Value Stream Map Importance in the Field of Electrostatic Powder Painting

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Abstract. Many companies struggle to find the right solution to grow their business. The main purpose of a business is to make a profit that is to get money by the investment and the work done. One useful instrument to do it is a Value Stream Map (VSM). A value stream always begins and ends with a customer. Based on this, we had created a tested and implemented VSM to increase in profits which can be achieved the field of electrostatic powder painting business. Regardless of the results obtained by using a VSM, it is very important to identify those points and those factors that determine the results. Management must consider the results obtained for the decisions on the decision to reduce the lead-time and parallel with this the cost of the process.

Keywords: Electrostatic field painting · Pretreatment · Value stream map · Efficiency · Waste · Work-in-Progress (WIP)

1 Introduction

Electrostatic field painting with powder paint is a process by which a layer of decorative powder paint is applied to a metallic surface to color it and provide protection against the action of external factors.

This process employs charged particles to paint a work piece more efficiently.

The raw pieces go down a conveyor belt towards a paint booth, or paint tank, where it is sprayed with, electrostatically charged paint particles. Before this, all raw pieces are passing a pretreatment step to clean and passivate the surface which is going to be painted. After, the raw pieces are coated; it continues the conveyor belt to an oven, where the paint is cured. The benefits to the process of electrostatic coating are the ability to recover the little over-spray and having the process automated which will cut costs. To be more efficiently, the whole quantity of the raw products should be going true the entire process on the shorter time.

Saving time, we save money, so the process is more efficiently [1].

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2 Theoretical Foundations

The paper aims to present a solution which can generate profit in the field of electrostatic powder painting business [2–4].

The value-stream mapping [5] identifying and reducing "the waste" in value streams, thereby increasing the efficiency of a given value stream [6–8].

The "waste" removal increasing productivity by creating leaner operations which in turn make waste and quality problems. The used methods are often used in Lean environments to analyze and design flows at the system level [9].

Commonly accepted types of waste are:

- Processes which are creating too much of a good or service that damages production flow, quality [10], productivity
- Steps when the goods are not being transported or worked on
- Unnecessary inventory, excess stock
- Poor layout and communication and unnecessary motion in the process
- Double-handling and excessive movement
- Unnecessary movements, excess energy using
- Resources and costs required to correct the defects.

3 The VSM Build Up Process

Schematically, the electrostatic field painting with powder paint process takes place in 20 steps and it the looks as follows (Fig. 1):

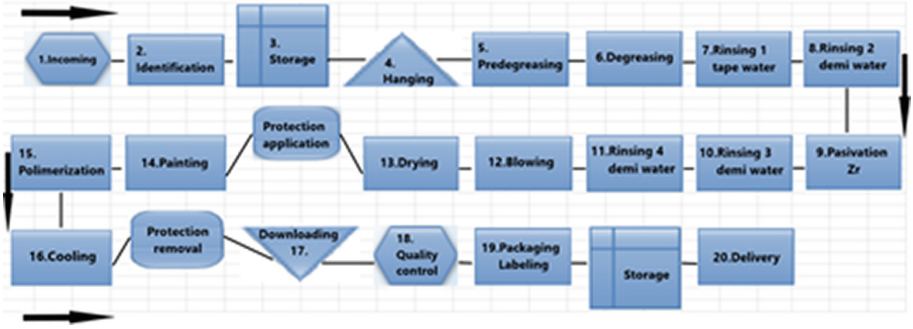

Fig. 1. The process flow diagram in the electrostatic field powder paint.

After a sampling quality control at the workshop for the reception of raw products [11], they are placed on the painting line by hanging them on the conveyor. They pass through the pre-treatment tunnel where a chemical attack by sprayers [12, 13] made in several steps:

1. Coarse washing with water

- Degreasing using a strongly alkaline solution
- Rinse with water
- Rinse with demineralized water
- Passivation with a nanoceramic multimetal solution
- Rinse with recirculated demineralized water
- Rinse with fresh demineralized water.

The products enter the drying oven to dry and completely remove the water residues.

The painting step is the next step done in a special booth, ready to apply the powder paint on the surface of the products by means of automatic guns and manual guns based on the electrostatic field created between the ends of the guns and the body of the paint product. The powder passes on the surface of the product and adheres to it thanks to the electronic loading of the paint powder.

The next stage is the polymerization of the paint layer on the surface of the product takes place in the polymerization oven. The products are cooled and after quality control they are sent for packaging and delivered to the customer.

The essence of the implementation consists in reducing all the unproductive times and movements known as waste, without creating dysfunctions and discount from the painting process and the quality of the painted product.

a.

Symbols	Description	Symbols	Description	Symbols	Description
	Customer/ Supplier Start or end point for material flow	Kaizen	Kaizen Blitz Area for Improvement		External Shipment Shipments to or from suppliers
Process Box Shared Process Box	Process Machine, operation or department through which material flows		Supermarket Small inventory for immediate production	FIFO	FIFO First in, First out lane
P/T = 15 L/T = 15 %C&A = 99% Rel. = 95%	Data Box		Buffer Safety Stock	IN	In Box Information Queues

b.

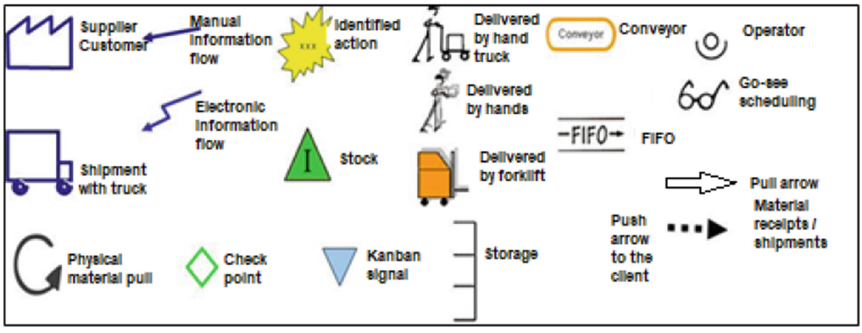

Fig. 2. a, b. Common symbols to build up a value stream map.

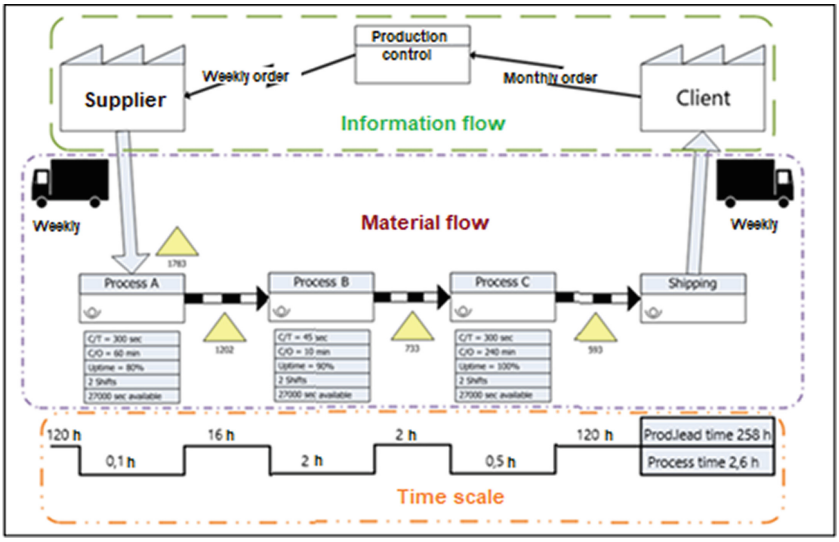

Fig. 3. VSM raw representation.

The value stream map (VSM) gives the possibility to do this [14].

Are three main flows which helps to build up the map helping to split up the process into steps and see where are the waste:

- Information flow
- Material flows
- Lead time ladder.

Using simple graphical instruments, we can build up the VSM based on those three main flows. The mapping employs standard symbols to represent items and processes. The knowledge of these symbols is essential to correctly interpret the production system problems (Fig. 2).

Knowing the process steps and using the symbols we have a raw representation of the VSM: (Fig. 3).

Using these instruments, the activities from the process becomes easily separated into the value stream, which is the focus of one type of attention and the "waste" steps, another type. Identifying them, the waste would be eliminated from the process.

The VSM manager using sheets, pens, and colored pencils, together with 6 team members, is creating the map. One of these members is Lean expert who is working together with a production supervisor, operator, a quality engineer, a logistical leader and maintenances responsible. Before starting, is necessary to clarify the aim of the mapping. It is done in a representative day, not peak or leave.

As a result, the VSM it looks like in Fig. 4.

Baseline Metrics

Based on the internal management report the administrator of the company reviewed the financial balance and determined the baseline metrics and set the next goals [15]:

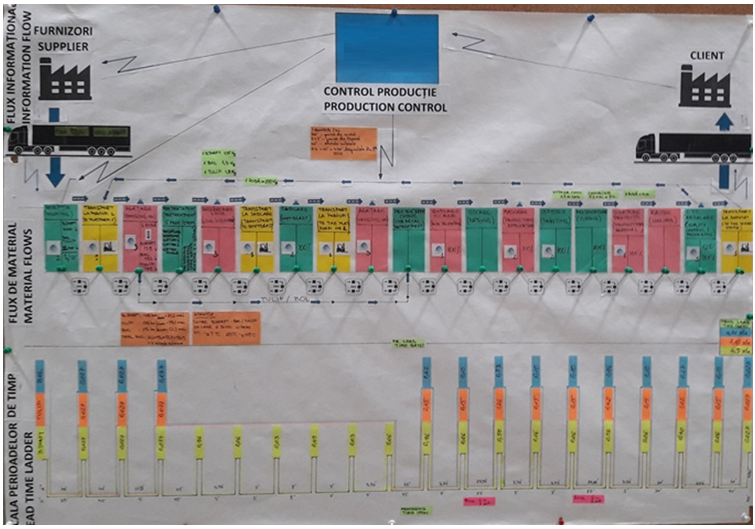

Fig. 4. The value stream map after implementation.

- Reduce lead-time from 9 to 5 days (−44,44%)
- Reduce the price from 5 to 4,6 euro/m^2 (−8%)
- Maintain profit margin.

VSM Data – Takt Time

Takt time is a tool used to design work and it measures the average time interval between the start of production of one unit and the start of production of the next unit when items are produced sequentially.

Current volumes were 1000 m^2/day painted products but after the new goals setting the total painted surface increase to 1500 m^2/day. The company's employees work 2 shifts of 8 h with a lunch break of 20 min and 2 breaks of 5 min break/shift. So, total work time is 7.5 h, means 450 min/shift. Takt time currently painting 1000 m^2/day/shift is 0.45 min/m2 and for 2 shifts is 0.90 min/m^2 (Table 1).

Table 1. Key metrics of the daily volumes.

Key metrics	Current values	Target values
Volumes (m^2/day)	1000	1500
Shifts/day	2	2
Effective working time (min)	450	450
Takt time/day (min/m^2)	0,90	0,60

Takt time, the rate at which the company would need to be created to meet the goals, would be: 900 min/1500 m^2, respectively 0.60 min/m^2.

Other Key Metrics
Other key metrics that have been taken into account are presented in Table 2.

Table 2. Other daily key metrics.

Key metrics	Current values
Employees	56
Labor cost/hour (euro)	560
Painting cost euro/m^2	15
Rework rate (of total order) %	2

Current State VSM
Reviewing the map, we are checking the resources as Work-In-Process (WIP) and Lead-Time. These match the current state metrics of the company. If wouldn't match, the actual current state is useless and must be corrected before processing.

The term Work-In-Progress (WIP) is a production and supply-chain management term describing partially finished goods awaiting completion. These costs are subsequently transferred to the finished goods account and eventually to the cost of sales [16].

Key Observations
Process step "Hanging" has less resources than needed to keep up with demand. Discussions with the line operators show that many times the person from the "Downloading" process is helping out at "Hanging" process and is contributing to the low FPY at "Hanging". The person at "Downloading" does not have the proper training to be working at "Hanging". Process" Painting" has more resources than needed.

FPY (First Pass Yield) is a measure of quality in a process that reflects the percentage of product made correctly without any rework or corrective activity.

Current Profit Margin
The calculation of the profit margin assumes no lost painted material for rework.

In the working conditions with a cost of 10 euro/hour/employee, with a takt time of 0.84 min/m^2 and a material cost of 5 euro/m^2, the total cost for painted m^2 becomes 13.4 euro. Under these conditions, the marginal profit is 11.94 euros (Table 3).

Current state – Takt time 0.84 min/m^2
Since the company goal is to achieve 1500 m^2/day the Future State needs to take into consideration these increased volumes: 1500 m^2/day make at takt time of 0.60 min.

Future Profit Margin
With the same conditions of infrastructure and human resources, the company tends to lower production costs and obtain a more competitive price. This assumes no lost material for scrap or rework. The goal is to obtain the same marginal profit with a reduction of the costs of the painted surface from 13.4 to 10.2 euro/m2 without losing from the marginal profit (Table 4).

Table 3. Current profit margin.

Key metrics	Current values
Labor cost/employee (euro/hour)	10
Takt time (min/m^2)	0,84
Labor cost (euro/m^2)	8,4
Material cost (euro/m^2)	5
Total cost (euro/m^2)	13,4
Profit margin (euro)	11,94

Table 4. Future profit margin.

Key metrics	Target values
Labor cost/employee (euro/hour)	10
Takt time/m^2 (min)	0,56
Labor cost/m^2 (euro)	5,6
Material cost /m^2 (euro)	4,6
Total cost /m^2 (euro)	10,2
Profit margin	7,84

We notice that the result is not as expected: the marginal profit is reduced. It means that despite the constructive intention to reduce production costs, management cannot make the decision to pursue this action as the marginal profit decreases, as such in the long run the business will suffer.

4 Conclusion

This potential Future State is not meet the goals of 1500 m^2/per day and a 5 days lead-time. It will not meet the product price reduction to 4.6 euro/m^2 while maintaining the profit margin.

The type of projects selected need to be realistic. An experienced operations and supply chain project manager needs to facilitate project selection so that the Future State is achievable just with the right management parameters settings.

Before any projects are started their expected results need to be plugged into a Future State map to confirm that company goals will be met.

By using this methodology, it was desired to obtain results that would strengthen the fairness of the decision to reduce the lead-time and parallel with this the costs of the process creating the decision to make couple implementations on the “waste” removing as are in the process, logistic or human resources.

We started from a thematic qualitative empirical research by observing the results obtained from the process during the production. Empirical research was followed by applied research aimed at finding a solution or tool to reduce production costs [17].

After data collection and information processing, the conclusion was that at this moment isn't the right time and way to decrease the price of the painting process in the condition of the 5 days processing time aim.

During the process observation, has been found couple not useful elements which are creating leaner operations which in turn make waste and quality problems.

The main identified "waste" elements during the monitoring are:

- Steps when the goods are not being transported or worked on
- Unnecessary inventory, excess stock
- Poor layout and communication and unnecessary motion in the process
- Double-handling and excessive movement
- Unnecessary movements, excess energy using
- Resources and costs required to correct the defects.

Monitoring reported in the paper is carried out for the entire painting process, started from the raw material incoming, hanging of the products on the pre-treatment line to the last, packing and final control after the painting and polymerization of the powder paint from the surface of the products, finalized with the storage and delivery steps.

Every step was monitored individually; these are parts of the whole painting process, so the obtained results helped to take the right decision at the level of the management regarding the proposed goals to be achieved.

Based on the results has be decided to continue with a deeper involvement and create a new VSM using the results after the last implementations.

In this way we will have later a new VSM, subject of a new upcoming research.

Even if using a developed and technologically advanced system of painting in electrostatic field is not sufficient to purchase and connecting the performant devices to the painting and pre-treatment system, but must be carried out the surveillance, monitoring, namely to achieve continuous implementations to reduce costs of production and to cope with increasing competition in the market in the field, without forgetting the other important elements that make up the final price of the transaction cost of painting in an electrostatic field [18].

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