING

Future state is developing changes of the above improvements, and the summary will change with that. Then we can define the target levels in each process and entire process and map in the future state with a defined target period. And this is the time to define the future state by using pull systems/FIFO/Sequence pull and continuous flow. That's how the material flow can streamline. Those were discussed at the beginning, and those concepts are very useful to determine future.

Future State Map (Date)

Product family XXXXXXXXX



Dock to Dock	8.5 days
NVA time	8.511 days
VA time	105 min
Lead time	8.14 days
VA %	0.00015%

Figure 28 VSM Future state map

3.5. SET UP IMPROVEMENT PLAN

Execution to fill the gap between the current state and future state is very important. As mentioned above, the identified improvements need to execute as project teams through project charters or any other project execution methodology through a proper plan. The below methods or any standard method can be used to develop the execution plan for a value stream map. Please see the documents below for your reference for project documentation and reviews.

3.5.1. PROJECT CHARTER DOCUMENT

<table>
<tr><th colspan="5">PROJECT CHARTER</th></tr>
<tr><td colspan="2">PROJECT NAME</td><td>DATE</td><td colspan="2">AREA OF FOCUS</td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2">BUSINESS CASE</td><td colspan="3">SCOPE</td></tr>
<tr><td colspan="2" rowspan="3"></td><td>IN SCOPE</td><td>IN SCOPE</td><td>OUT OF SCOPE</td></tr>
<tr><td colspan="3">KEY DELIVERABLES</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="2">MEASURABLE TARGET/GOAL</td><td colspan="3">TIMELINE</td></tr>
<tr><td colspan="2"></td><td colspan="3" rowspan="3">Gantt Chart with responsibilities and milestones</td></tr>
<tr><td colspan="2">TEAM MEMBERS</td></tr>
<tr><td>NAME</td><td>FUNCTION</td></tr>
<tr><td></td><td></td><td colspan="3">FINANCIALS</td></tr>
<tr><td></td><td></td><td colspan="2">BUSINESS IMPACT</td><td>INVESTMENT</td></tr>
<tr><td colspan="2">ASSUMPTIONS/CONSTRAINTS</td><td colspan="3">RISK PLANNING</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
</table>

Figure 29 Project charter

Or else some companies use the concept call A3 thinking to drive the projects. That is also like project charter.

3.5.2. A3 THINKING

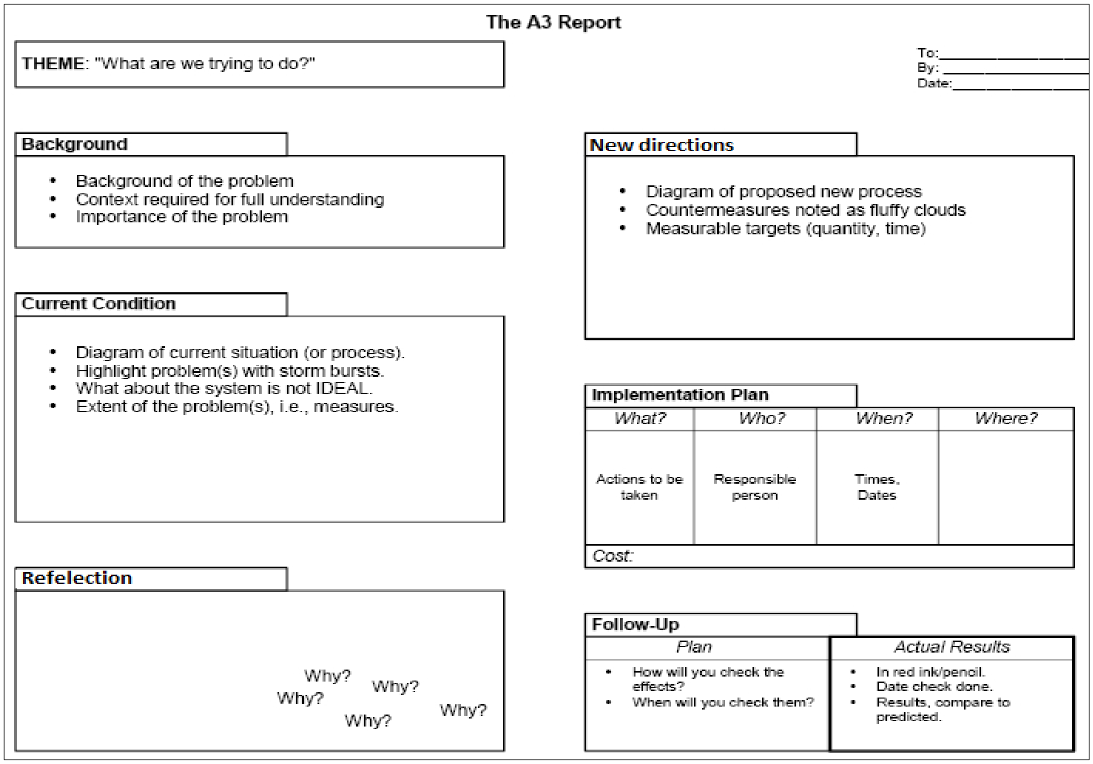


Figure 30 ; A3 sample

These are some structured approaches, and it is very easy to review and follow up from those documents. Or else the final option is to make only a Gantt chart and follow up to execution.

3.5.3. GANTT CHART

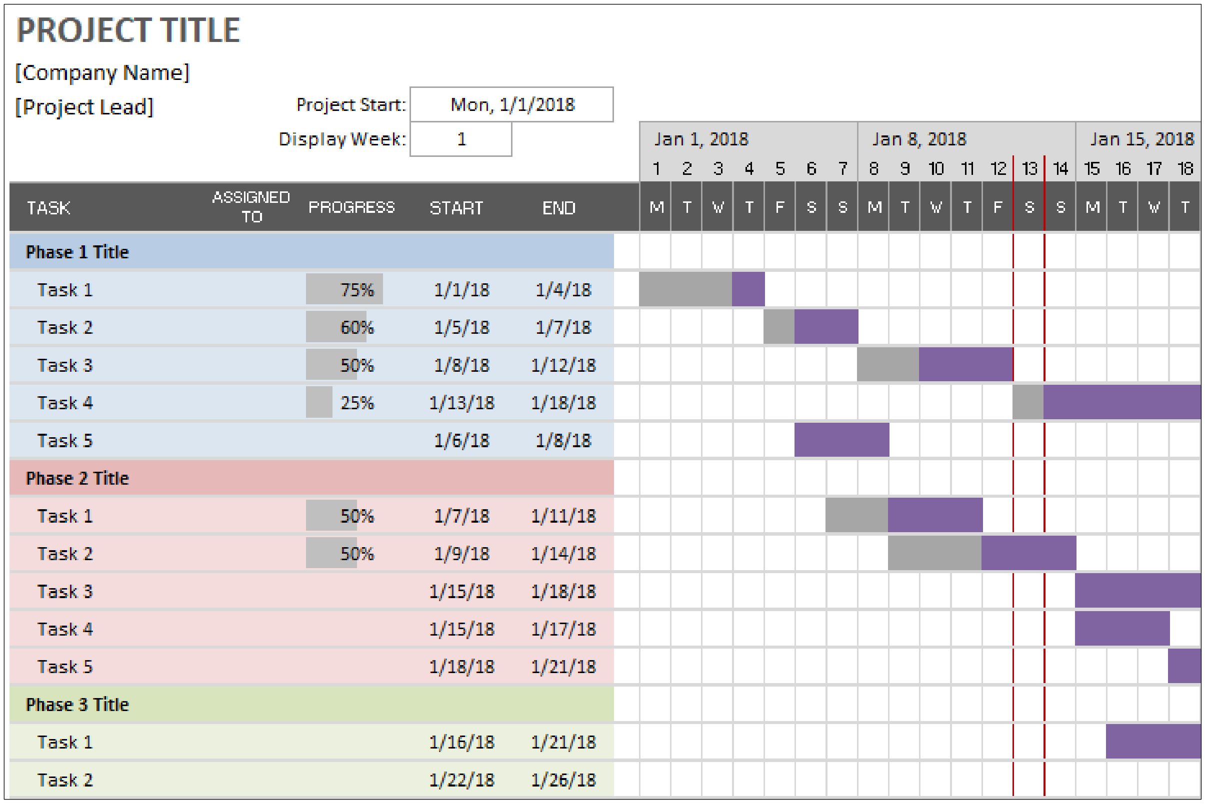


Figure 31 Sample of Gantt chart

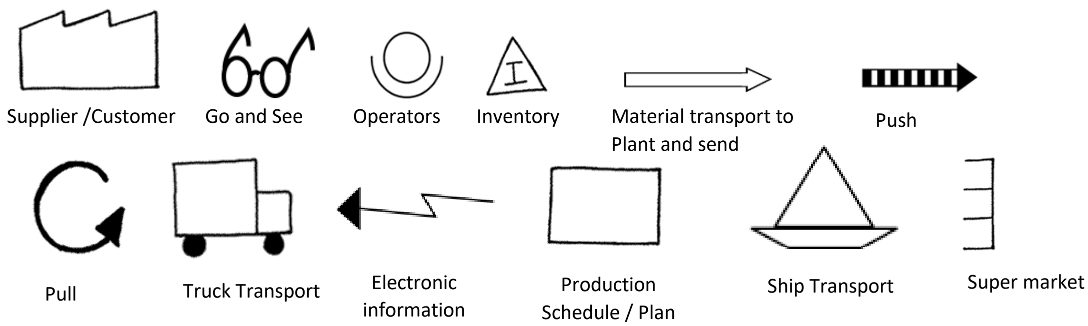
3.6. MANAGEMENT REVIEW AND LEADERSHIP ROLE

To reach the target levels, management must play a critical role. Initially, belief should be embraced and need to drive the improvement initiatives. Those project plans can take into one board close to the value stream map and must be reviewed on a monthly basis with the relevant project owners as well as process owners. This is the point where the data is reviewed after living the value stream map. Management can understand whether improvement happens or not with the projects at that point. Therefore, to drive the value stream, there must be a management system and review mechanism. One hour per month is enough for that activity, and all the project teams should be ready and need to present to the most senior management. This discussion helps both parties to further improve as well as get new directions support from senior management.

CHAPTER 04:

4. CASE STUDIES TO VALUE STREAM MAPPING

Read the case study below and try out the VSM by placing the correct symbols into the correct place. Some symbols are given below, and you can find others from the above list of symbols.



There are three members in each RM issuing and Packing process while there are six members for cutting and 10 for stitching. And has a pull system among the RM issuing and cutting. Cutting and stitching has FIFO. There is a push system from sewing to packing. And waiting to send from packing to customer, and waiting to accept by RM warehouse after receiving from supplier, and they are keeping as inventories.

Merchandizing division receives the order through email from the customer, and they send the fabric order to the supplier. Supplier (Overseas) sends the fabric to the plant. Finally, the finished goods are sent to the customer in Europe.

After the order is received at the Merchandizing Division, then send email to the central planning team and then prepare a weekly loading plan. And send to the Stitching department for production. Cutting, packing and RM issuing receives a weekly plan as reference

There are two improvement areas highlighted and need to go and see further. They are cutting and sewing.

This is just a simple case study to understand the mapping and use a limited number of symbols to further understand actual value stream mapping.

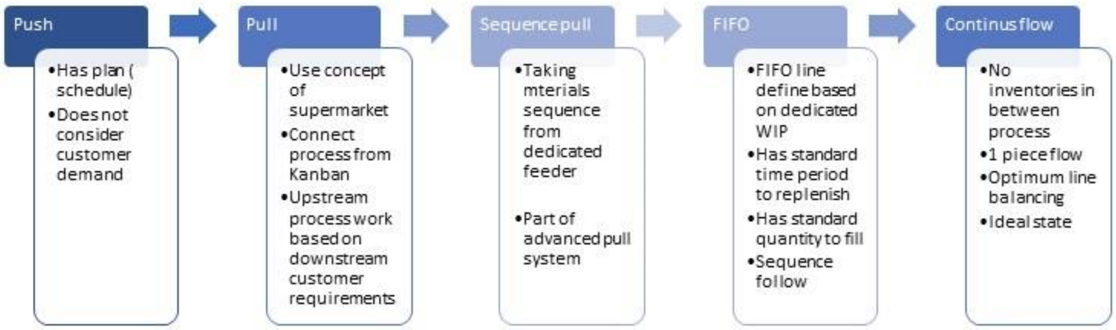
RM issuing	
Cycle time	***10 sec***
Process time	***300 sec***
C/O time	***10 min***
FTT	***95%***
Batch Size	***30 pcs***

Cutting	
Cycle time	***30sec***
Process time	***1255 sec***
C/O time	***13 min***
FTT	***98%***
Batch Size	***90 pcs***

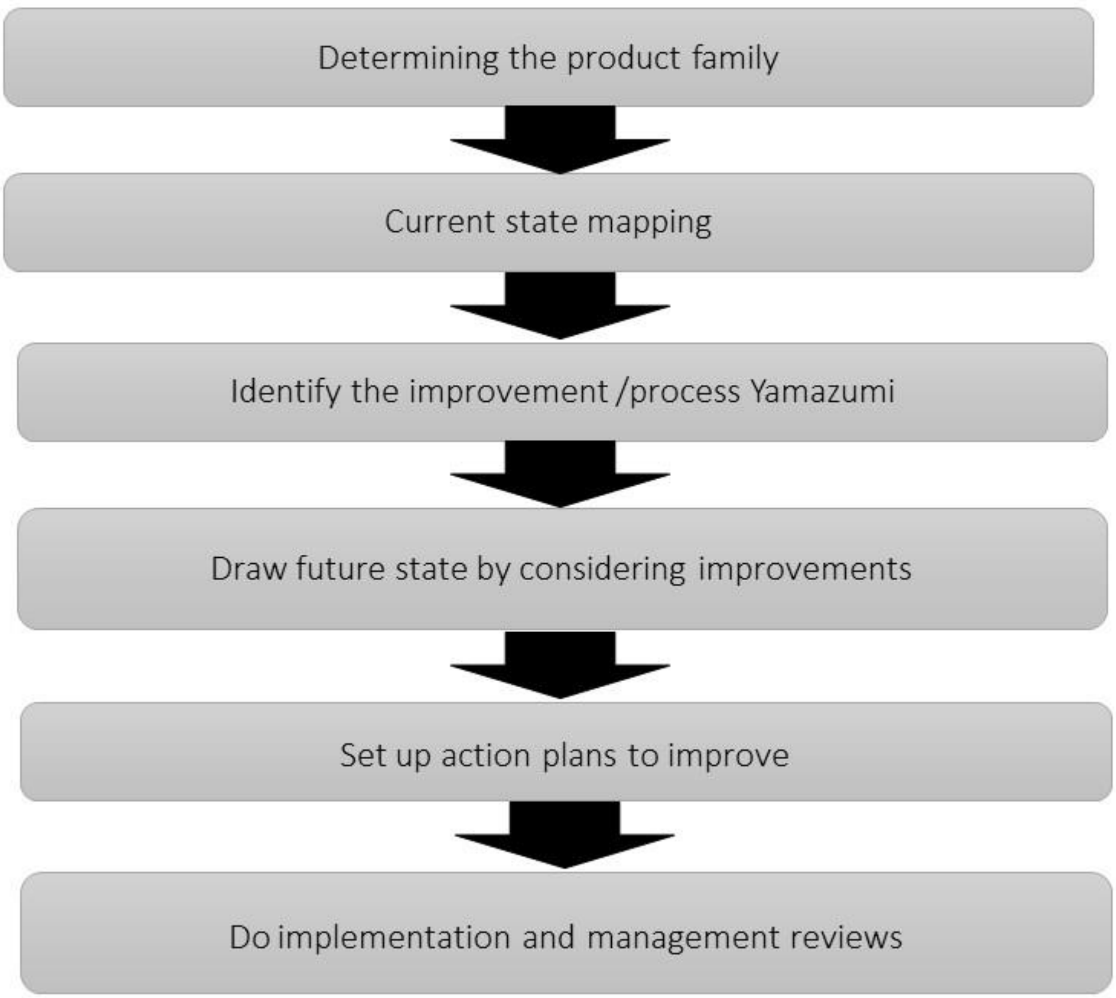
Stitching	
Cycle time	***400sec***
Process time	***400 sec***
C/O time	***30 min***
FTT	***96%***
Batch Size	***1 pcs***

Packing	
Cycle time	***2sec***
Process time	***500 sec***
C/O time	***2 min***
FTT	***100%***
Batch Size	***250 pcs***

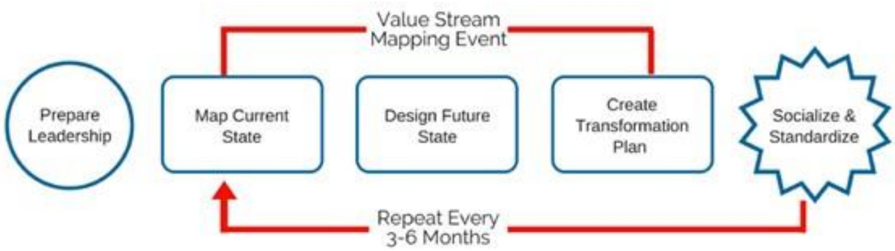
Types of material flow

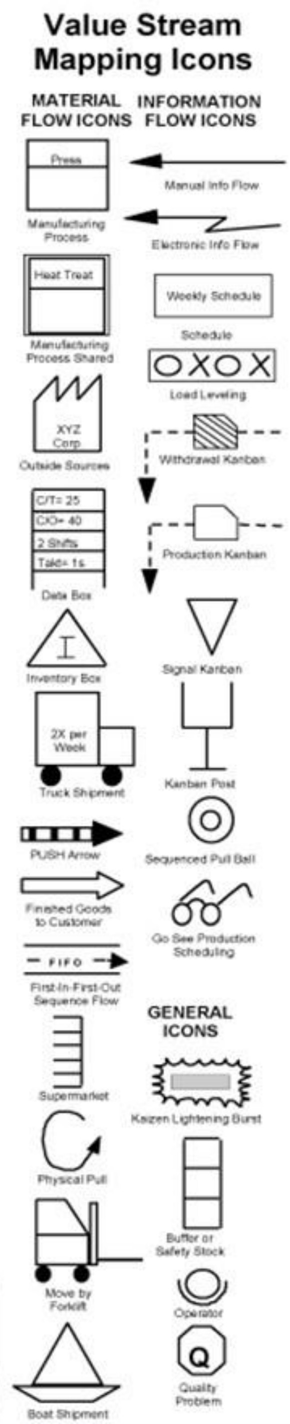


Process of value stream mapping



Value Stream Mapping Process





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