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Production Flow Analysis through Value Stream Mapping Switchgear Manufacturing Industry

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ABSTRACT

A significant element of lean production is the assessment and elimination of inefficiency. Manufacturers use LM to maintain the pinnacle of competition by increasing the efficiency of their industrial technologies and increasing product reliability.The aim of this research is to improve the operational process of the company that manufactures various features for MV Switchgear manufacturing lines by minimizing waste and non-value added process variations using Value Stream Mapping (VSM), one of the most important lean production methods.First, a current value stream map of the assembly line was created using structured interviews, surveys, and supporting information from the company. Thereafter, the potential Future Stream map application of lean production concepts was suggested to highlight the total production lead time and additional value time.Impact on the previous decision, VSM is a valuable and adaptable technique that ultimately helps in conceptualizing different types of waste and defects.It also proposed a Future Stream Map(FSM) to increase overall process performance and illustrated using value stream mapping by reducing rotation time, total lead time and waiting time by suggesting a new de-burring arrangement.

Keywords: LM, VSM, FSM, technique, stream

INTRODUCTION

Value stream mapping (VSM) is a useful technique for visualizing time wastage in a production system; The tool was popularly introduced by Rother and Shook (1999). At the centre of industrialization are large companies and businesses. Companies and large manufacturing companies can claim ownership of the ability to process data quickly (analytically, functional, etc.), which will form the basis for upgrade operations [1, 2]. The ultimate aim of VSM is reshuffle assembly process to enhance with advanced thinking for future development. All value-added and non-value-added functions are associated in the sequence of operations necessary to create a part / product of its current state VSM records [3]. While damage is inevitable in some situations, some objectives of the VSM process are to make the work look uniform and to determine where the waste can be greatly reduced.The development of long-term industrial systems requires innovation. This change necessitates a holistic view of the fundamental inefficiencies that extend beyond primarily time-based waste to include environmental and social muda. Faulkner and Badurdeen (2014) suggested a technique for visualizing and evaluating ecological programs towards the main objective [4, 5]. Sus-VSM incorporated the recent lean manufacturing process including additional features to analyze the environmental effects and societal health.

This research visualizes the key processes of value stream mapping (VSM) for the entire work process distribution from raw materials to finished products. VSM is a process of gathering statistical information to value added and as well as non-value added and monitored the wastes such as production delay, transportation availability, increasing over production, inventory and reducing the wastes. The value of this product is that the primary goal of stream mapping is to change the method, processing time, process interruptions, and integrated process costs.

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This study focuses on KAIZENs, difficulties and wastes that impede the flow of useful information in the value stream. Flow barriers are names given to deeper and broader causes [6, 7]. Geographical separation between processes, extended transition periods, sequence variations, delivery times, shutdowns, overlapping value streams, unpredictable performance enhancement and systematic interpretations are all recognized as barriers to the flow of goods. The limits to the spread of communication have not really been identified and summarized.

Significant investment is required to adopt digital digitization of data and smart production methods. SMEs often involve money in digitizing performance data at this time, resulting in undesirable work and process consequences [8, 9].Modern technology progress is hampered by several obstacles.Individuals reject any attempt to integrate them with the modern paradigm of the management system, especially those with displaced or limited capabilities. Such barriers focus not only on the economic and social components, but also on the technical capabilities of an organization. This study shows that with simple production support and storage capabilities (Lean implementation and TPM components) employees can also improve when they create digital data manually [10, 11].The focus of this research is to demonstrate managing material and physical flows in small and medium-sized businesses. Analysing the effects of digitalization and critical retrieval of information, to determine what steps need to be taken to improve the flow.

MATERIALS AND METHODS

In this research enhance the two important approaches: Value Stream Mapping (VSM) and TPM analysers [12]. The main purpose of the study was to see whether the implementation of digitization technologies in small manufacturing companies would improve the productivity of system-managed production processes in MV Switchgear manufacturing industries. The objective was achieved by implementing changes in the collection of statistical information on the subcommittee of workstations (which, by inference, would generate greater losses). The key assumption is to be able to retrieve electronic information instantly from the specified sections of the application. For this purpose, the information in the diagram was augmented by an evaluation of the OEE (overall equipment performance) coefficients, and the distribution process for the production process (for material cutting and bending operations in this case) was mapped. Provides instant knowledge of the capabilities and applications of the OEE display engine, as well as the performance of the manufacturing process system [13]. Only OEE - Function 3 - was measured for the functions that affect Flow time, and it was recognized as a barrier.

Value Stream Mapping (VSM) focuses on large image analysis ideas. One technique used to create an intelligent production system for SMEs is the Value Stream Mapping System (VSM) with appropriate development. On the basis of the VSM system, five selected areas are followed, which showed data on the basis of observations. The areas are production management, internal information management, material supply management, absorption of materials flows with information's and value added (VA) and non-value-added (NVA) completion of work flow time consumption. Five different regions were monitored using the VSM technology, which displayed data based on inspections. According to the Kaizan and Six-sigma Methodology, losses are observed by different types such as dispensable actions, excess production, wasting time, deficiency, increases excess storage, material expenditure and not used resources. However, VSM analysis has been enriched with characteristics that allow OEE to be evaluated as an overall process determinant. The OEE statistic were converted into digital information for processes and encompassed integrity, accessibility, overall profitability, in accordance to the fundamental premise of TPM assessment.

DATA ANALYSIS AND RESULTS

3.1 Current State Map

The current state of the current state mapping function is higher than the end of the good products from the raw materials.CSM is mainly used to analyze more time and non-value added activities.CSM's Inquiry shows 98% of non-value-added time accounts for information product distribution.Some interruptions may be unavoidable; However,

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it is surprising significant time is spent on waiting or non-value-adding operations during the delivery process.A major hurdle in the current process is excess, which contributes to the long wait time, resulting in longer delivery.

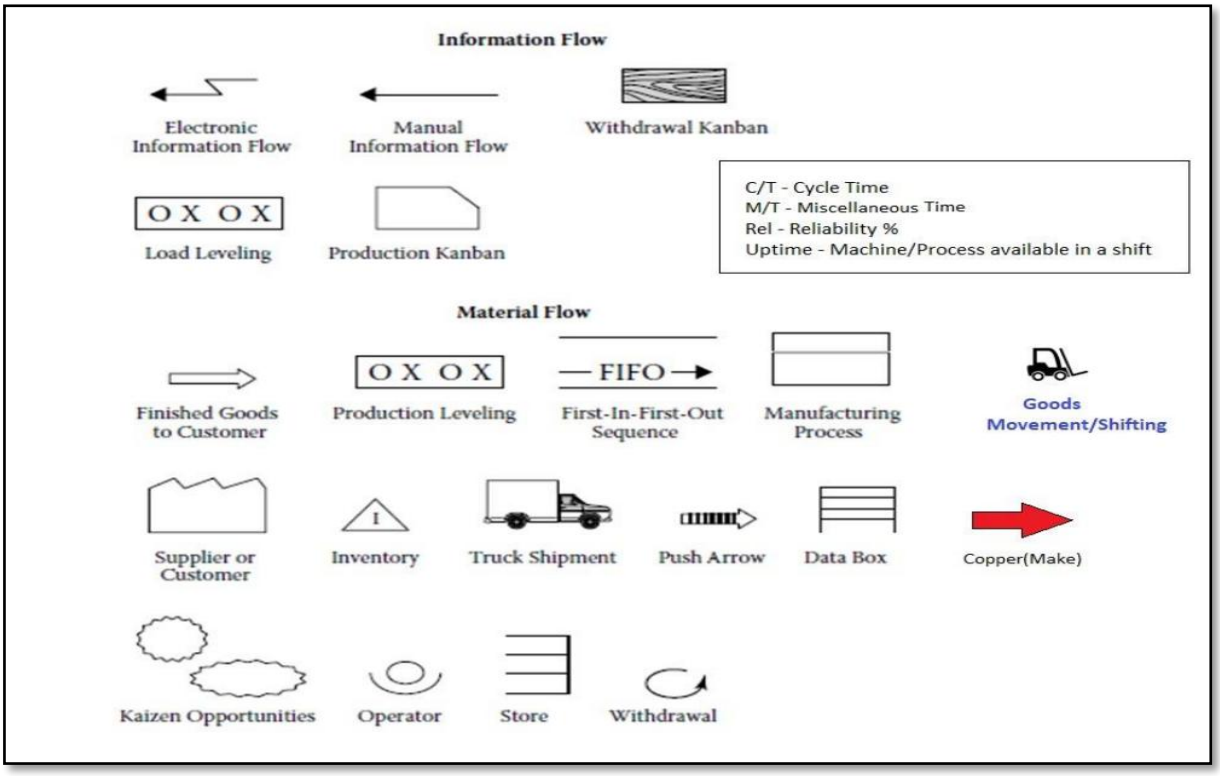

Figure 1 Value Stream Mapping Symbols

It has been decided to represent the current state of production activity known as the 'current state map', and the measures to be taken and the changes to be proposed are indicated on the map, which is estimated to be the 'proposed map'. Transactions of the current level mapping had 20 and 30 more processing times, and the required time was recorded using a timer accordingly.According to the current status diagram, the waiting time for deburring and buffing for model number XYZ is 9 days, which is wasted according to the Lean Production Policy, so a caisson explosion is carried out on a project to solve the problem.The basic reason is the unstructured defragmentation database and the overall defragmentation arrangement that does not follow the process flow chart of the deferring section. To solve the above problem, the following strategies were used.

3.2 Value Stream Mapping Symbols

Value stream mapping is represented by multiple codes (VSM). Each typically resembles their standardized identity in the VSM; The codes are listed in Figure 1 below.

3.3 VSM Process Steps

3.3.1 Product Family Selection

Identifying a component family is based on a number of characteristics, including a history of failure to deliver to customers, which in turn affects the performance and profitability of the area.

3.3.2 Selection of VSM Parts

The area selected for the VSM function is XYZ, which contains a history of performance issues over time. This is model analysis to understand about VSM and moving on to the next stage of the parts /visualizations.

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3.3.3 Data Collection

After the part is selected, the process is analyzed by the raw materials for the finished product and information about the processing times is collected, i.e., pre-determined time, lead times, change with time, sequence time etc.

3.3.4 Preparation of Current State Map

Customer demand is always at the forefront of value stream mapping. The steps below will help you to establish the current value stream map.

(i) Talk time Calculation

$$Talk\ time = \frac{Total\ available\ time\ to\ produce\ part}{customer\ demand}$$

(ii) Receiving customer expectation: Customer expectation can be quarterly or daily, depending on the customer preferences.

(iii) Process Flow Mapping: This process combines a set of plans to accomplish research and development and calculates lead times, processing times, and method effectiveness.

(iv) Material flow mapping: Raw materials to finished products and processed through supplier to customer.

(v) Information flow Mapping: This approach determines production time, order processing and method performance by combining a mix of proposals for product development.

(vi) Total C/T calculation: Once both object and information flows are represented, a sequence of events is displayed at the bottom of the map, showing the time it takes to prepare for each activity and the time it takes to transfer data between operations. In current architecture, a sequence of events is used to identify value-added conditions and waste.

RESULT AND DISCUSSIONS

4.1 VSM-Current State Mapping

In the course of material difficulty, quality data was collected in the redistribution sector and moved backwards for Laser cutting and other process improvements, collecting image data such as inventory levels, rotation times (CTs) process, number of employees and change (CO) method before starting each process.The Current State Map (CSM) for generating the Copper Cell process is shown in Figure 3.In this mapping of all unit small boxes represent the different level of operations and progressions and number of cellular manufacturing departments. The whole process is carried out according to the main scheme visualized in the map. Also, each process has an info box with CT process, number of transitions, machine reliability (MR) and CO time.It should focus on the information gathered when wandering around the store floor and talking to the supervisor and staff at each location. Production and installation periods are all based on an average of historical information. Figure 3 depicts the timeline at the bottom of the current situation map with two characteristics. The first component is the waiting period for production in days, which is calculated by calculating the number of lead times from each inventory triangle before each process.The calculation time for each function in the value flow is added together to come to this period. The CT for each process is the average CT calculated from the real-world data in the company.

Figure 4and Table 1 and 2 shows the Current State Map (CSM) of required information, value added and non-value-added operations based on the analysis and observations, and process flow chart determined on the basis of operation and all delayed sources were chosen. The complexity of the period under evaluation is that VSM depicts a production chain controlled by a small and medium-sized business with highly temporary hierarchical structure and insecure management processes.According to research studies, the main problem in the management of the described process is that individuals do not follow the guidelines and procedures developed at the beginning of the process.Table 1 shows the simplified representation of functions as part of the complete production process.Table 1 shows the

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simplified representation of functions as part of the complete production process. Furthermore, digital information may not be used by the company until information is obtained, which may have provided valuable insight into the need to implement process improvements.

4.2 VSM Talk Time

Talk time play an important role in lean manufacturing system. Many businesses do anything by realizing what they are doing, i.e. how much money they are losing or how everything is going right for a moment. And being realistic, when they have an unique direction of seeing interruptions, acting the remove it, and then addressing the actual issue, those who are as "lean" than anybody else. Whenever these production start-ups are designed to fit the customer demand level, takt time is usually the time between the start of operations of one unit and the start of production of the following unit.Now and here's the first stigma: you must have a mechanism for finding the minimum manpower required to complete a task (JIT), as well as a way to compare what is happening now with what can happen, and the process of acting immediately on any difference (Zidoka).This is how "lean" is achieved. Takt Time is merely an instrument for improving this goal. It is a reflection of customer prerequisites which have normalised and balanced out across the preferred production time. Throughput time includes the capacity to calculate in a requirement for a system. In addition, the required performance of machines and other machinery and equipment is established. This technique is used to predict the minimum inventory volume if there are unplanned working hours. To determine the takt time, we use the equation below.

$$Talk\ time = \frac{Available\ minutes\ of\ production}{Required\ miniutes\ of\ production}$$

4.2.1 Create a Cycle Time: The cycle time / talk time diagram in Figure 1 is created using data obtained throughout the construction of the current value stream mapping. The total time study and performance times for each operation are compared in this diagram. This position is important in determining when and what will be improved in the next steps.

4.2.2 Order Model: The mechanism of distribution of goods should be established within the next stage. In this scenario, only one product is made, and customer expectation remains unchanged. As a result, a node-forming architecture must have been created. As a result of the inefficiency when switching from one function to another, the PLT for the function is significantly reduced.

4.2.3 Optimal Crew Size: The other important step is to establish the size of the board. This technique is used to calculate the optimal naval volume: (Total Rotation Time / Takt time). In our example, the band size is 188 seconds and 60 seconds. As a result, the staff size with 3.13 controllers was determined to be optimal 3 people gathered as 0.13 could not be present.

4.2.4 Pull Process: Finally, there is said to be a signal that tells us when to create a system and when not to build it. In this example retailers were structured using the Kanban technique. Figure 3 depicts the current value stream chart for the selected company, obtained and analyzed by size.

4.3 VSM Future State Map

The process of describing the future state map begins with the construction of the current state map, and the highlighted construction zones begin to appear.When reviewing the full value stream across the timeline to create the best future state map, it is important to define slim production equipment to minimize both.It must have performed an effective technique that attempted to react to multiple predetermined responses, allowing to create a better future state map that would help reduce or eliminate current solid and liquid waste in the Production system. To enable future value flow chart, related tools were developed in this scenario.

Balancing Line: To begin, it is necessary to identify the presence of a "dash" - the value of the stream required for it to flow. During uncontrolled operation with any kind of fluctuations, sequential vulnerabilities usually develop late in each operation and accumulate work in disruptions. Standing can be caused by a number of factors beyond practice, such as insufficient evidence, expertise or recognition to move forward.It waits if skills like staff are not

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approached to start an operation. If privately provided data is not available, tasks must wait or continue with "bad" data, which may need to be reworked subsequently. Finally, if additional approval is obtainedit is not available and the work will be postponed. Each criterion is required to reduce the waiting time:

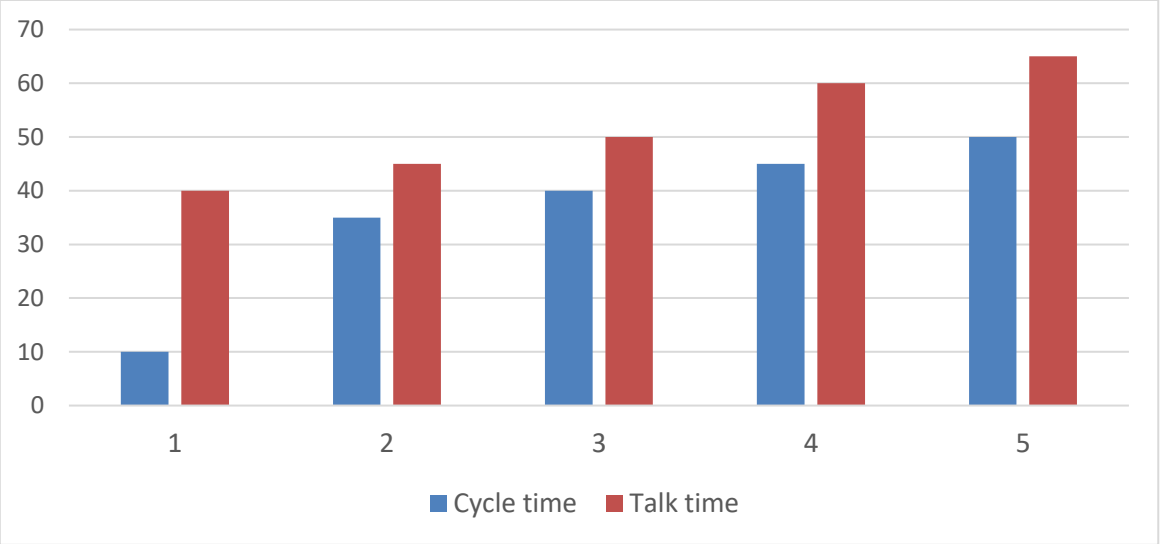

Figure 1 Cycle time Vs Talk Time

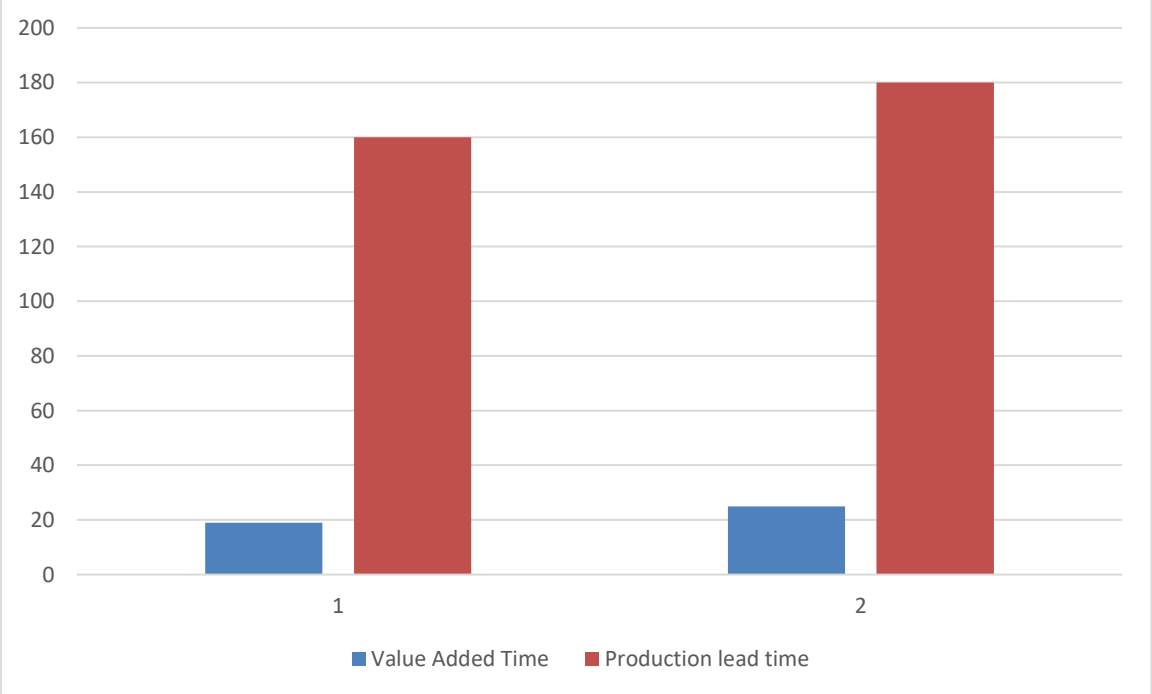

Figure 2 Comparative analysis of Current and Future state

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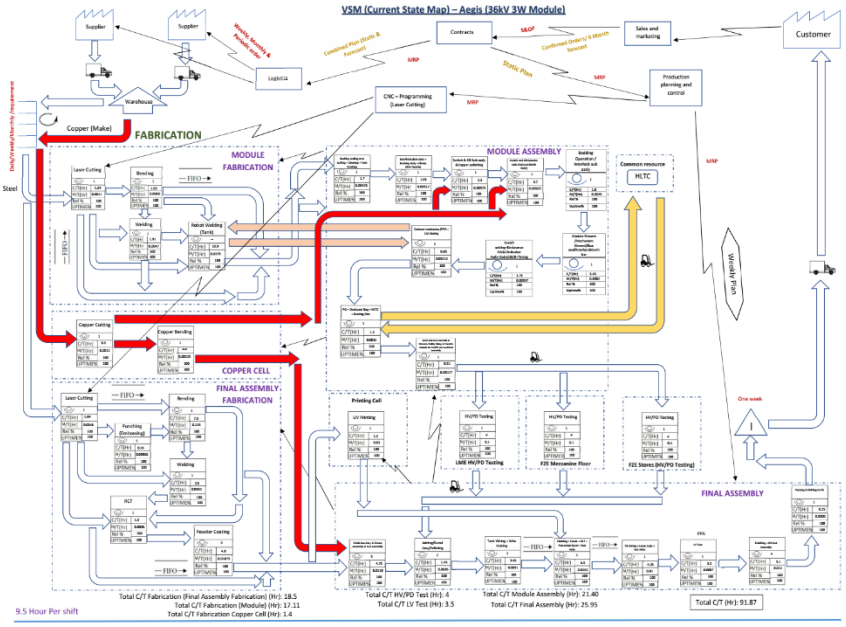

Figure 3 VSM-Current State Map (CSM) for 3W module Eliminate bottlenecks

Disruptions are those that require more time to complete and / or less assets to operate than they were before the workflow was interrupted. In light of the actual VSM, it is clear that the module assembly 01 port, which has the longest rotation time of 62 seconds, puts WIP ahead of the platform. Resources and efforts should always be directed to reduce the barrier at this location because, on the whole, each station uses the same time.

Buffer variation: Diversity is one of the most important characteristics of production techniques and should be minimized by access.That includes removing excellent productivity, which including technological advancements, from the right trajectory and establishing drop measures in place to cushion against equipment problems.On the other hand, at lower altitudes, it implies having the necessary training to set aside simple operations for standardization and to prevent delays caused by tools or system failures.Differences generate changes in the workload, which may involve managing by transferring assets to jobs facing unexpected problems or by maintaining a backup of available resources.

Eliminate Unnecessary Wasteand Approvals: Customer reviews widely used for reduce the work. All they can do is identify the faults, which are already among the greatest achievements in value-added quality control work. Materials must be organized at all stages so that maximum results are produced at the lowest cost of the process. Preparing for approvals that will eventually be granted, as well as the maintenance cycle whenever ratings reveal errors or value-added opportunities, are two major costs.The former must be full-time wasted and removed; The other, though valuable, should always be handled

It rarely happens that providing a way to speed up an assessment without maintaining or improving the importance. Required projects are included with estimates, in which performance is reviewed, as well as any issues with the project, subsequent processes, task integration, or changes in environmental components that may require redesign.It examines concerns about integration and change in environmental factors, and a joint assessment is made. The amount of change required to resolve issues raised in the assessment is then determined by a second value-based assessment. If repetition or maintenance is necessary, the first step is to develop a strategy for maintenance, rather than "trying to send back". In addition, the graph study was replaced by a concept check, in which the sample is reviewed by a panel of pressure and production experts. Its purpose is to detect structural defects early on and reduce long and expensive redo loops. Figure 3 illustrates the future effects of a continuous improvement map as a result of the changes.

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Furthermore, digital information may not be used by the company until information is obtained, which may have provided valuable insight into the need to implement process improvements. Manually generating data from the production system also increased the efficiency of the machine leading to an increase in productivity value during the research weeks. As a result of a series of reports prepared, operational involvement in the workplace grew. However, there was also a sharp drop in customer satisfaction in this situation.

Table 2. Value Added and Non-value-addedoperations of entire production process of Current State Map (CSM)

Operation Number	Operation Characteristics	C/T	M/T
		3W module	
Copper Fabrication			
1	Laser Cutting	1.64	0.0041
2	Bending	2.65	0.0066
3	Robot welding	10.9	0.0275
4	Copper cutting	0.5	0.0012
Module Assembly			
4	Tank washing	1.7	0.00425
5	Bushing Assly	2.05	0.00512
6	Copper polishing	2.3	0.00575
7	Casetteassly	3.7	0.00925
8	Mechanism fitment	3.45	0.0082
9	Snatch setting	3.75	0.00937
10	Phase barrier assly	0.85	0.00212
11	Bushing Disc assly	1.3	0.0032
12	HV/Pd test	0.51	0.00127
13	UV printing	1.2	0.03
14	Stand assembly	1.45	0.0036
Final Assembly Fabrication			
15	Laser cutting	1.84	0.0046
16	Punching	0.26	0.00065
17	Bending	7.6	0.115
18	Welding	2.5	0.0062
19	RCT	1.5	0.035
20	Powder coating	4.8	0.01075

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Operation Number	Operation Characteristics	C/T	M/T
		3W module	
Final assembly			
21	Assem/Sub Assem	4.75	0.0118
22	Wire making	3.65	0.0091
23	TB wiring	4.25	0.01
24	LV test	3.5	0.0087
25	Finishing	5.1	0.012
26	Packing shifting	0.25	0.0006

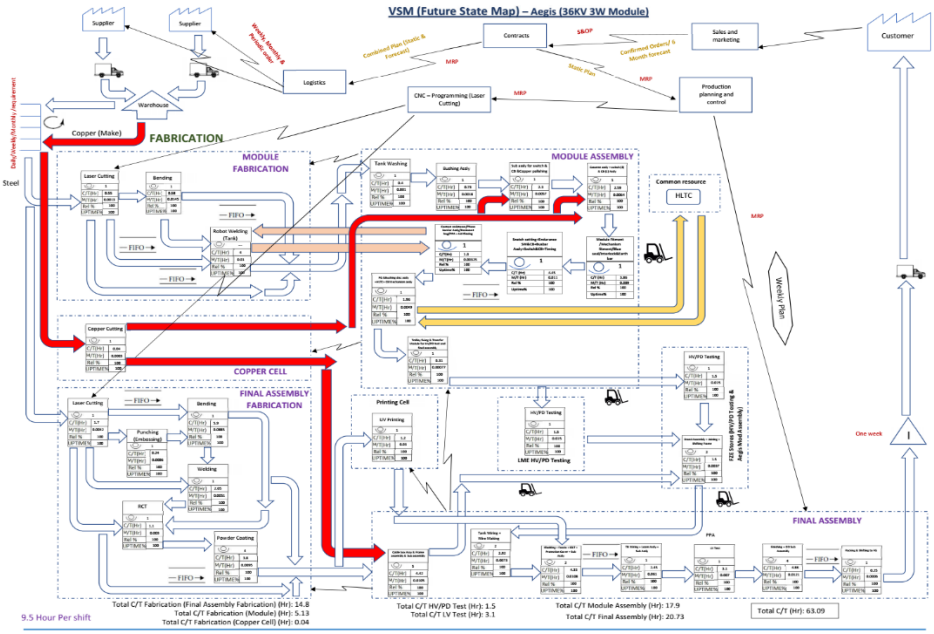

Figure 4 VSM-Future State Mapping (CSM) for 3W module

Table 2 Future State Mapping

Operation Number	Operation Characteristics	C/T	M/T
		3W module	
Copper Fabrication			
1	Laser Cutting	0.55	0.0013
2	Bending	0.58	0.0145
3	Robot welding	4	0.01
4	Copper cutting	0.12	0.0003
Module Assembly			
4	Tank washing	0.4	0.001
5	Bushing Assly	0.73	0.0018

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6	Copper polishing	0.23	0.0057
7	Casetteassly	2.59	0.0064
8	Mechanism fitment	3.86	0.009
9	Snatch setting	4.45	0.011
10	Phase barrier assly	1.3	0.00325
11	Bushing Disc assly	1.96	0.0049
12	HV/Pd test	1.5	0.015
13	UV printing	1.2	0.03
14	Stand assembly	1.5	0.0037
Final Assembly Fabrication			
15	Laser cutting	1.7	0.0042
16	Punching	0.24	0.0006
17	Bending	5.9	0.0885
18	Welding	2.05	0.0051
19	RCT	0.24	0.0006
20	Powder coating	3.8	0.0095
Final assembly			
21	Assem/Sub Assem	4.42	0.0105
22	Wire making	2.92	0.0073
23	TB wiring	2.45	0.061
24	LV test	3.1	0.007
25	Finishing	4.86	0.0121
26	Packing shifting	0.25	0.0006

Table 3 Cycle time for Current & Future State Map of 3W module

S.no	Process	Completion time	
		Current State	Future State
1	Total C/T Fabrication (Final Assembly) (Hr):	18.5	14.8
2	Total C/T Fabrication Module (Hr):	17.11	5.13
3	Total C/T Fabrication Copper Cell (Hr):	1.4	0.04
4	Total C/T HV/PD Test (Hr):	4	1.5
5	Total C/T LV Test (Hr):	3.5	3.1
6	Total C/T Module Assembly (Hr)	21.40	17.79
7	Total C/T Final Assembly (Hr):	29.95	20.73
	Total C/T (Hr):	91.87	63.9

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This study focuses on Value Stream Mapping (VSM), an important technique for implementing lean production under real conditions. Similarly, standard codes and terms, algorithms and syllabus integration strategies are all explored. Figure 3 depicts the future value stream map after some slimming policies have been implemented. The results are presented in the form of current and planned project planning, improvements indicated by value addition time and reduction of production lead time. In the future stateDiagram for assembly and welding process, two processes are collectedTo minimize value added time during processes. Are supermarketsWhen placed between processes to reduce inventory wastageProcess and return stock process from build to order. By including a scheduled pacemaker into the process, the data and knowledge flow among production lines was enhanced, and the procedures were transformed from push to pull via the Kanban method.

Factors causing low access to equipment have also been identified based on systematic evaluation. As the performance of the machines in the system improves, more failures are created, resulting in reduced availability. Some reasons of such large losses in the efficient use of a particular machine should be accompanied by:startup, malfunction, change modifications and so on.The provided evaluation of computer performance reductions demonstrates the need for digitalisation of information in businesses of all sizes. The effects of pre-existing digitization on designated terminals are presented in the text, indicating that all operating and maintenance periods and the number of items and errors are recorded.

CONCLUSION

The purpose of this report is to provide a VSM technique for describing, reviewing, and evaluating key opportunities for development throughout organizational processes. Using VSM, we were able to identify previously unnoticed wastes in the process flow. In this work, a current status diagram was created, which shows that there is a lot of waste in the copper cellular product layout in terms of rotation time, lead time and waiting time. As a result, VSM helps the company to identify different types of value-added activities or waste. The recommended diagram is created when various changes are made in the process to reduce waste. Furthermore, due to the gap between production and lead times, it can be assumed that there are many invaluable development areas such as waiting for production, transporting raw materials from one sector to another and establishing time. Also, the mechanism shifts from push to pull. Results are presented in the form of current and future process mapping, with improvements in value-added time and reduction in production lead time. Two procedures are grouped on the future state map for assembly and welding operations and minimize valueless overtime throughout the procedures. Retailers take intermediate measures to reduce inventory waste and stop production from growing.When orders are received, the ordering process leads to the area assembly. This allows inventory to be reduced. By incorporating the planning pacemaker into the process, the data and knowledge flow between the production lines was increased, and the procedures were changed to pull Bush first through the Kanban method.

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