Available online at www.elixirpublishers.com (Elixir International Journal)

Mechanical Engineering

Elixir Mech. Engg. 56 (2013) 13422-13434

ISSN: 2229-712X

Application of Value Stream Mapping with Value Engineering in Furniture Manufacturing Small Scale Industry

Chougule Mahadeo Annappa[1] and Kallurkar Shrikant Panditrao[2]
[1]A.G. Patil Polytechnic Institute, Vijapur Road, Solapur (Maharashtra), India.
[2]Dr. D.Y. Patil School of Engineering, Ambi, Talegaon, Pune, Maharashtra.

ARTICLE INFO

Article history:
Received: 15 January 2013;
Received in revised form:
5 March 2013;
Accepted: 8 March 2013;

Keywords
Value Stream Mapping (VSM),
Value Engineering,
Lean,
Furniture Industry,
Lead Time,
Current Value Stream Map,
Future Value Stream Map,
VA Time,
NVA Time.

ABSTRACT

The purpose of this paper is to develop a plan for reducing a lead time in a small scale furniture manufacturing industry by using Value Stream Mapping Technique with Value Engineering. In this paper VSM technique is applied in furniture manufacturing small scale industry to identify the ways of reducing waste while at the same time increasing the proportion of the processes that add value to the product. The wastes in this furniture industry is mostly in the form of over production, transportation and delay. The reasons observed are inadequate coordination among the operators, improper planning, non effective use of machine, improper flow etc. Here the flow process chart is constructed to calculate the number of operation, transportation, delay, inspection and storage with distance travelled by the product for existing and proposed methods in which considerable saving is achieved. Also the Current and Future VSM is created for small scale furniture industry which manufactures office tables. In this the lead time can be reduced considerably with the reduction in NVA time and the process time. There is a considerable rise in VA time of 10.41% with the value addition by modification of the table with less process time.

Introduction

A value stream is all the actions (value-added and non-value added) required to take a product from raw material to the customer, the design flow from concept to completion. Taking a value stream view means looking at the whole picture, not just individual processes, and improving the whole, not just individual parts. Value Stream Mapping is a pencil and paper tool that helps to see and understand the flow of material and information as a product makes its way through the value stream. The meaning is simple: Follow a product's production path from customer to supplier, and draw a visual picture of every process in the material and information flow. Within the production flow, the movement of material through the factory is the flow that usually comes to mind. But the information flow must also be considered since it tells each process what to make or do next; both flows must be mapped.

Value Stream Mapping can be a communication tool, a business-planning tool, and a tool to manage change in production processes. The first step is drawing the current state, done by gathering information on the plant floor. This provides the information needed to map a future state. The final step is to prepare and begin actively using an implementation plan that describes, on one page, how the future state can be achieved.

More organizations with successful plant Lean programs are also applying Value Stream Mapping methods and Lean principles to administrative areas. Value Stream Mapping provides a simple, yet thorough method that relies on current data analysis and display. It links reporting requirements, metrics, people, and Lean tools to continue improvement and promote process learning. It gives managers and employees the same tool and language to communicate.

Lean Thinking and Traditional Manufacturing

Lean thinking is a process focused on increasing the value added to products and services and the reduction of waste. The term “lean,” coined by Womack during one of his visits to the Japanese carmaker Toyota in the early 1980s (Womack and Jones 2003), has become the universally accepted term for increasing value and reducing waste.

Examples of added value for manufacturers include extra product features deemed valuable by customers, shorter lead times, and more convenient deliveries in smaller batches. On the other hand, activities such as keeping excessive inventories, unnecessary transportation, waiting time, and reprocessing are considered waste (Womack, Jones, and Roos 1991). Lean manufacturing is based on the Toyota Production System developed by Toyota which focuses on eliminating waste, reducing inventory, improving throughput, and encouraging employees to bring attention to problems and suggest improvements to fix them (Womack et al.1991). Lean manufacturing has increasingly been applied by leading manufacturing companies throughout the world. A core concept of lean manufacturing is pull production in which the flow on the factory floor is driven by demand from downstream pulling production upstream. Some of the changes required by lean manufacturing can be disruptive if not implemented correctly and some aspects of it are not appropriate for all companies (Hobbs, 2004). A lean manufacturing facility is capable of producing product in only the sum of its value added work content time. Features of a typical lean manufacturing model

Tele:
E-mail addresses: chougulema@yahoo.co.in

include: one unit at a time production, non-value added time eliminated, production in the work content time only, and relocation of required resources to the point of usage.

1. **Overproduction** – When more articles are produced than are required in a production order. This causes an increase in finished inventory and holding costs.

2. **Waiting** – Idle equipment or operators waiting for raw materials, tools, or a maintenance crew.

3. **Unnecessary transportation** – Avoidable transportation of goods, parts, or information is waste. Also, mechanical damage can be inflicted to parts or goods while being transported.

4. **Over processing or incorrect processing** – If project orders or processes are not clearly defined, tasks will be performed in the wrong way, producing the wrong outputs. This will add more cost to the product or service, and customers will not receive what they are paying for.

5. **Excess inventories** – Excess raw material, work in process (WIP), and finished goods inventories produce long waiting times, obsolescence, damaged products, unnecessary transportation, and holding and production costs. Also, excess inventory is related to uneven demand, supplier problems, defects, long setup times, and maintenance problems.

6. **Unnecessary movement** – Any unnecessary movement by employees, such as searching for parts or tools or excessive walking distances are wasteful.

7. **Defective products** – Manufacturing products that do not meet customer specifications is a waste, which creates unsatisfied customers and increases total manufacturing costs. Recently, an eighth kind of waste is being included with the previous seven (Liker 2004):

8. **Unused employee creativity** – Not listening to employees and losing time, ideas, skills, potential

Table No. 1: A comparison of traditional versus lean manufacturing

Traditional Manufacturing	Lean Manufacturing
Standard products	Customized products
Data management	Statistical control per production line
Automate everything	Eliminate nonvalue-added activities first
Measure everything	Measure what is needed
Price is first	Quality is first
Quality inspectors	Quality on the source
Quality costs	Quality is free
New equipment purchases	Improve equipment first
Use technology to increase productivity	Use process improvement to increase productivity
Inflexible	Flexible
Push	Pull
Ignore setup times	Setup minimization
Accept cycle times	Cycle time reduction

The pricing formula is reformulated to

Profit = price – cost.

Therefore, the only way to increase profits is by reducing wastes or costs.

The Lean Thinking Process

Lean thinking initiatives require complete commitment from the organization's leadership. If such a commitment is not made, an organization is better served to continue going about their business in traditional ways and to involve alternative process improvement initiatives.

Companies with the necessary leadership commitment need to have formulated, agreed on, and worked on implementing its strategic elements: mission statement, vision statement, strategic goal formulation, and action plans. Once these elements are in place, an assessment can be made as to whether the lean thinking philosophy is the appropriate improvement process to use. If lean thinking proves to be the appropriate philosophy, four concepts need to be embraced: value, flow, pull, and continuous improvement.

Lean = Waste Elimination

Figure No. 1

Value

The critical starting point for lean thinking is value (Womack and Jones 2003). Value has to be defined before analysis can start. Customers buying a product or service signal that they require a certain value at a reasonable price. Thus, end customers define value.

However, when investigating the typical production sequence of a product, as displayed in figure 1, one realizes that the entire process has few steps that add value for the consumer. All activities shown in figure 1 with the exception of "production" are considered not value-added from the consumer's perspective. For final customers, only the production sequence matters; they do not care about the other steps, such as order placement, raw material purchasing, raw material reception, raw material storage, machine setup, inspection, rework, and shipping. All these activities represent waiting, inspections, rework, or transportation that is not relevant and adds no value from the customer's point of view (muda type II; "muda" is a Japanese word that means waste).

While some of these activities cannot be eliminated (these processes are referred to as necessary, nonvalue-added processes or muda type I), lean thinkers strive to minimize them as much as possible. Typically in manufacturing organizations, 99 percent of the total product lead time is nonvalued-added (Quesada-Pineda, Haviarova, and Slaven 2009).

Flow: The focus of lean projects is to eliminate all nonvalue-added activities from the process and to focus on value-added activities from the customer's point of view. Value stream maps (VSM) — a graphic tool used to analyze the entire process and identify steps that add value and those that don't add value — are used for this purpose. Once the value-added processes are identified through VSM, the challenge is to achieve smooth flow among the remaining process steps.

Flow is limited by the organizational structure and the way raw material and data are processed to produce value in each operation. For example, traditional organizations are structured by departments or functions, which disconnects departments. Raw material and data is processed in batches, requiring the next process to wait until the whole batch has arrived. Therefore, flow is impossible to achieve if the organization does not change its structure to a process-oriented form and reduce its batch sizes.

Pull: Inventory control in traditional manufacturing is used to purchase and stock the correct quantity of raw materials. Information used for making these decisions is mostly based on forecasts that rely on historical data, and such history-based systems result in under- or overstocking.

Raw material inventory gets pushed into the production process, thus becoming work in process inventory, and processed material gets pushed into the finished goods warehouse. Money and other resources are tied up in these inventories and affect the financial health of the company. At the end of an accounting period, products get pushed to the wholesalers and retailers. A lean manufacturing system changes the mode of operation from push to pull. Raw material is only received, converted into a product, and stocked in the finished goods warehouse if a product is sold. So, no excess inventory accumulates and products flow smoothly through the process of receiving orders and producing and delivering goods.

Continuous Improvement

Because the ideal state described above concerning value, flow, and pull is never reached, continuous improvement is the method used to systematically improve operations to deliver better value to customers and to achieve better financial performance. Thus, efforts to eliminate nonvalue-added activities, to achieve flow, and to pull production will never be entirely successful, so striving for perfection is a never-ending, continuous undertaking.

A perfect process has to be:

Capable – The process consistently delivers the output expected with minimum variability.

Adequate – The process has the right capacity.

Available – The process is available to perform its function when needed.

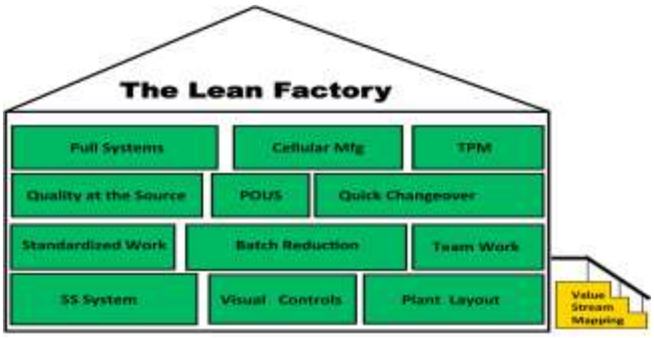


Figure No. 2. Basic tools for lean efforts

There are some tools that can help us reach for the perfect value chain, considered the fundamental blocks of lean efforts (figure 2). These tools can be used alone or in combination to eliminate waste, increase value added, eliminate or reduce variability (capability), increase process availability (flow), and level demand (adequacy).

Case Study of Office Table for Value Stream Mapping

Figure No. 3 Office Table

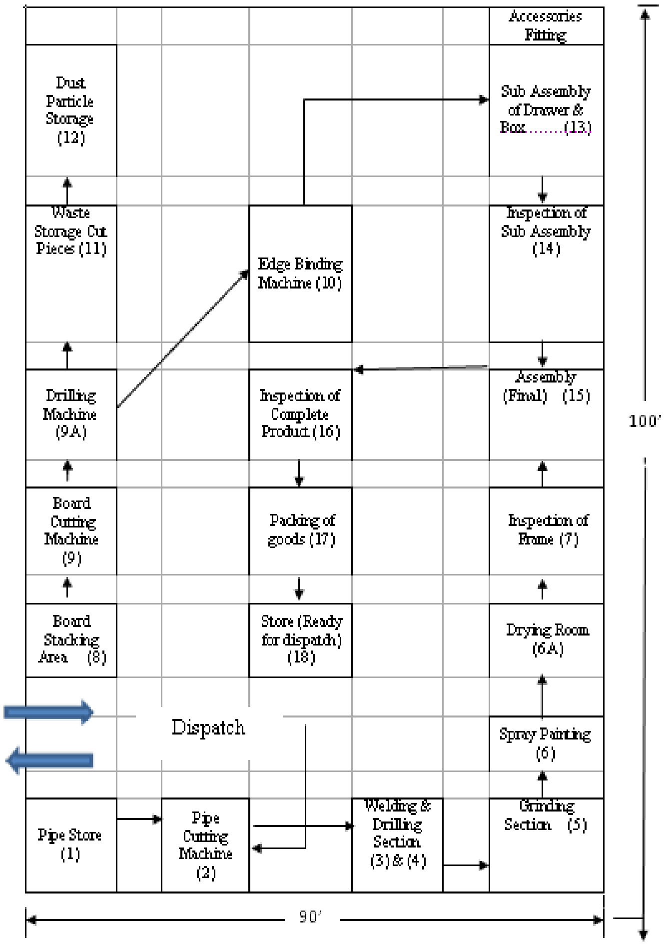
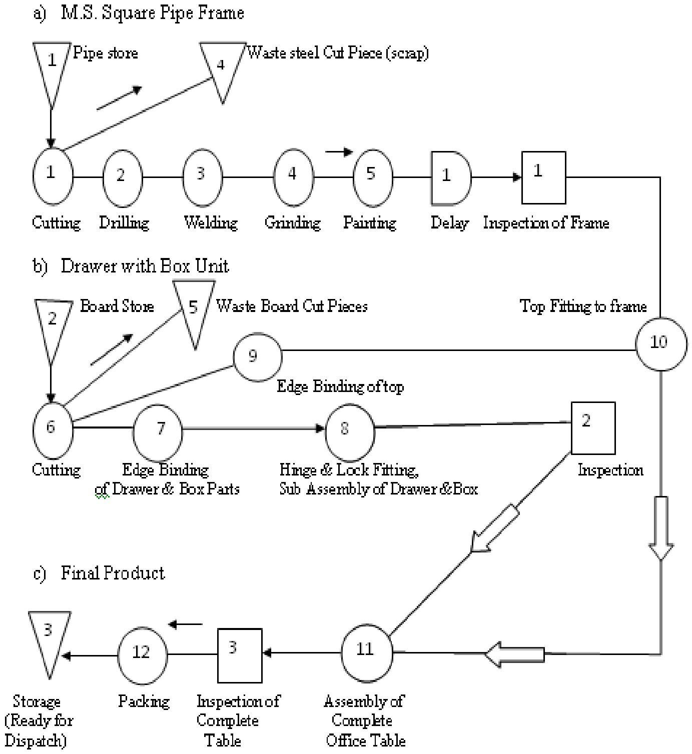


Figure No. 4: Layout of Office Table Manufacturing Industry (Total Area 9000 Sq. Feet)

Flow process chart for production of Office Table (Current)



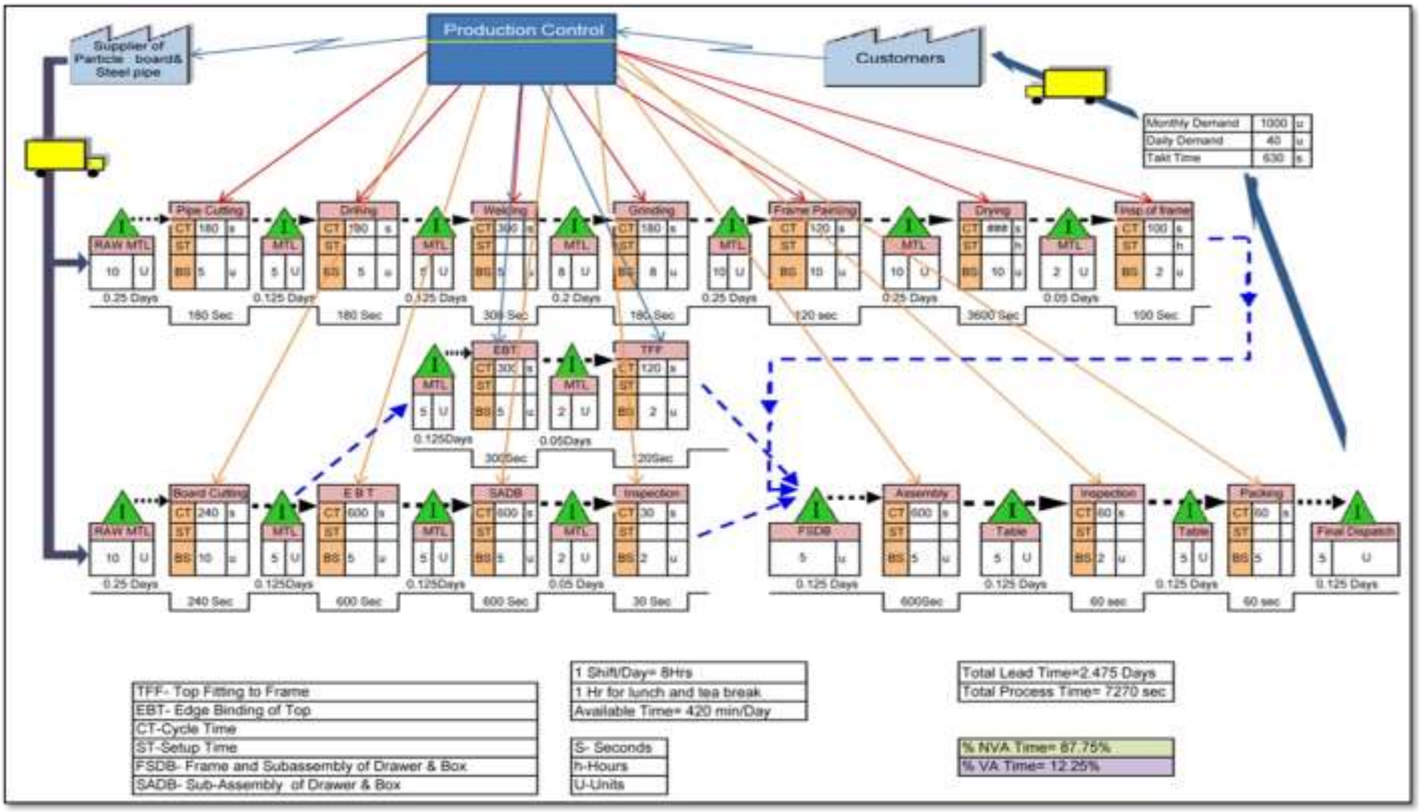


Figure No. 6: The current Value Stream Map for Office Table Manufacturing Industry

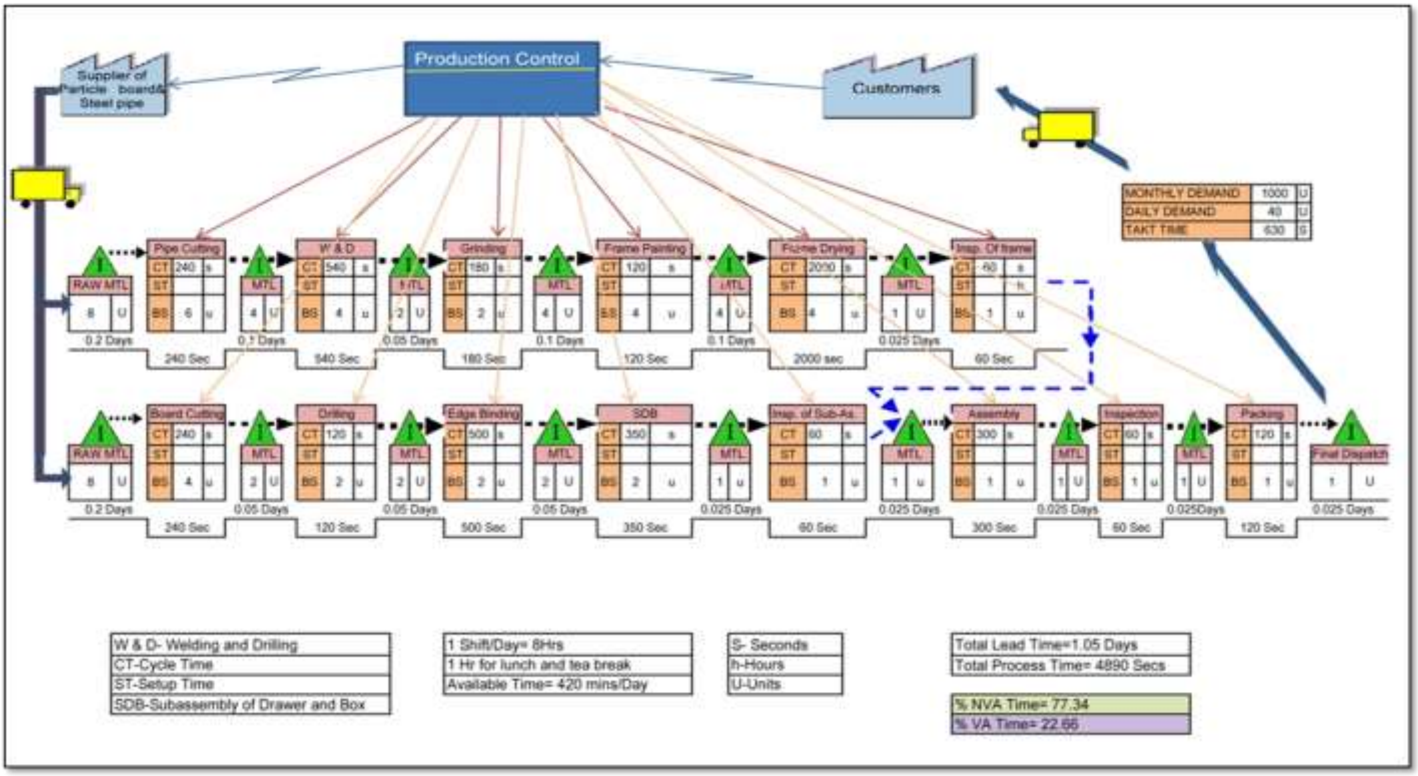


Figure No. 8: The Future Value Stream Map for Office Table Manufacturing Industry [Conversion of Office Table in to Office Table cum Computer Work Station]

Table No. 2: Flow Process chart for Production of Office Table (Current)

Product	**Office Table**	**Location**	**Production Shop**
Process	**Cutting, Welding, Grinding, Drilling, Painting, Edge Binding**		
Distance in Meters	Symbol	Activity	Type of Activity
		i) Steel Frame	
	▽	Pipe in store (M.S.)	
	⇨	Picked up by operator	Non Productive
1.52	⇨	Transport to cutting machine	Non Productive
	⇨	Unload on cutting machine	Non Productive
	○	Pipe cutting	Productive
	⇨	Picked up by operator	Non Productive
1.82	⇨	Transport to drilling machine	Non Productive
	○	Drilling the pipe	Productive
	⇨	Picked up by operator (Frame)	Non Productive
1.52	⇨	Transport to Welding machine	Non Productive
	○	Welding the pipe	Productive
	⇨	Picked up by operator (Frame)	Non Productive
1.52	⇨	Transport to Grinding machine	Non Productive
	○	Grinding the steel frame	Productive
	⇨	Picked up by operator (Frame)	Non Productive
1.52	⇨	Transport to painting & Drying	Non Productive
	○	Painting the frame	Productive
	D	Drying the frame	Non Productive
	□	Inspection of Frame	Non Productive
	⇨	Picked up scrap of steel pipe	Non Productive
	▽	Dumped in scrap area	
	⇨	Picked by transport frame to Assembly section	Non Productive
		ii) Drawer and Box unit	
	▽	Particle board in store	
	⇨	Picked by operator	Non Productive
4.56	⇨	Transport to cutting machine	Non Productive
	⇨	Unload sheet on cutting machine	Non Productive
	○	Board cutting of different sizes for Drawer, Box, Keyboard, Top etc.	Productive
	⇨	Picked by operator (Board for drawer and box only)	Non Productive
4.56	⇨	Transport to edge binding machine	Non Productive
	○	Edge binding for board	Productive
	⇨	Picked by operator	Non Productive
3.04	⇨	Transport to Hinge fitting & Accessories Fitting & Sub Assembly of drawer and box	Non Productive
	○	Sub Assembly of drawer and box with Hinge & Lock fitting	Productive
	□	Inspection of drawer and box sub assembly	Non Productive
3.04	⇨	Picked and transport drawer and box to assembly section	Non Productive
		iii) Table top	

1.52	⇨	Picked waste pieces of different sizes	Non Productive
	▽	Dumped in scrap area (Board)	
	⇨	Picked by operator (Top for cutting section)	Non Productive
4.56	⇨	Transport to edge binding machine	Non Productive
	⇨	Unload board on edge binding machine	Non Productive
	○	Edge binding for board	Productive
4.56	⇨	Transport top to Assembly section (Final)	Non Productive
	○	Fixing top to steel frame	Productive
	○	Assembly of complete office table	Productive
	⇨	Picked by operator	Non Productive
3.04	⇨	Transport for inspection	Non Productive
	□	Inspection of Complete table	Non Productive
1.52	⇨	Transport for Packing	Non Productive
	○	Packing of office table	Productive
	⇨	Picked by operator	Non Productive
1.52	⇨	Transport to store	Non Productive
	▽	Ready for dispatch to customer	

Table No. 3

Flow Process chart – (Material Type) for Office Table Manufacturing Industry **(Current)**

Flow Process chart	~~Worker~~ /Material/~~Machine Type~~			
Chart No.1 Sheet No. 1 of 1	Summary			
Subject Charted: office Table production	Activity	Current	Future	Saving
	Operation ○	14		
Activity: Cutting, Grinding Drilling, Welding etc.	Transport ⇨	31		
Method: Current/ ~~Future~~	Delay D	1		
Location: Production shop	Inspection □	3		
Charted by: ABC Dtd.	Storage ▽	5		
Approved by: XYZ Dtd.	Time work-Min			
	Dist. in mt.	39.82		

Description	Dist. in mt.	Time in Min	Symbol ○	⇨	D	□	▽	Remark
Pipe in store								
Picked up by operator								Manual
Transport to cutting machine	1.52							Manual
Unload on cutting machine								
Pipe cutting								
Picked up by operator								Manual
Transport to welding & drilling machine	3.34							
Welding the pipe								
Picked up by operator (Frame)								
Transport to Grinding machine	1.52							Manual
Grinding the Steel frame								
Picked up by operator (Frame)								Manual
Transport to painting & Drying	1.52							Manual
Painting the frame								
Drying the frame								
Inspection of Frame								
Picked up scrap of steel pipe								Manual

Dumped in scrap area							•	
Picked & transport frame to Assembly section				•				Manual
Particle board in store							•	
Picked by operator				•				Manual
Transport to cutting machine	4.56			•				Manual
Unload sheet on cutting machine				•				
Board cutting of different sizes for Drawer, Box, Keyboard, Top etc.			•					
Picked by operator (Board for drawer and box only)				•				Manual
Transport to Drilling machine	3.04			•				Manual
Drilling as per requirement			•					
Picked by operator				•				Manual
Transport to Edge binding machine	4.56			•				Manual
Edge Binding for board			•					
Picked by operator				•				
Transport to Hinge & Accessories firings				•				Manual
Hinge & Accessories fittings			•					
Picked by operator				•				
Transport to sub assembly of Drawer & Box	3.04			•				Manual
Lock Fitting			•					
Sub Assembly of drawer and box with Hinge & Accessories Fitting			•					
Inspection of drawer and box sub assembly						•		
Picked and transport drawer and box to assembly section	3.04			•				Manual
Picked waste pieces of different sizes	1.52			•				Manual
Dumped in scrap area (Board)							•	
Picked by operator (Top for cutting section)				•				Manual
Transport to edge binding machine	4.56			•				Manual
Unload board on Edge binding machine				•				
Edge binding for board			•					
Transport top to Assembly section (Final)	4.56			•				Manual
Fixing top to steel frame			•					
Assembly of complete office table			•					
Picked by operator				•				
Transport for inspection	3.04			•				Manual
Inspection of Complete Table						•		
Transport for Packing	1.52			•				Manual
Packing of office table			•					
Picked by operator				•				Manual
Transport to store	1.52			•				Manual
Ready for dispatch to customer							•	
Total	39.82		14	31	1	3	5	

Table No. 4 VA/ NAV Time Analysis (Current)

Sr. No.	Name of Process	% VA	VA Time in Seconds	NVA Time in Seconds	Average Processing Time in Seconds
01	Pipe cutting	2.77	180	6300	6480
02	Drilling	5.4	180	3150	3330
03	Welding	8.7	300	3150	3450
04	Grinding	3.45	180	5040	5220
05	Frame Painting	1.89	120	6300	6420
06	Frame Drying	00	00	6300	6300
07	Inspection of Frame	00	00	1260	1260
08	Board Cutting	3.7	240	6300	6540
09	Edge Binding	16	600	3150	3750
10	Sub Assembly of Drawer & Box	16	600	3150	3750
11	Inspection of Sub Assembly	00	00	1260	1260
12	Edge Binding of Top	8.69	300	3150	3450
13	Top fitting to frame	8.69	120	1260	1380
14	Assembly of final product	16	600	3150	3750
15	Inspection of Final Table	00	00	3150	3150
16	Packing of final product	1.9	60	3150	3210
Total		5.8	3480	59220	62700

Table No.6 Flow Process chart for Production of Office Table cum Computer Work Station (Future)

Product	**Office Table cum Computer Work Station**	**Location**	**Production Shop**
Process	**Cutting, Welding, Grinding, Drilling, Painting, Edge Binding**		
Distance in Meters	**Symbol**	**Activity**	**Type of Activity**
		i) Steel Frame	
	▽	Pipe in store	
1.52	⇨	Picked up & Transport to cutting machine	Non Productive
	⇨	Unload on cutting machine	Non Productive
	○	Pipe cutting	Productive
3.34	⇨	Transport to welding machine & Drilling machine	Non Productive
	○	Welding the pipes & drilling holes on frame	Productive
1.52	⇨	Transport to Grinding machine	Non Productive
	○	Grinding the steel frame	Productive
1.52	⇨	Transport to painting	Non Productive
	○	Painting the frame	Productive
	D	Drying the frame	Non Productive
	□	Inspection of Frame	Non Productive
		ii) Drawer and Box unit	
	▽	Particle board in store	
4.56	⇨	Transport to cutting machine	Non Productive
	⇨	Unload sheet on cutting machine	Non Productive
	○	Cutting board for Drawer, Box, Keyboard, Top	Productive
3.04	⇨	Transport to drilling machine	Non Productive
	○	Drilling as per requirement	Productive
4.56	⇨	Transport to edge binding machine	Non Productive

	○	Edge binding for board	Productive
3.04	⇨	Transport for accessories fitting	Non Productive
	○	Sub Assembly of drawer and box with keyboard Fitting of all accessories (Hinge, Lock etc.)	Productive
1.52	⇨	Transport to inspection of sub assembly	Non Productive
	□	Inspection of drawer and box sub assembly	Non Productive
1.52	⇨	Transport to assembly section (Final)	Non Productive
	○	Assembly of complete office cum computer work station	Non Productive
3.04	⇨	Transport to inspection of complete table	Non Productive
	□	Inspection of complete table	Productive
1.52	⇨	Transport to packing	Non Productive
	○	Packing of goods	Productive
1.52	⇨	Transport to store	Non Productive
	▽	Ready for dispatch to customer	

Table No. 7

Flow Process chart – (Material Type) for Office Table cum Computer Work station Manufacturing Industry **(Future)**

Flow Process chart	~~Worker~~ /Material/~~Machine Type~~			
Chart No.1 Sheet No. 1 of 1	Summery			
Subject Charted: office Table production	Activity	Current	Future	Saving
	Operation ○	14	11	3
Activity: Cutting, Grinding etc.	Transport ⇨	31	15	16
Method: ~~Current~~/ Future	Delay D	1	1	0
Location: Production shop	Inspection □	3	3	0
Charted by: ABC Dtd.	Storage ▽	5	3	2
Approved by: XYZ Dtd.	Time work-Min			
	Dist. in mt.	39.82	32.22	7.6

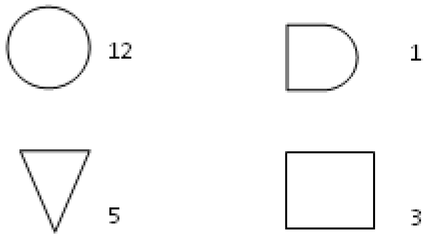
Description	Dist. in mt.	Time in Min	○	⇨	D	□	▽	Remark
Pipe in store							•	Manual
Picked up & Transport to cutting machine	1.52			•				
Unload on cutting machine				•				
Pipe cutting			•					
Transport to welding machine & Drilling machine	3.34			•				Manual
Welding the pipes & drilling holes on frame			•					
Transport to Grinding machine	1.52			•				Manual
Grinding the steel frame			•					
Transport to painting	1.52			•				Manual
Painting the frame			•					
Drying the frame					•			
Inspection of Frame						•		
Particle board in store							•	
Transport to cutting machine	4.56			•				Hoist
Unload sheet on cutting machine				•				
Cutting board for Drawer, Box, Keyboard, Top			•					

Transport to drilling machine	3.04			•				Manual
Drilling as per requirement			•					
Transport to edge binding machine	4.56			•				Manual
Edge binding for board			•					
Transport for accessories fitting	3.04			•				Manual
Fitting of all accessories (Hinge, Lock, Slider, Knob etc.)			•					
Sub Assembly of drawer and box with Keyboard			•					
Transport to inspection of sub assembly	1.52			•				Manual
Inspection of drawer and box sub assembly						•		
Transport to assembly section (Final)	1.52			•				Trolley
Assembly of complete office cum computer work station			•					
Transport for inspection	3.04			•				Trolley
Inspection of complete table						•		
Transport to packing	1.52			•				Trolley
Packing of goods			•					
Transport to store	1.52			•				Trolley
Ready for dispatch to customer							•	
Total	32.22		11	15	1	3	3	

Table No. 8 VA/ NAV Time Analysis (Future)

Sr. No.	Name of Process	% VA	VA Time in Seconds	NVA Time in Seconds	Average Processing Time in Seconds
01	Pipe cutting	4.55	240	5040	5280
02	Welding & Drilling	17.65	540	2520	3060
03	Grinding	12.50	180	1260	1440
04	Frame Painting	4.55	120	2520	2640
05	Frame Drying	100	2000	00	2000
06	Inspection of Frame	8.69	60	630	690
07	Board Cutting	4.55	240	5040	5280
08	Drilling	8.69	120	1260	1380
09	Edge Binding	28.41	500	1260	1760
10	Accessories fitting with Sub Assembly of Drawer & Box	21.74	350	1260	1610
11	Inspection of Sub Assembly	8.69	60	630	690
12	Assembly of final product	32.26	300	630	930
13	Inspection of Final Table	8.69	60	630	690
14	Packing of final product	16.00	120	630	750
	Total	17.34	4890	23310	28200

Summary



- **Detailed Value Stream Mapping (VSM) Analysis for Office Table Manufacturing Industry (Current)**

Calculation of Final Metrics

1. Raw material (Steel Pipe) Inventory point = $\frac{10\ \text{units}}{40\ \frac{\text{Units}}{\text{day}}}$ = 0.25 day

[Raw Material Inventory Point = 0.25 Days = 0.25 x (60 x 60 x 7 Hrs.) = 6300 Second]

2. Drilling Inventory point= $\frac{5}{40}$ = 0.125 day
3. Welding Inventory point= $\frac{5}{40}$ = 0.125 day
4. Grinding Inventory point= $\frac{8}{40}$ = 0.2 day
5. Pipe Painting Inventory point= $\frac{10}{40}$ = 0.25 day
6. Drying Inventory point= $\frac{10}{40}$ = 0.25 day
7. Raw material (Particle Board) Inventory point = $\frac{10\ \text{units}}{40\ \frac{\text{Units}}{\text{day}}}$ = 0.25 day
8. Inspection of Frame = $\frac{2}{40}$ = 0.05 day
9. Edge binding inventory point= $\frac{5}{40}$ = 0.125 day
10. Sub Assembly (Drawer & Box) inventory point= $\frac{5}{40}$ = 0.125 day
11. Inspection of Sub Assembly (Drawer & Box) = $\frac{2}{40}$ = 0.05 day
12. Edge binding of Top Inventory point= $\frac{5}{40}$ = 0.125 day
13. Top fitting to frame Inventory point= $\frac{2}{40}$ = 0.05 day
14. Assembly (Table / Final Product) inventory point= $\frac{5\ \text{units}}{40\ \frac{\text{units}}{\text{day}}}$ = 0.125 day
15. Inspection of Table Inventory point = $\frac{5}{40}$ = 0.125 day
16. Packing of Table Inventory point= $\frac{5\text{units}}{40}$ = 0.125 day
17. Final Product inventory point= $\frac{5}{40}$ = 0.125 day

Available Time = 420Min/ Day

Total Lead Time = (0.25 + 0.125 + 0.125 + 0.2 + 0.25 + 0.25 + 0.05 + 0.25 + 0.125 + 0.125 + 0.05 + .125 + 0.05 + 0.125 + 0.125 + 0.125 + 0.125)

= 2.475 Days

Process Time = (180 + 180 + 300+ 180 + 120 + 3600 + 100 +240 +600+ 600+30 +300 + 120 + 600+60+60) = 7270 Sec.

VA = $\frac{7270\ \text{Sec.}}{1\ \text{Min}} \times \frac{1\ \text{Min}}{60} \times \frac{1\ \text{Hr}}{60} \times \frac{1\ \text{Day}}{7\ \text{Hrs.}}$ = 0.288 Days

NVA = Total Lead Time – VA

= 2.475 Days – 0.288 days = 2.187 Days

% VA = $\frac{VA}{NvA} = \frac{0.2678}{2.1877}$ = 0.1225

= 0.1225 X 100 = 12.25 %

% NVA = 1 - % VA

= 1- 0.1225 = 0.8775

= 87.75%

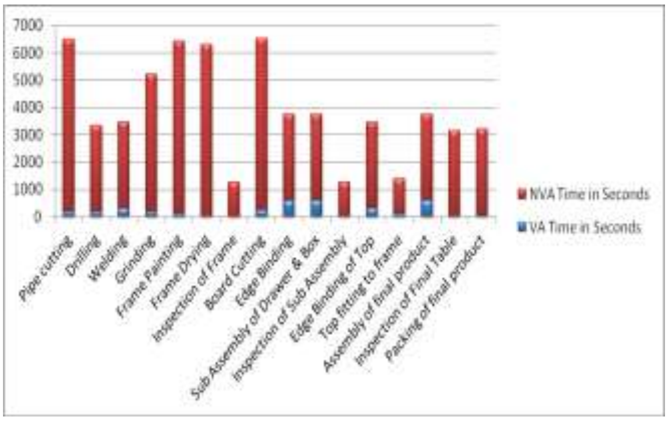
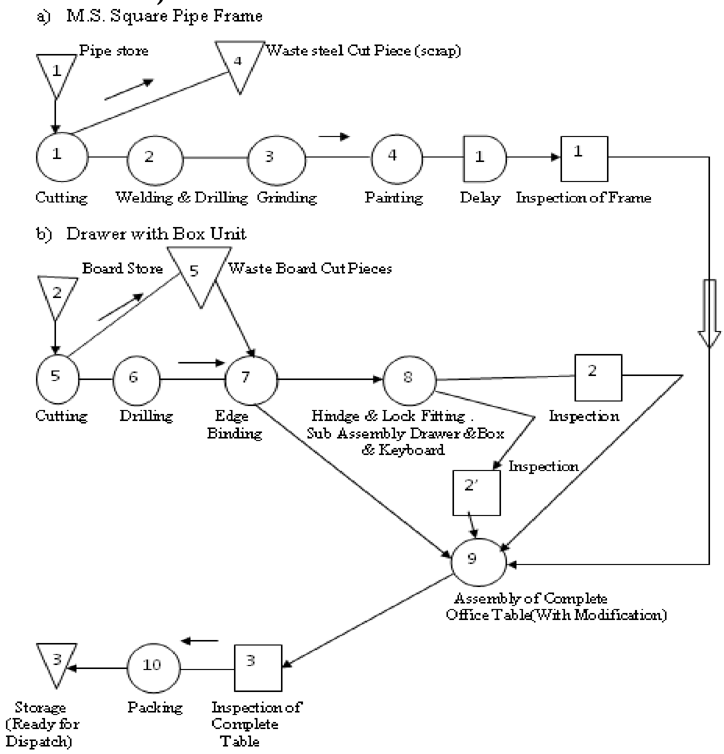
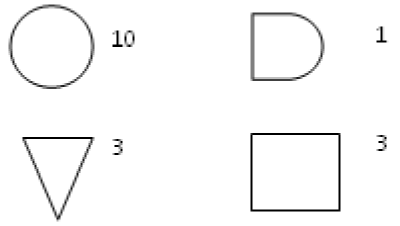


Figure No. 5

Flow process chart for production of Office Table (Future) (Conversion of Office Table into Office cum Computer Work Station)



Summary



Detailed Value Stream Mapping (VSM) Analysis for Office Table manufacturing Industry (Future)

Calculation of Final Metrics

1. Raw material (Steel Pipe) Inventory point = $\frac{8 \text{ units}}{40 \frac{\text{Units}}{} \text{day}}$ = 0.2 day

2. Welding & Drilling inventory point= $\frac{4}{40}$ = 0.1 day

3. Grinding inventory point= $\frac{2}{40}$ = 0.05 day

4. Frame Painting inventory point= $\frac{4}{40}$ = 0.1 day

5. Frame Drying inventory point= $\frac{4}{40}$ = 0.1 day

6. Inspection of Frame = $\frac{1}{40}$ = 0.025 day

7. Raw material (Particle Board) Inventory point = $\frac{8 \text{ units}}{40 \frac{\text{Units}}{} \text{day}}$ = 0.2 day

8. Drilling inventory point= $\frac{2}{40}$ = 0.05 day

9. Edge binding inventory point= $\frac{2}{40}$ = 0.05 day

10. Sub Assembly (Drawer & Box with Accessories fitting) inventory point= $\frac{2}{40}$ = 0.05 day

11. Inspection of Sub Assembly (Drawer & Box) = $\frac{1}{40}$ = 0.025 day

12. Assembly (Final Product) inventory point= $\frac{1}{40}$ = 0.025 day

13. Inspection (Final Product) inventory point = $\frac{1}{40}$ = 0.025 day

14. Packing inventory point= $\frac{1 \text{ units}}{40}$ = 0.025 day

15. Final Product inventory point= $\frac{1}{40}$ = 0.025 day

Available Time = 420Min/ Day

Total Lead Time = (0.2 + 0.1 + 0.05 + 0.025 + 0.1+ 0.1 + 0.2+ 0.05 + 0.05 + 0.05 + 0.025 + 0.025 + 0.025 + 0.025 + 0.025)

= 1.05 Days

Process Time = (240 + 540 + 180+ 120 + 2000 + 60 +240 + 120+500+350+60+300+60+120)

= 4890 Sec.

VA = $\frac{4890 \text{ Sec.}}{1 \text{ Min}} \times \frac{1 \text{ Min}}{60} \times \frac{1 \text{ Hr}}{60} \times \frac{1 \text{ Day}}{7 \text{ Hrs.}}$ = 0.1940 Days

NVA = Total Lead Time – VA

= 1.05 Days – 0.1940 days = 0.856 Days

% VA = $\frac{VA}{NvA} = \frac{0.1940}{0.856}$ = 0.2266

= 0.2266 X 100 = 22.66 %

% NVA = 1 - % VA = 1- 0.2266 = 0.7734

= 77.34%

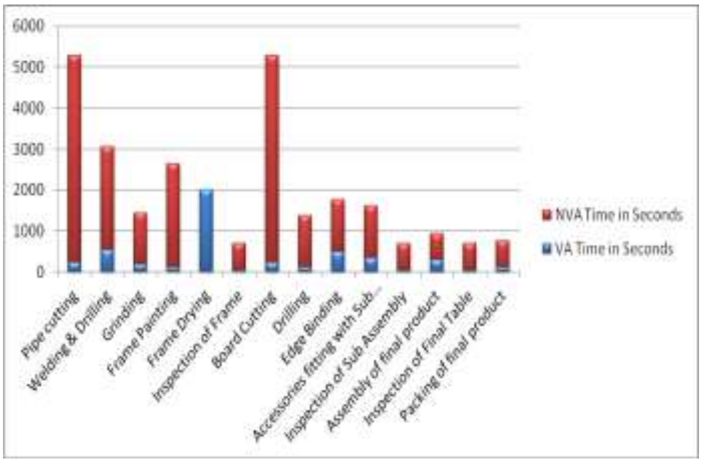


Figure No. 7

Conclusions:

The Value Stream Mapping with Value Engineering is applied in furniture manufacturing small scale industry to identify the ways of reducing waste while at the same time increasing the proportion of the processes that add value to the product.

The waste in this furniture industry is mostly in the form of over production, transportation and delay. The reasons observed are inadequate coordination among the operators and workers, improper planning, non effective use of machine, improper flow etc. The flow process chart is used to calculate the number of operation, transportation, delay, inspection and storage with distance travelled by the product for current and proposed methods. In this considerable saving is achieved (Table No. 7).

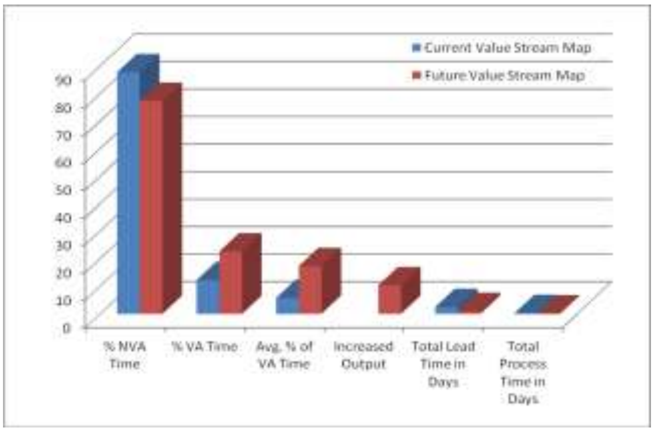
The future Value Stream Map is created by implementing the lean manufacturing technique with value engineering. This suggests that the lead time can be reduced considerably with the reduction in NVA time and the process time. There is a considerable rise in VA time of 10.41% with the conversion of current office table in to future office table cum computer work station. Here the Current Value Stream Map helped to identify areas of potential improvement while the Future Value Stream Map suggested the ways to reduce waste and increase output with value addition (Fig. 6 & 8).

Comparison of Current Value Stream Map and Future Value Stream Map

Table shows a comparison of the Current Value Stream Map and Future Value Stream Map of furniture manufacturing small scale industry to highlights the increase in output with value addition by modifying the existing the Office Table into

Office Table cum Computer Work Station in less process time and ultimately the increase in output.

	Current Value Stream Map	Future Value Stream Map
% NVA Time	87.75	77.34
% VA Time	12.25	22.66
Avg. % of VA Time	5.80	17.34
Increased Output	--	10.41
Total Lead Time in Days	2.475	1.05
Total Process Time in Days	0.29	0.19



The Value Stream Mapping is not limited to small scale furniture manufacturing industries but can also be applied to different other industries.

References:

[1] Use of The Value Stream Mapping Tool For Waste Reduction In Manufacturing. Case Study For Bread Manufacturing In Zimbabwe. By William M. Goriwondo, Samson Mhlanga, Alphonce Marecha

[2] Waste Minimization in the Furniture Industry by Novak Nikolić Dušan Gordić

[3] Lean Thinking: Examples and Applications in the Wood Products Industry by Henry Quesada, Assistant Professor, Wood Science and Forest Products, Virginia Tech

[4]Process Cycle Efficiency Improvement Through Lean: A Case Study by D. Rajenthirakumar, P.V. Mohanram, S. G. Harikarthik

[5] Value Stream Mapping & Vm By William C. Thorsen, Avs, Leed Ap

[6] Value Stream Analysis And Mapping For Product Development by
Hugh L. McManus† and Richard L. Millard

[7] Integrating Value Stream Mapping Value Analysis And Value Engineering By Gurav R.D, Dolas D.R.

[8] Application of Value Stream Mapping to Eliminate Waste in an Emergency Room By Preetinder Singh Gill

[9] Value Stream Mapping - A Effective Tool to Go Lean: A Case Study by Manil Gogia and Dr. J.S. Oberoi