Application of Value Stream Mapping in a Manufacturing Firm in Bosnia and Herzegovina

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ABSTRACT

The goal of this study is to examine one of the pivotal tools in the lean production methodology, a method known as value stream mapping (VSM). The implementation of the VSM method was done within a medium sized organization that produces parts and delivers them directly to one of Europe's biggest automotive OEM`s. The result of the undertaken research proves that through the application of value stream mapping not only sources of waste can be identified, but also through the application of methods such as 5S and SMED, considerable process improvements can be achieved. The paper explains the steps of value stream mapping for the firms that plan to use this technique. The paper also gives suggestions for the firms in Bosnia and Herzegovin for applying value stream mapping in their firms.

Keywords: *Value Stream Mapping (VSM), Value Stream Management, Lean production*
JEL Classification: *L62, M11*

Bosna Hersek'te Bir Üretim İşletmesi'nde Değer Akış Haritalaması'nın Uygulanması

_ÖZ_

Bu çalışmanın amacı yalın üretimin temel araçlarından birisi olan değer akış haritalama yöntemini değerlendirmektir. Değer akış haritalama yönteminin uygulaması Avrupa'nın en büyük otomotiv üreticisine parça tedarik eden orta ölçekli bir işletmede gerçekleştirilmiştir. Gerçekleştirilen araştırmaya göre değer akış haritalama ile sadece israflar belirlenmekle kalmadığı, aynı zamanda 5S ve hazırlık sürelerinin düşürülmesi gibi tekniklerin uygulanması ile birlikte önemli süreç iyileştirmeleri de elde edilebildiği görülmüştür. Yürütülen araştırma değer akış haritalamayı işletmelerinde uygulamak isteyen işletmeler için izleyebilecekleri adımları göstermek bakımından da önemlidir. Bu çalışmada Bosna ve Hersekte'ki işletmelere işletmelerinde değer akış haritalamayı uygulamaları süreçleri için öneriler de sunmaktadır.

Anahtar kelimeler: *Değer Akış Haritalama, Değer Akış Yönetimi, Yalın Üretim*
JEL Sınıflandırması: *L62, M11*

INTRODUCTION

The value stream mapping process, in short, can be defined as the representation of all the activities transpiring within the value stream of a product or group of products (Womack and Jones, 1996: 353). Value stream mapping is now explored throughout the world, in many businesses both to strategically plan and to offer a starting point to any lean transformation and implementation (Shankar and Kumar, 2015: 414). An important feature of value stream mapping is that it includes both material flow and information flow, reflecting the reality

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(Makale Gönderim Tarihi: 20.12.2018 / Yayına Kabul Tarihi: 05.03.2019
Doi Number: 10.18657/yonveek.499994

that a problem with information flow can be just as disruptive to production as a bottleneck in the material flow (Stoller, 2015: 22). Value stream mapping is simply transferring information about the value stream to a 'map', which represents either the current or future state of the manufacturing system. As the name implies, a current-state value-stream map (VSM) shows how both materials and information flow through the processes in the current system. A future-state VSM represents the ideal state of the manufacturing system (Chen et al, 2010: 1072).

The main objective of the research is to show an application of VSM in a manufacturing company in Bosnia and Herzegovina. It was a case study developed in a manufacturing company focused on production of small parts for various European car manufacturers or OEM`s. With the application of VSM in this case study, the value stream map tool to identify possible improvement points through the implementation of lean methods in the production processes is utilized. The paper begins with a brief literature review of value stream mapping. Secondly, the company within which the case study was commenced is described. Following the presentation of the company, the research methodology and the limitations are defined. The development of the project is presented as per the VSM approach (choosing the product family, mapping the current state VSM, designing the future state VSM and drawing the future state VSM). Finally, the later part of the paper offers the identified potentials for improvements.

I. VALUE STREAM MAPPING

The value stream mapping process, in short, can be defined as the representation of all the activities transpiring within the value stream of a product or group of products (Womack and Jones, 1996: 353). A more precise definition of value stream mapping would define it as the simple process of directly observing the flows of information and materials as they currently occur, summarizing them visually and then envisioning a future state with much better performance (Jones and Womack, 2000: 1). The primary objective of the VSM is to identify all kinds of waste in the value stream to take actions to eliminate these waste (Rother and Shook, 2009: 11-15). Because of its ability to transparently present the "as-is" state of a process and simulate the impact of possible improvements it has been widely adopted as one of the key tools in the lean production methodology.

On a theoretical and academic level, VSM has been presented as an original, practical method to design and create efficient and flexible productive environments. Rother and Shook (1998) affirm that the main properties of VSM fulfil the needs for a manufacturing system improvement technique (Lasa et al, 2009: 83). Value stream mapping analyzes the current material and information flow in order to arrive at the future state of material and information flow wherein the non-value added activities are curbed out so that it can be possible to make the product at faster pace and passing on the benefits to the customer by serving them better. Value adding activities are those activities that transform or improve the product for the customers hence raising its value to the customers. On the other hand, non-value adding activities can be defined as those activities that consume resources yet do not directly contribute to the product or service. This can be over-production, work-in-process, excess transportation, scrap and rework, wasted time, and people or products waiting (Shankar and Kumar, 2015: 413).

VSM origins were mainly focused on the analysis and improvement of discontinuous flow line manufacturing environments. According to Rother and Shook, VSM is based on five phases implemented by a special team created for such a purpose (Rother and Shook, 1998). The phases are (1) selection of product family; (2) current state mapping; (3) future state mapping; (4) definition of working plan; and (5) achievement of working plan. Various adaptations have been developed after the methodology developed by Rother and Shook. Mostly applied methodologies used in academic studies are the developed by Tapping and Shuker 2002 and Rother and Shook 1998.

VSM helps to show more than just waste. The mapping process helps to clearly show the sources of waste in the value stream. It provides a common language for talking about manufacturing processes. It shows the linkage between the information flow and material flow and it is much more useful than quantitative tools and layout diagrams that produce a tally of nonvalue-added steps, lead time, distance traveled, the amount of inventory etc. Value stream mapping is a qualitative tool by which a detailed description of how a facility should run in order to create flow is given (Rother and Shook, 2009: 2).

One of the major benefit to the value stream mapping is that it utilizes a format provides a common language for the manufacturing process, which ties together lean concepts and techniques (Cudney, 2009: 47). VSM forms the basis for lean production implementation and relates the manufacturing process internal to the facility to the whole supply chain (Braglia et al.,2006: 3930). Unlike most process mapping techniques that often only document the basic product flow, VSM also documents the flow of information within the system (Singh and Sharma, 2009: 59).

Value stream mapping is more than a neat tool to draw pictures that highlight waste. It helps in showing linked chains of processes and to envision future lean value streams. Underlying value stream mapping is a philosophy of how to approach improvement (Liker and Meier, 2006: 41). The Value stream mapping process consists of four main steps; selecting a product family, drawing the current state map, drawing the Future state map and preparing a work plan and implementation of improvements (Rother and Shook, 2009: 7). As stated earlier the value stream mapping is a continuous process which means that the creation of the current state and future state are overlapping processes. Future state ideas may come up during the current state or the designing of the future state will point out information that has been looked over during the drawing of the current state map.

The first step to any value stream mapping approach is to illustrate the flow of a part or part family from a given start point, usually the raw material delivery to a facility, to a given end point, the shipping of finished product. While creating this map, a set of key statistics illustrating the characteristics of both the individual processes and the manufacturing system need to be collected. Value stream mapping is a continuous process which means that the creation of the current state and future state are overlapping processes. Future state ideas may come up during the current state or the designing of the future state will point out information that has been looked over during the drawing of the current state map.

Singh and Singh (2013) used VSM technique in a small company. Current state map and future state map have been prepared and analyzed to highlight the benefits of a lean system in a small company. In replacement ball, there is 69.41 percent reduction in cycle time, 18.26 percent reduction in work in process inventory and 24.56 percent reduction in production lead times. In Weldon ball end, there is 51.87 percent reduction in cycle time, 21.51 percent reduction in work in process inventory, 25.88 percent reduction in lead time after future state map application. Seth and others (2008) used VSM to identify and remove wastes present in the cottonseed oil industry. Two tools, process activity mapping and supply chain response matrix as suggested by Hines and Rich (1996) have been used to effect. An attempt is made to draw a current picture of value stream and develop a framework for the investigation. Lasa and others (2008) evaluated how the VSM is put in practice. By a case study developed in an industrial company which manufactures plastic parts; they tried to find answers to the questions such as, is VSM really effective in practice? How much time and resources are necessary for its correct application? Which are the key aspects for the teams to obtain as much performance in use as possible? What aspects should the VSM theory improve in order to make it a reference tool?

II. CASE STUDY

The manufacturing company considered in this case study is situated in Bosnia and Herzegovina and employs over a hundred employees in the sector of automotive interiors. Although quite small in size, the selected company is a part of larger group that is a leading player in the sector of automotive interiors in Europe. The company is focused on production of small parts for various European car manufacturers or OEM`s. The company has two production locations. In the production site named Location GOR serial manufacturing of plastic parts through injection molding and plastic extrusion is applied. The Location SRE plant is specialized in the production of hand break grips. In the last three years since its founding company “Bosna” has exhibited quick growth which is best demonstrated by the growth in the number of employees, from twelve in 2013 to over a hundred in 2016.

It is important to note that while the company itself is quite young (founded in 2013), it is a subsidiary of a major player in the European automotive industry in the field of automotive interiors with over ten thousand employees worldwide. The product for which the value stream was created is the leather hand break grip, the main product group of company. The production of these parts was started in 2011 as a side project and has since flourished with the company producing over a million standardized and original parts for major European car manufacturers/OEM`s under serial conditions.

The following procedure is adopted for this case study:

- Selection of product family
- Information gathering and takt time calculation
- Development of current value stream map
- Development of future value stream map

A. Selection of Product Family

The first step in creating any Value Stream Map is the selection of the product family and the value stream to be mapped. For the selection of the product family to be mapped in company, a PQPR (Part Quantity Process Routing) analysis was performed. This was done to make sure that the selected product family not only represented the bulk of the production of the company but also incorporated the majority of all the processes that exist within the company. The selected product family named “OEM XYZ hand break grip” represents about 80% of the total hand break grip production volume of company (high volume – low variety production). Table 1 shows the results of the PQPR analysis.

Table 1: Part Quantity Process Routing Analysis

Part Quantity Process Routing (PQPR) Analysis				Process / Task														
Part #	Part Name	Demand (pcs)	% of total	Injection Moulding	Leather marking	Leather Cutting	Skyving and	Sewing	Glue application	Mould flaming	Assembly	Therm al	Hole punctur	Pneumatic treatment	Profile cutting	Final control	Packaging	
1	OEM XYZ handgrip	720.000	17%	x	x	x	x	x	x	x	x	x	x			x	x	Location
2	Other handrgrips	175.000	4%		x	x	x	x			x					x	x	SRE
3	Injection moulding	1.850.000	44%	x												x	x	Location
4	Profile treatment	1.500.000	35%											x	x	x	x	GOR
	Total	4.245.000	100%															

Hand brake grips total	**895.000**
BMW hand brake grip %	**80%**

The product “OEM XYZ hand break grip” has been selected because the entire production process is carried out within company. The plant in Location GOR produces the plastic frames through the process of injection molding while the rest of the processes, mainly leather cutting and sewing, are carried out in the Location SRE plant. Furthermore, the handgrip value stream has been selected because of the limited number of raw material suppliers and the number processes which take place within.

The leather acquired from customer nominated suppliers is ordered and received on a weekly basis. The initial step is the marking or control of the leather so as to ascertain whether or not the delivered leather hides meet the final customer’s high quality requirements. Once the leather is cleared for production it is cut into cut parts for the purpose of sewing. The two parts are joined during the assembly process, but prior to that both parts are laced with a special glue. Following the assembly process the completed hand break grips are thermally treated so as to ensure durability and cleanliness. The final process is the packaging of the completed hand break grips into customer defined and supplied returnable packaging. It is important to note that the final customer has required company to keep one week of safety stock of finished products in order to cope with oscillations in the orders and the possible lack of raw material. Deliveries to the customer are realized once per week. The planning of the production is centralized in one department however each production process is planned on an individual basis with the aim of maximum capacity utilization per process.

B. Information Gathering and Takt Time Calculation

The "OEM XYZ hand break grip" product has an average daily demand of 3.000 units, split between the European (80%) and English (20%) models. Due to the different positions of the steering wheel in cars produced for the European and the English markets it was necessary to split the hand break grips according to the same principle. The flow of information within the supply chain is managed via EDI orders from the OEM through the company to the raw material suppliers.

Upon collecting basic the information about the customer demand and the working hours for the selected value stream it was possible to calculate the takt time. Table 2 shows takt time calculation.

Table 2: Takt Time Calculation

Takt Time Calculation - Company "Bosna"					
Net Available Time			**Customer Demand**		
Working shifts / day	2	shifts	Customer demand / day	3000	pieces
Hours / shift	8,5	hours			
Available time / shift	*510*	minutes			
Break time / shift	10	minutes			
Lunch time / shift	20	minutes	Net available time / day	*57000*	seconds / day
Planned downtime / shift	5	minutes	Customer demand / day	*3000*	pieces / day
Net working time / shift	*475*	minutes			
Net working time / shift	*28500*	seconds			
Net available time / day	*57000*	seconds	**takt time =**	**19**	seconds / piece
			takt time =	**0,32**	minutes / piece
			container size =	**60**	pieces / container
			pitch =	**19**	minutes / container

In order to meet the customer requirements finished goods have to come out of the production line at a takt time of 0.32 minutes per piece. While it is true that the customer orders on a piece basis, the deliveries are carried out in standard returnable containers of 60 pieces. This essentially means that with a takt time of 19 seconds and 60 pieces per container, the pitch is calculated at 19 minutes. The calculated pitch is in tune with the industry standard of 12-30 minutes for high volume low variety production processes. Takt time represents one of the most important pieces of information needed to create a Value Stream map and will later be used to identify not only bottlenecks within the production process but also analyze labor needs and work load distribution.

C. Development of Current State Value Stream Map

The next phase in the case study was the mapping of the current state of the production processes with the aim of determining the drawbacks of the current state and the possible areas of improvement, i.e. determining the sources of waste and the ways to eliminate it from the processes. Using the information gathered prior to the mapping and the newly calculated takt time it was possible to commence the mapping of the current state using the standard symbols for value stream mapping and in accordance with the generally accepted methodology used in in value stream mapping.

For each process step the same basic information regarding cycle time, changeover time, WIP levels, availability, uptime, defect rate, setup time and manpower was collected. The bulk of the data was collected on site while another important source of information were internal company documents measuring machine breakdowns, quality performance etc. The stock duration presented at each production step has been calculated by means of a correlation between the physical number of units observed and the average daily customer demand. Stock levels at the plastic molding process and leather marking process were calculated by a correlation between present raw material and per piece average utilization.

It is important to note that defect rates and uptime have been taken into account during the calculation of the stock duration, either as additional stock or as an actual capacity constraint. Quality indicators were taken from internal company documentation. The same applies to uptime indicators that varied from lost time due to maintenance issues, setups or tool changeovers. Figure 1 shows current state production process information and figure 2 shows current state value stream map.

Figure 1: Current State Production Process Information

Company name	Bosna	
Net minutes/shift	475	min
Daily order	3000	pcs
Takt time	0,32	pcs/min

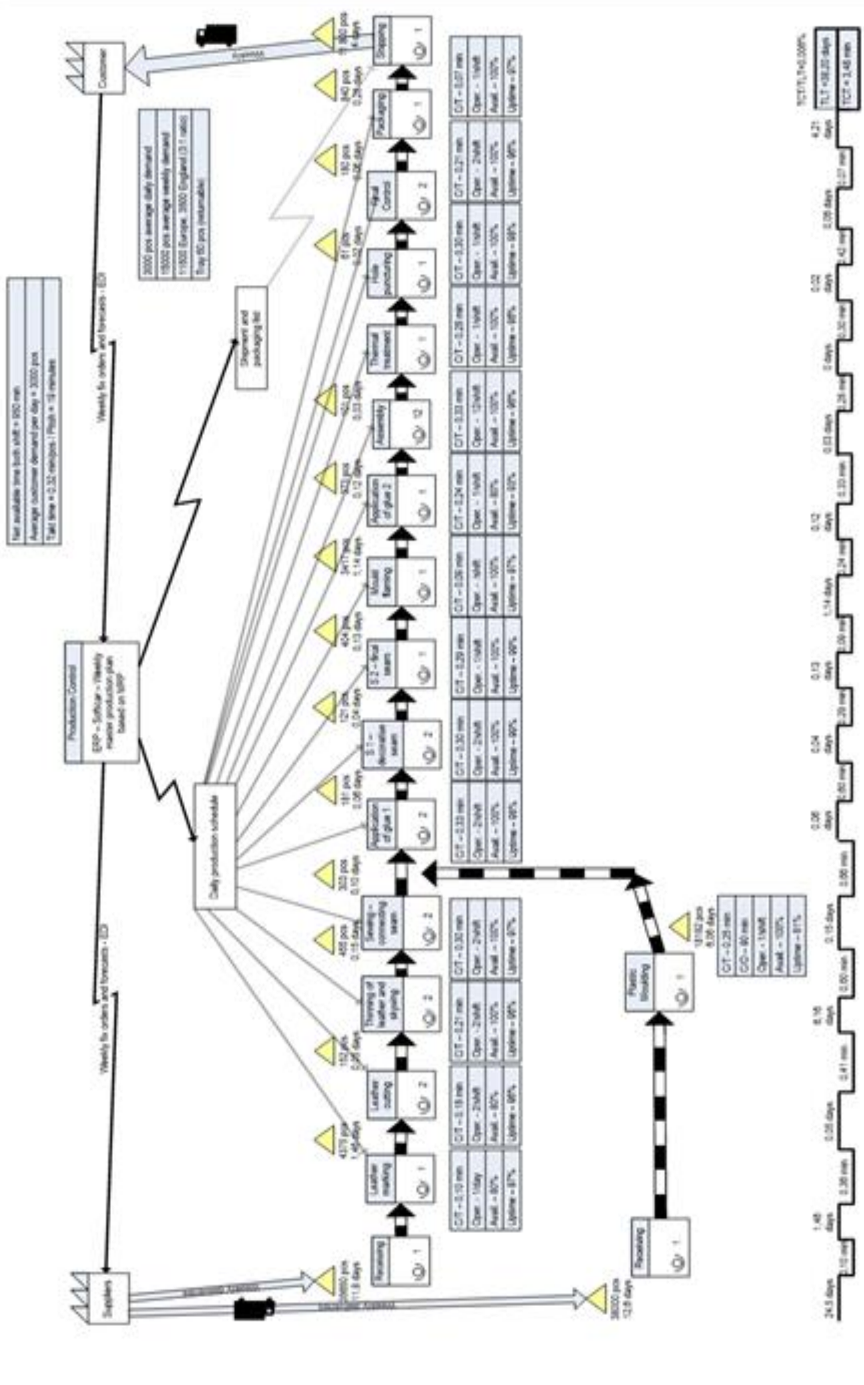
Process name	Plastic Moulding	Leather Marking	Leather Cutting	Thinning and skyving of leather	Sewing - connecting seam	Application of glue 1	Sewing - decorative seam	Sewing - final seam
Manual/Machine process	Machine	Manual	Manual	Manual	Manual	Manual	Manual	Manual
Nr. Operators	2	1	2	2	2	2	2	1
Production time	0,25	0,10	0,36	0,41	0,60	0,66	0,60	0,29
Cycle time	0,25	0,10	0,18	0,21	0,30	0,33	0,30	0,29
Nr. Shifts	2	1	2	2	2	2	2	2
Capacity - theoretical	3.800	4.750	5.278	4.634	3.167	2.879	3.167	3.276
Lost time (min/shift)	40	15	10	20	15	10	5	5
Uptime %	92%	97%	98%	96%	97%	98%	99%	99%
Capacity - actual	3.480	4.600	5.167	4.439	3.067	2.818	3.133	3.241
Daily order	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Capacity constraint	480	1.600	2.167	1.439	67	- 182	133	241
Defect %	1,0%	0,0%	1,0%	1,0%	1,0%	0,5%	1,0%	1,0%
Quality %	99,0%	100,0%	99,0%	99,0%	99,0%	99,5%	99,0%	99,0%

Process name	Mould flaming	Application of glue 2	Assembly	Thermal treatment	Hole puncturing	Final control	Packaging
Manual/Machine process	Machine	Manual	Manual	Machine	Manual	Manual	Manual
Nr. Operators	1	1	12	1	1	2	1
Production time	0,09	0,24	4,00	0,28	0,30	0,42	0,07
Cycle time	0,09	0,24	0,33	0,28	0,30	0,21	0,07
Nr. Shifts	2	2	2	2	2	2	2
Capacity - theoretical	10.556	3.958	2.850	3.393	3.167	4.524	13.571
Lost time (min/shift)	20	30	20	20	10	20	15
Uptime %	96%	94%	96%	96%	98%	96%	97%
Capacity - actual	10.111	3.708	2.730	3.250	3.100	4.333	13.143
Daily order	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Capacity constraint	7.111	708	- 270	250	100	1.333	10.143
Defect %	0,5%	0,0%	2,0%	0,0%	1,0%	0,0%	0,0%
Quality %	99,5%	100,0%	98,0%	100,0%	99,0%	100,0%	100,0%

Value Stream Uptime %	58%
Value Stream Quality %	90%
Total production time	8,67 min
Total cycle time	3,48 min
Total lead time (stock in days)	38,20 days
TCT/TLT	0,006%
Total employees - current state	33
Required number of employees	27
Productivity/Performance % assumption	96%
Uptime*Quality*Performance KPI	50%

	Raw materials	Plastic Moulding	Leather Marking	Leather Cutting	Thinning and skyving of leather	Sewing - connecting seam	Application of glue 1	Sewing - decorative seam	Sewing - final seam	Mould flaming	Application of glue 2	Assembly	Thermal treatment	Hole puncturing	Final control	Packaging	Finished goods
Stock (pieces)	73.650	18.182	4.379	150	455	303	181	121	404	3.417	373	101	-	81	180	840	11.800
Stock (days)	24,55	6,06	1,46	0,05	0,15	0,10	0,06	0,04	0,13	1,14	0,12	0,03	-	0,03	0,06	0,28	3,93

Figure 2: Current State Value Stream Map



D. Development The Future State Value Stream Map

The analysis of the current state and the designing of the future state, from a lean perspective, was done in three stages; the demand stage, flow stage and leveling stage as per the framework described by Don Tapping, Tom Luyster and Tom Shuker in the book "Value Stream Management" (Tapping et al., 2002).

The designing of the future State value stream map focused on removing identified waste and designing the flow within the value stream so as to achieve a leaner, quicker, more efficient and levelled production. The first step was to understand and ensure customer demand. A safety stock and a finished goods supermarket of 5.5 days' worth of stock was placed at the very end of the value stream prior to shipping as a means of meeting customer demand and requirements. On the other hand the extensive stock of raw materials was decreased through strategic partnerships with key suppliers and the implementation of VMI. Table 3 shows the flow stage.

Table 3: Flow stage

Designing the Future state - Flow stage		
Observed problems	**Proposed improvement action**	**Planned result**
Two processes with cycle times less than takt time, variations in cycle time, internal effieciency issues	1 day stock in supermarket before shipping	Customer demand is satisfied
Customer requirement for 5 days of safety stock is not systematically implemented	Safety stock and buffer stock due to internal process inefficiencies and customer requirement (total 5 days)	Meet customer requirement for 5 days of safety stock in finished goods
High amount of raw material (leather and plastic) on stock	Supplier supermarket and VMI implementation	Reduction in raw material stock to maximum of delivery transit time

The next stage focused on implementing continuous flow manufacturing throughout the plant so that both internal and external customers could receive the right product, at the right time, in the right quantity. In order to achieve this goal line balancing had to be performed as well as the reorganization of the entire production process in four work cells and introduction of Kanban cards. For this to be accomplished a number of improvement actions, such as the implementation of 5S, SMED and work standardization needed to be realized. Table 4 shows the demand stage.

Table 4: Demand stage

Designing the Future state - Customer demand stage		
Observed problems	Proposed improvement action	Planned result
Uneven distribution of work within the value stream, surplus of capacity at some stages and bottlenecks at others	Line balancing	Balanced workload for smoother flow
	Implementation of work cells for raw material treatment, cover production and shipment preparation	Promote flow and increase worker efficiency
	Standardized work	
Production planning for individual production processes	Implementation of in-process supermarkets and kanban	Aid in creation of flow and production control
Low value stream level uptime	5S, SMED and Autonomous maintanance	Increase in Uptime, decrease CT
Low value stream level quality	5s, Autonomous maintanance	Increase in quality, increase in capacity

The last stage of the future state designing process had the aim of leveling the production through even distribution of work and defining the flow of material and information within the future state value stream map. Table 5 shows levelling stage.

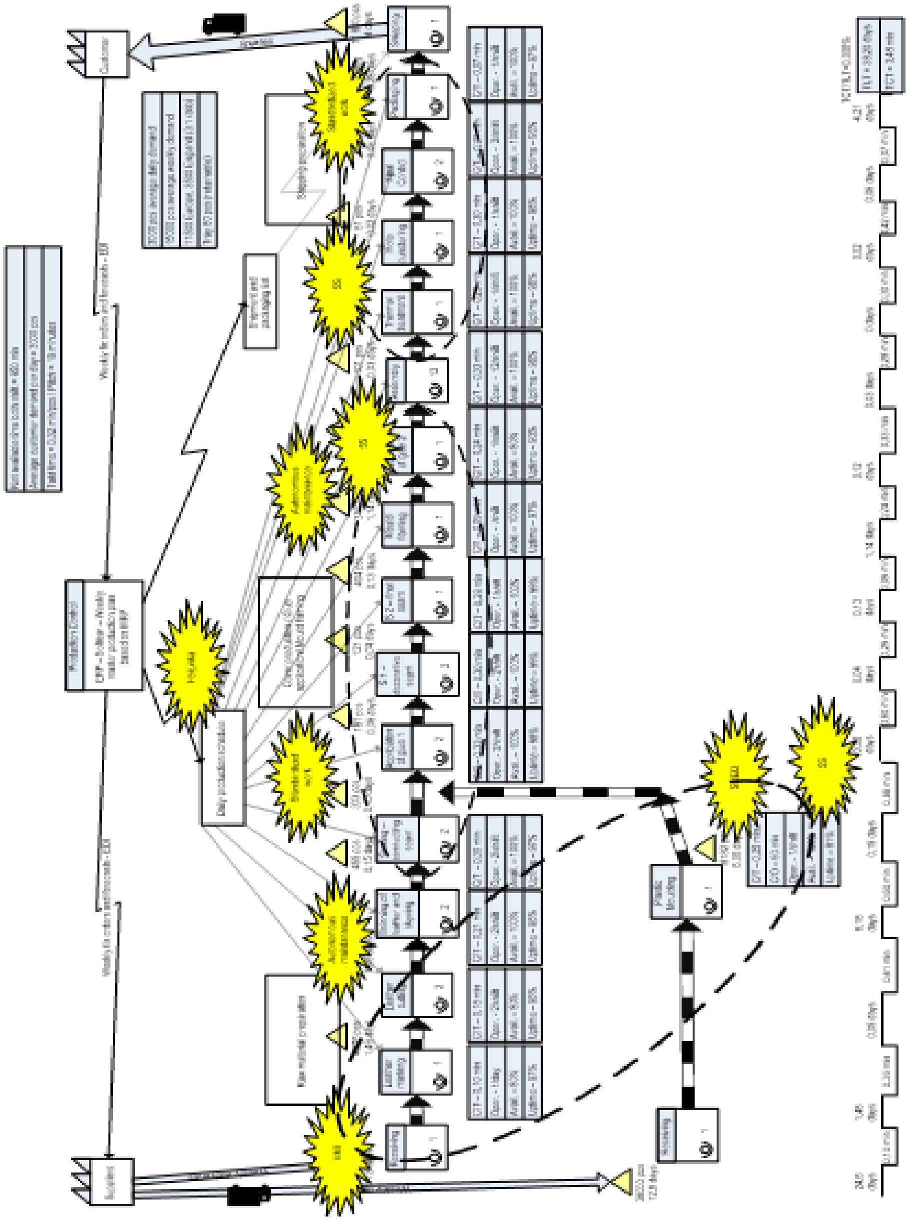
Table 5: Leveling stage

Designing the Future state - Leveling stage		
Observed problems	Proposed improvement action	Planned result
Disbalanced production and inefficient central production planning	Kanban implementation and Heijunka leveling of production	Leveled production
	Implement runner between finished goods supermarket and heijunka box	

Despite the fact that the analysis of the current state value stream map showed that company is nearly capable of meeting customer demand (except two processes with minimal exceeding of takt time) as a first step in the future state both a finished goods supermarket and safety/buffer inventories have been installed at the end of the production processes as a means of fulfilling customer demand and aiding in the creation of flow. On the other hand the future state value stream map begins with a supplier raw material supermarket that limits the amount of raw material stock at company to two days for leather (two days is the transit time) while the stock of plastic granulate has been completely eliminated through the implementation of vendor managed inventory as a lean supply chain improvement method.

Before designing future state value stream map improvement proposal were determined. Figure 3 shows improvement proposals in current state value stream map.

Figure 3: Improvement Proposals



Once the customer demand and raw material supply were secured, reorganization of the production into work cells and the even distribution of work through line balancing was performed. Raw material treatment, cover production and glue application, assembly and shipping preparation cells were formed through the fusion of the elongated individual production process steps into work cells and employee training through which operators were trained to perform multiple tasks within one cell.

For the newly formed cells to function according to takt time certain improvement activities were undertaken, such as SMED, 5S and autonomous maintenance implementation in the raw material treatment cell. The implementation of 5S and autonomous maintenance eradicated uptime issues and improved the quality output of the cell. Through the relocation of the molding machine from Location GOR to Location SRE and the implementation of SMED the lost time due to change overs was reduced to 30 minutes.

The undertaken improvements which reduced the changeover time were linked to external setup activities and a significant reduction was achieved through better positioning of the die and the tools that are needed during the change process. The die in the future state is stored next to machine as opposed to the warehouse, while a 5S implementation achieved a better organization of the workplace during the change process. Additionally, by adding a second technician to the fold it has been able to further reduce the change over time.

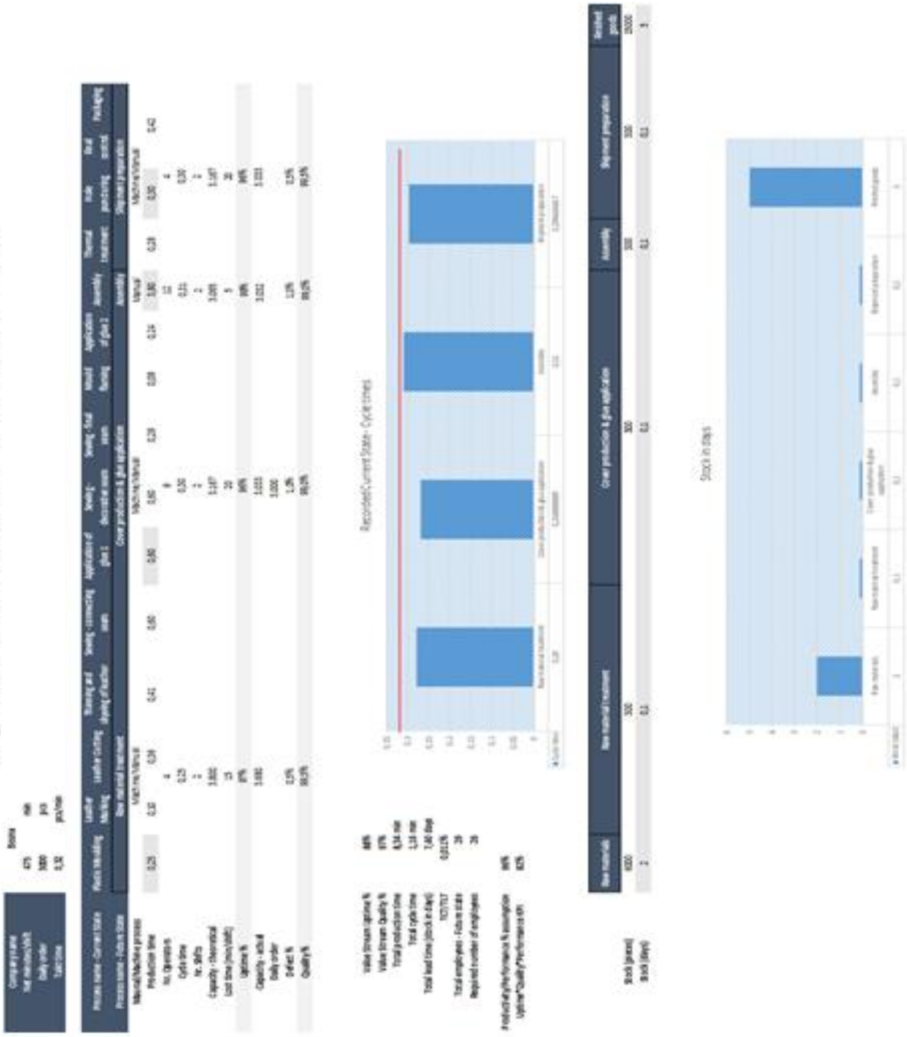
The application of the previously mentioned methods along with work standardization allowed the newly formed cover production and glue application cell to meet the takt time with the same number of employees as in the current state. This was done by partially allocating resource from the mold flaming process to the second glue application process, to be exact the second employee took over physical transfer of the plastic molds from the glue chamber to the assembly. Furthermore, lost time was decreased to 45 minutes in total eradicating maintenance issues at sewing production and halving downtime at the second glue application process.

The assembly process was optimized through the implementation of 5S so that it could reach takt time without the need for additional employees. A 5% reduction in the cycle time was achieved just by organizing all production tools to be neatly placed on the two assembly tables as well as by providing a sufficient amount of functional hot fans. By eradicating lost time on waiting for parts from the second glue application process (through a supermarket preceding the assembly process) and through proper maintenance of the hot fans the down time was also decreased.

The shipment preparation cell was organized so that final control and packaging were combined and the cycle time was decreased through the implementation of 5S and visual workplace. The improved maintenance lowered the downtime to the minimum of the characteristics of the thermal heating oven. Due to the nature of the thermal heating oven, this process was selected to be the pacemaker of the value stream.

The flow of the shipments and subsequently the production was organized through the implementation of Heijunka load leveling of the mix with a 4 to 1 ration of EU parts in comparison to the UK parts and with a pitch of 19 minutes per container. Figure 4 shows future state production process information and figure 5 shows the future value stream map.

Figure 4: Future State Production Process Information



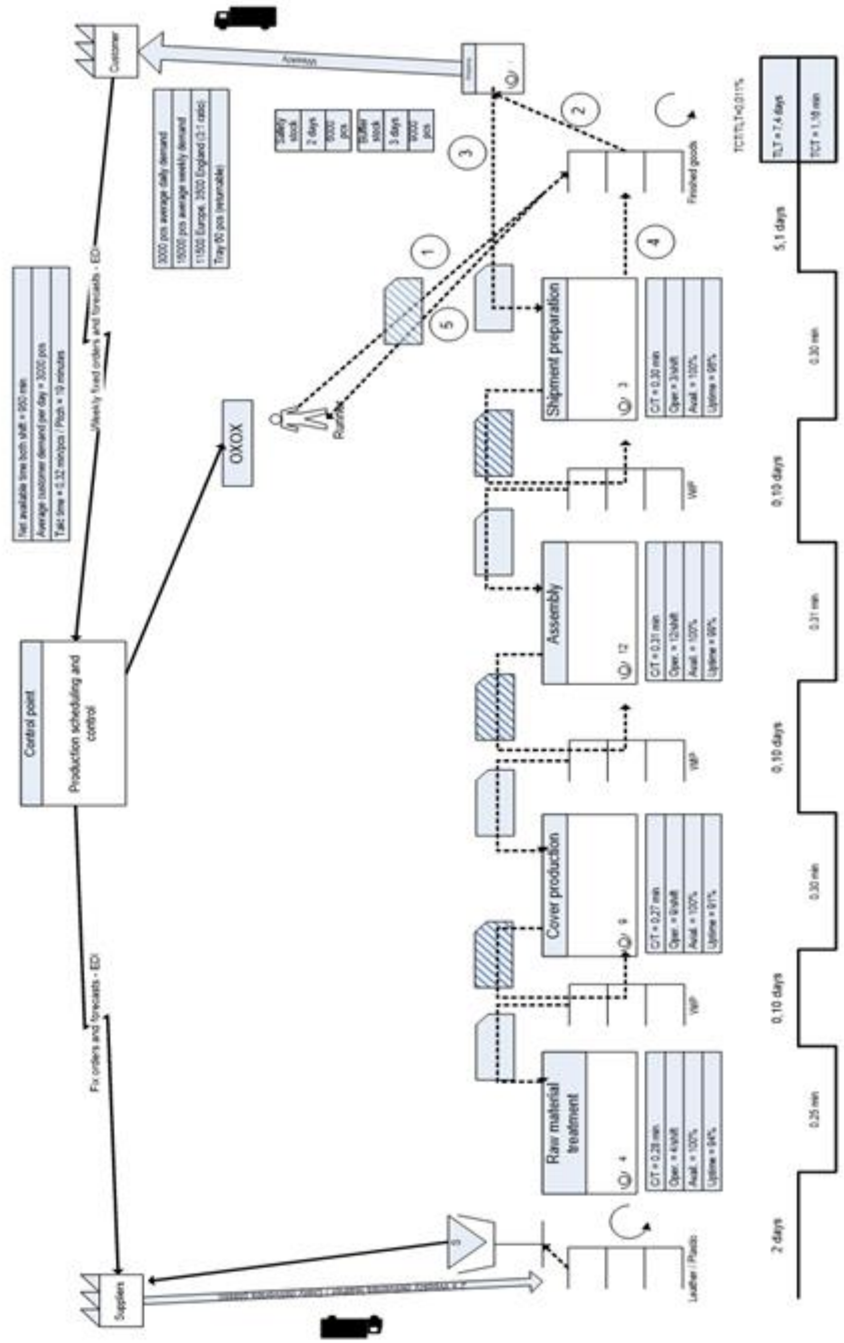


Figure 5: Future State Value Stream Map

III. RESULTS AND DISCUSSION

In terms of lean metrics the initially observed total Lead Time of 38,2 days has been decreased to 7,4 days, almost by 75%. An improvement has been made in the total cycle time which decreased by an estimated 65% to 1,16 minutes from an earlier 3,48 minutes. Improvements made at both fronts have resulted in an increase in the TCT/TLT key performance indicator, from 0,006% at the beginning to 0,011% in the future state value stream map meaning inventory turns were almost doubled.

It is usually most helpful, when presenting the results of Lean, to put forward an amount of money that has been saved. In terms of stock reduction some 30,8 days have been eliminated or roughly 92.000 units. If we assume that the average price of one hand break grip is 10 Euros we come to the realization that the amount of freed capital is nearly 920.000 Euros. From the stand point of labor costs, the Future state has decreased the number of workers by 13% or 5 workers in an absolute number. When we assume that each worker costs the company on a brutto level 2000 Euros per month, the operation reduction has freed up a 120.000 Euros per year while maintaining and improving previous output. The goal of lean not being staff reduction, the surplus employees could be reassigned to other projects and carry on as promoters of lean. Another example may be given through the most direct costs of quality, i.e. not taking into account potential customer reclamations and loss of image. Due to poor maintenance the value stream level quality indicator in the current state was calculated at 90%. This would translate to 72.000 additionally produced units per year or 720.000 Euros per year of quality costs.

The summarized results of the project are presented in the table 6.

Table 6: Improvement Possibilities

Assumptions	Piece price	€ 10	Takt (pcs/day)	
	Brutto operator cost per month	€ 2.000	3000	
	Value stream "Productivity" Indicator	96%		
		Current State	Future State	Improvement ratio
Process indicators	Total Lead Time (days)	38,2	7,4	**-81%**
	Total Cycle Time (minutes)	3,48	1,16	**-67%**
	TCT / TLT	0,006%	0,011%	**72%**
		Current State	Future State	Improvement ratio
OEE indicators	Value Stream level Uptime indicator	58%	88%	**52%**
	Value Stream level Quality indicator	90%	97%	**8%**
	Value Stream level OEE indicator (Uptime*Quality*Performance)	50%	82%	**64%**
		Current State	Future State	Saving
Financial indicators	Number of required operators	33	29	€ 96.000
	Value of stock on hand	€ 1.146.000	€ 222.000	€ 924.000
	Cost of reworked NOK parts	€ 720.000	€ 216.000	€ 504.000

As has been clearly presented, the holistic approach of the value stream mapping methodology has not only identified significant improvement points but also offered a tangible and realistic solution for each encountered problem or source of waste. More importantly, the value stream mapping methodology enables the practitioner to simulate the desired effects of process improvements with a relatively high level of accuracy.

IV. MANAGERIAL IMPLICATIONS

Recent economic developments in Bosnia and Herzegovina have defined the country's manufacturing sector as a primarily processing orientated one. The close proximity to the market of the European Union, trade liberation and the relatively low labor costs are the main drivers of this trend. It would also be beneficial to note that the IT (programming) and engineering industries are exhibiting strong growth on the abovementioned basis, i.e. through the process of outsourcing made possible by developments in software and connectivity.

Even though the manufacturing sector is exhibiting constant year-on-year growth, the need to stay competitive requires these companies to adopt a holistic approach aimed at process improvements as well as put more focus on vertical/local integration in order to optimize the supply base. The current philosophy of low labor rates needs to be overcome and projects such as the one described above are important step in that direction as they clearly demonstrate the waste within the systems as well as the improvement possibilities. Simply put, in order to remain competitive companies in the manufacturing and service sectors need to adopt the cost reduction philosophy through which it is possible to lower prices and increase margins. Furthermore, the rise of e-commerce places additional pressure on lead-time reduction in the face of demand that does not accept long lead-times. The VSM methodology offers an initial step in the resolution of both quarries.

During the implementation of the project, the authors encountered initial resistance in the form of disbelief that any improvements are needed or necessary due to the low labor cost advantage. Furthermore, the lack of educated Lean practitioners is a limiting factor as well. Firstly, VSM being a holistic approach requires complete end-to-end management of the value stream and the accompanying data, which is either not available or in a slightly better case not harmonized/standardized in quality throughout the organization. Lastly, it is important to note that lean techniques are not wide-spread in Bosnia and Herzegovina and that literature in Bosnian language is scarce.

CONCLUSIONS

When pondering on the state and the direction of the global business environment the two most predominant truths are that competition is increasing each day while customer demand is constantly becoming finite. This puts companies, both in the production and in the services industries in an exceedingly difficult situation. How to meet ever more specialized customer demand whilst enduring a constant increase in competitiveness? Results in countless companies over the past three decades have shown that one of the correct answers is lean production.

From a commercial perspective lean production is best exemplified by the cost reduction principle. Traditional thinking dictates that the price of a service or product is calculated as a sum of costs and desired profit. In a fiercely competitive environment however, companies are price takers, i.e. prices are determined by the market and such a calculation could quite easily lead to ruin. This makes companies focus on their bottom lines and aggressively optimize costs while at the same time increasing flexibility and quality. Some of the most successful companies in the world have been able to accomplish this feat through waste elimination from their value streams. In essence they have succeeded because they were able to take the prices set by the market and optimize costs in such a way so as to achieve a profit. To phrase the situation in a lean terminology, the customers are willing to pay for value while it is the companies' duty, if companies wish to remain in business, they should eliminate all waste impacting the sales price. This paper examined in detail and demonstrated in practice one of the most important methods used down the road to Lean production, value stream mapping or the so called "blueprint for change".

The value stream mapping method embodies the very essence of lean philosophy because it promotes continuous improvement by searching for a more perfect solution that the one at hand. The company that has been selected as the case study has been present in the automotive sector for quite some time and has demonstrated its competitiveness on the market. However, upon the analysis of the production processes through the prism of lean the management of the company was quite surprised by the results and the presented space for improvement. Perhaps the most valuable outcome of the analysis was successful presentation of a different perspective, a new way of thinking to the management and employees.

With the above limitations in mind, the authors would recommend any future practitioners to develop a framework for VSM (standardized data collection forms, takt or cycle time calculation forms, throughput calculations forms). Furthermore, it would be beneficial to prepare concrete and simple examples of lean techniques through which to gain the trust and support of the management and later on the support of the operatives within a company. Additionally, future practitioners must be prepared for the reality that extensive literature regarding lean techniques is not available in Bosnian language. As a consequence, the need to prepare reading materials in Bosnian is imperative and a key bottleneck in the process of introducing the employees of a company to lean thinking and lean techniques. Without adequately presenting the key concepts and goals of lean to the employees there can be no hope of a successful implementation of any project.

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