Journal of International Trade, Logistics and Law, Vol. 4, Num. 1, 2018, 111-125

VALUE STREAM MAPPING IN LEAN PRODUCTION AND AN APPLICATION IN THE TEXTILE SECTOR

Utku İnce
Istanbul Commerce University, Turkey

Berk Ayvaz, (Asst. Prof. Dr.)
Istanbul Commerce University, Turkey

Fatih Öztürk, (Asst. Prof. Dr.)
Istanbul Medeniyet University, Turkey

Ali Osman Kuşakcı, (Asst. Prof. Dr.)
Ibn Haldun University, Turkey

Received: May. 05, 2018 Accepted: June 01, 2018 Published: June 1, 2018

Abstract:
With increasing competition from globalization, in many sectors, global brands have shifted their production lines to countries with low labor costs in order to reduce their costs in the last two decades. The way to produce in other countries in order to maintain their production at their own centers is to reach competitive production cost levels. Under these circumstances, firms focus on the idea of reducing costs by focusing on production systems and removing all activities that do not produce value and consume resources. One of the ideas that has emerged in recent years and will help the company in this regard is the philosophy of Lean Manufacturing. Value stream mapping is one of these tools. It is an important and effective tool because each process in the value chain of a product reveals a visual "map" and information flow. The textile industry, one of the labor-intensive sectors, has succeeded in developing its competitive power over time by acquiring new production and marketing strategies. With this study, it is aimed to show the success achieved by applying one of lean manufacturing technique which name is "value stream mapping" at a textile manufacturing company and to contribute to the literature.

Keywords:
Value Stream Mapping, Single Minute Exhange of Dies, Yarn Dyeing, Fabric, Lean Manufacturing

1. Introduction
With Lean production's starting step is the value. The producers should refine the production steps and procedures with value concept and eliminate the process from all activities that do not create value but create additional cost to the product. Lean manufacturing, compared with the old mass production, is considered precisely compatible with customers' requests and which can produce with less waste, with less workforce, with less place to organize and manage product development, production operations, suppliers and customer relations (Shook, Marchwinski, & Schroeder, 2011).

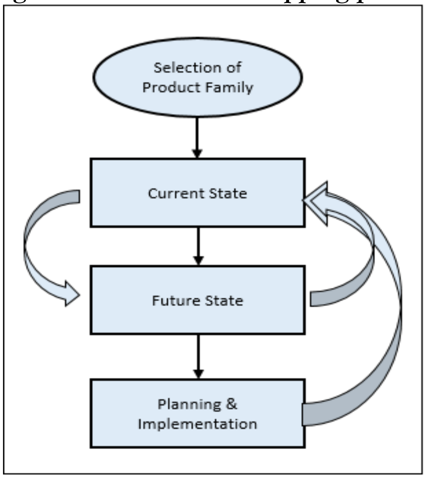
Waste, one of the most important concepts of lean production, refers to activities that consume resources without creating any value. Since wastes are usually hidden behind general habits, they are normally encountered in the working environment and are difficult to detect. For this reason, it only can be noticed and correctly defined by a very careful observer (Rampersad & El Homsi, 2007). Improving operations without stopping to find and remove wastes should have a strategic priority (Byrne, 2015). Even if the production system environment is different, the typical waste seen in factories is very similar. Known types of waste are; wastage due to excess production, waiting wastage, transportation wastage, unnecessary process wastage, wastage from inventory, waste caused by mistakes;

movement wastage and unused ability wastage. In the philosophy of lean manufacturing, Kaizen, 5S, Poka-Yoke, Tact-Time, One-Piece Flow, Value Stream Mapping etc. techniques are used (Dos Santosa, Vieira, & Balbinotti, 2015). Womack and Jones (2003) summarized the lean principles in five groups. Identify the value, map the value stream, build the flow, build the traction system and look for perfection (Womack & Jones, 2003). As you can see, there is the definition of value and the mapping of value stream on the basis of lean production. This work focuses on improvements to be made with Value Stream Mapping (VSM) and bottleneck "Single Minute Exchange of Dies (SMED)" approaches. By application of the methods discussed in a leading company in the textile sector in Turkey, statistical evaluation and the improvements achieved have been transferred. As far as we know, it is the first study that applied value stream mapping method in the field of textile (dyeing and fabric production) in our country. In this respect, this article will provide a roadmap for the implementation of the related techniques in the sector firms and will contribute to the applied literature in this area. Value stream mapping has been applied in construction (Matt, Krausea, & Raucha, 2013) , health (Kaale, ve diğerleri, 2005), transportation (Villarreal, Reyes, & Kumar, 2017), software development process (Musat & Rodriguez, 2010), minig (Kumar, 2014), maintenance services (Kasava, Yusof, Khademi, & Zame, 2015), automotive subsidiary industry (Kılıç & Ayvaz, 2016), etc. (Kennedy & Huntzinger, 2005) and in many different sectors in the literature. (Özkan, Birgün, & Kılıçoğulları, 2005) analyzed value streams for an automotive firm with variable demand (Abdulmalek & Rajgopal, 2007). In Alaca's (2010) study, value chain analysis was done with value stream mapping tools for the white goods sector (Alaca & Bayraktar, 2010). When conducting value-chain analysis in the study, proposals have been made to eliminate value-added activities by exploiting three different mapping tools (Sullivan, McDonald, & Van Aken, 2002). It has been assessed how the Analytic Hierarchy Process can be used in the selection of improvement points in the Devotional and Strong (2015) value stream charts (Özveri & Güçlü, 2015). For this purpose, the current state value map is drawn for a business operating in the footwear sector, and the points to be improved by the experts are selected by applying the AHP method (Womack & Jones, 2003). Bulut and Altunay (2016) used the Value Stream Mapping method to identify and eliminate waste sources in the lean transition process for an enterprise operating in the furniture sector (Bulut & Altunay, 2016). Doğan and Ersoy (2016) used a value stream mapping method to identify activities that add value and which do not add value in a university research and application center that provides laboratory analysis services, and made a proposal to eliminate activities that do not add value (Doğan & Ersoy, 2016). Kılıç and Ayvaz (2016) used Lean Production techniques such as mapping the value stream for a company's production process which produces seals for the automotive sector in Turkey, pull system, 5S, SMED, one-piece flow, cellular manufacturing, kaizen, poka-yoke, total productive maintenance, quality circles , heijunka, and shojinka in their work (Kılıç & Ayvaz, 2016). Jia et al. (2017) proposed a new Therblig embedded value stream mapping method to reduce energy expenditure in non-cutting activities (Jia , ve diğerleri). Stadnickaa and Litwin (2017) applied value stream mapping methodology to a firm that manufactures automobile doors. The above-mentioned summary publication survey shows that there are no large-scale applications, especially in the textile sector (Stadnicka & Litwin, 2017). The study is divided into the following main headings. In the first chapter, an introduction was made to the subject; In the second part, detailed information about DAH was given. In the third part, the DAH method was applied to a company operating in the textile sector and the improvements were transferred to statistical analyzes. In the last part, the conclusion and the proposal are given.

2. Value Stream Mapping

VSM is one of the widely used lean manufacturing techniques for destroying waste. These maps consist of the current situation drawing, the future state drawing and the transition plan to the application (Abdulmalek & Rajgopal, 2007). Figure 1 shows the steps of value stream mapping (Krajewski, Ritzman, & Malhotra, 2013).

Figure 1. Value stream mapping process



The most important and powerful part of the technique is a snapshot of how the value stream works over time at a given point (Nash & Poling, 2008). VSM can be assessed as a paper-paper and computer technique that creates added value and demonstrates value-added activities (Jimmerson, 2010). In addition, the technique includes simple graphs that show motion throughout the entire value stream (Kennedy & Huntzinger, 2005). The value stream map ensures that raw materials, information and cash flow can be seen and bottlenecks can be detected (Maskell, Baggaley, & Grasso, 2004). It is aimed to reach the future within one to twelve months, including the development of the current situation, the future situation and a detailed implementation plan (Locher, 2008). A value stream is the process flow between "demanded point" and "meeting all requirements" after product or service. It also allows the creation of detailed plans to implement lean production concepts (Sullivan, McDonald, & Van Aken, 2002).

2.1. Selection of Product Family

Unless it is a small, single-product factory, it is necessary to focus on a single product family for mapping, because it would be complex to show all product flows in a single map, and because customers are interested in only their products, not all products produced in a factory (Birgün, Gülen, & Özkan, 2006). These products are family members because they contain similar steps along the value streams. If the value streams are not clear, it may be useful to plot the production flow matrix. With a simple table, the matrix of the products and the steps in the production process are created. All products (or product families) produced in operation are sorted on the Y axis and all machines and / or production departments in the factory are sorted on the X axis and matrix is marked to show which product family is using which process (Maskell, Baggaley, & Grasso, 2004). Figure 2 shows the production flow matrix example and product families. We are ready to decide where to start when the process matrix is complete (Nash & Poling, 2008).

2.2. Drawing of Current and Future State Map

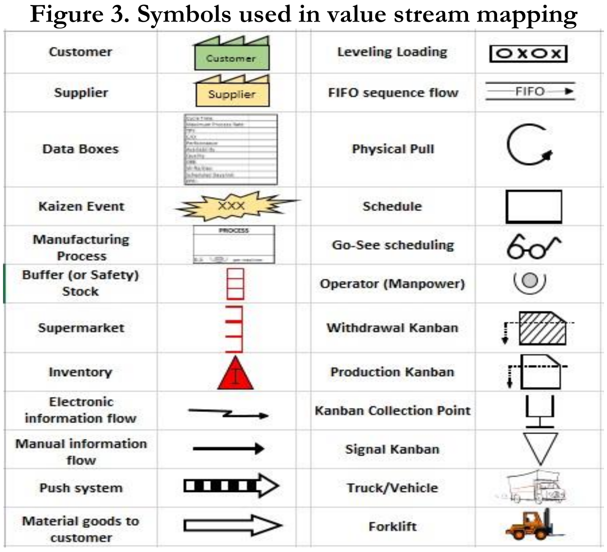
The current state value stream map, as the name implies, shows the current state of how materials and information are processed (Rother & Shook, 1999).

Figure 2. Process matrix and product family selection for product family selection

Process Matrix and Product Family Selection for Product Family Selection												
Item Number	Frequency (%)	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6	Process 7	Process 8	Process 9	Process 10	Product Family
252361-1	9	1	0	1	1	1	1	0	1	1	1	1011110111
252361-2	6	1	0	1	1	1	1	0	1	1	1	1011110111
252361-3	6	1	0	1	1	1	1	0	1	1	1	1011110111
252361-10	9	1	0	1	1	1	1	1	0	0	1	1011111001
252361-11	4	1	0	1	1	1	1	1	0	0	1	1011111001
252361-12	4	1	0	1	1	1	1	1	0	0	1	1011111001
252361-7	7	1	1	0	1	1	1	1	0	0	1	1101111001
252361-8	9	1	1	0	1	1	1	1	0	1	0	1101111010
252361-9	6	1	1	0	1	1	1	1	0	1	0	1101111010
252361-4	7	1	1	0	1	1	1	1	1	0	1	1101111101
252361-5	2	1	1	0	1	1	1	1	1	1	0	1101111110
252361-6	1	1	1	1	0	1	1	1	1	0	1	1110111101
252361-13	11	1	1	1	0	1	1	1	1	1	1	1110111111
252361-14	10	1	1	1	0	1	1	1	1	1	1	1110111111
252361-15	9	1	1	1	0	1	1	1	1	1	1	1110111111

In the value stream map the cycle time, turn-off time, preparation times, production batch sizes, product types, number of operators, package size, run time (except for movers), scrap rate, machine usage rates etc. and values are needed. While drawing the current situation map, it is necessary to go from the last step to the beginning and continue with the necessary inspections and observations (Birgün, Gülen, & Özkan, 2006). The basic symbols used in value stream mapping are those used to visually represent various tasks and functions (Figure 3). To complete the map, the supply time and timeline which records the time that creates the added value is added to the bottom of the map (Sullivan, McDonald, & Van Aken, 2002). When the existing situation map is drawn in VSM applications, improvement opportunities are seen and the future situation is drawn according to the foreseen improvements in these improvement opportunities. Knowing some of the important lean manufacturing principles in the future situation drawing will be useful for seeing improvement opportunities in the analysis of the current situation (Birgün, Gülen, & Özkan, 2006). The future state map should be based on workshop facts (Rother & Harris, 2001). There is no point in the value stream map unless the drawn current situation reaches the drawn future state.

Figure 3. Symbols used in value stream mapping



Improvements in a cycle;

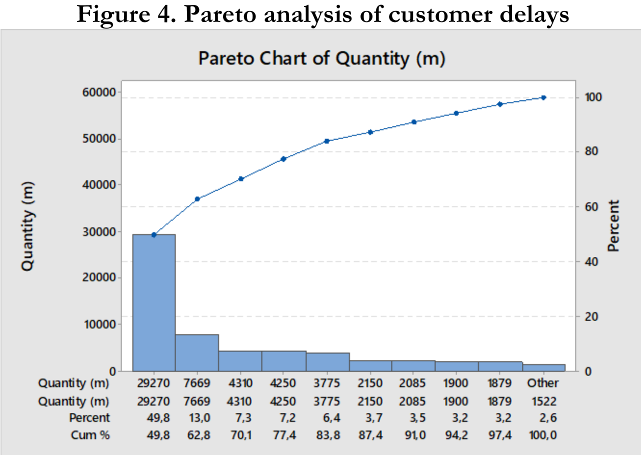
- Improvement of the continuous flow of work by tack time;
- Establishing a towing system to improve production;
- Leveling;

- Constantly taking steps such as shrinking the party size by removing wastes and making kaizenes to expand the continuous flow field by shrinking the supermarkets. This non-exhaustive process is the most basic philosophy of lean manufacturing, the perfect concept of continuous improvement. When the target situation is reached, a new target point is identified and continuous improvement is achieved by working to reach the new target point (Kahrıman, 2013).

3. Implementation

The VSM technique is a method that is used in our country and in the world, and it is still attracting interest for many researchers. The technique, since it started to be applied in the production processes of motor vehicles, has found application areas in many different sectors. However, when literature review is made, no research has been done in the field of textile (dyeing and fabric production) so far in our country. The research is important in order to achieve a certain degree of deficiency and to form a resource for future research. The value stream mapping application included in the study was carried out in an integrated facility serving as the textile industry. The plant produces yarns and fabrics from natural fibers and natural fiber blends. Many semi-finished products used in the production of the products are produced in the integrated facilities in the same location and each facility becomes the customer of one another. With this point of view, a VSM team was formed by senior management as the first step in the implementation of VSM in operation. In creating the team, it has been noted that the business has members with detailed knowledge of the value stream. Following the creation of the team, the team members were given 1 day VSM training as their first job. In order to decide where to start the application, the team first started to choose the facility that has problems in service to the customer. The customer terminating delays in Figure 4 are also registered by pareto analysis.

Figure 4. Pareto analysis of customer delays



For this purpose, it is aimed to improve the customer delays originating from the dyeing department included in the pareto analysis with the MG01 code, which is the half of the total delays and decided to create a value stream map in this section. It was started by analyzing the production carried out in the operation, by interviewing the engineers who planned and controlling the production. Information about procurement, stock, production processes and employees was obtained.

3.1. Product Family Selection

After collecting the relevant data required by the operator's automation infrastructure, the selection of the product family has started to work on the current situation to prepare VSM. The operator's raw material supply can be classified under three main groups; Yarns that need winding, yarns that do not need winding, twisted yarns that are produced in the integrated facility. The raw material yarns used by the operator for production purposes include wool, polyester, cotton, linen, viscose etc. Yarn supply is covered by procurement or other production departments in its integrated facilities, and the requirements are periodically made by the production planning and control department. Since the supply of yarn, which is one of the vital raw materials of the operator, is made in other parts, it is preferred that the operator keep the twin yarn of the value of 12 tons corresponding to the consumption of about one week in the in-house warehouse. The data on the number of employees, the tempo time (tact time), the model change time (C / O), the machine usage rate and the total work time per shift were obtained from the automation system used in the production process and the related values are shown on the map.

Figure 5. Production flow matrix

Production Flow Matrix										
Mixture/Process	Warehouse	Preperation for Dyeing	Soft Winding	Dyeing	Centrifuge	Drying	Pre Control	Final Preperation	Handling	Pre Process
Wool/Polyester	1	1	1	1	1	1	1	1	1	1
Wool	1	1	1	1	1	1	1	1	1	1
Wool/Nylon	1	1	1	1	1	1	1	1	1	1
Cotton	1	1	1	1	1	1	1	1	1	1
Linen	1	1	1	1	1	1	1	1	1	1
Polyester	1	1	1	1	1	1	1	1	1	1
Cashmere	1	1	1	1	1	1	1	1	1	1

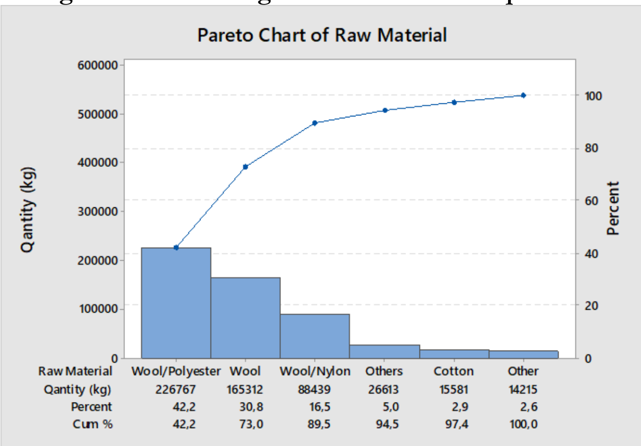
After these measurements, the duration of the operations carried out in the dyeing operation from the transportation as raw material of a dye to the delivery of the dyeing as the dyed yarn was calculated and added to the bottom part of the map. We can gather the information flow in business mainly in two groups: stock declarations made to the production planning unit and process information transfer from the automation system. The process started with the selection of the product family for the flow chart work in the dyehouse production. As understood from the production flow matrix, the raw material has to pass through all available operations, no matter what mix or how mixed it is. It has been found that differences between operations are caused by changes in time, pressure, temperature, etc. in the dyeing process and it is seen that the improvement to be made in any of the operations will provide an opportunity for improvement for all raw material types.

Figure 6. Product family selection

Product Family Selection				
Product Mixture	Total Production Qty (kg)	Process Time (Hour)	Weighted (kg*hour)	Weighted Qty Ratio (kg*hour %)
Wool/Polyester	215.789	7	1.510.523	42,2%
Wool	202.078	5,45	1.101.325	30,8%
Wool/Nylon	108.094	5,45	589.112	16,5%
Cotton	10.373	10	103.730	2,9%
Linen	13.257	7,15	94.788	2,7%
Viscon	7.204	7,15	51.509	1,4%
Wool/Cashmere	7.810	5,45	42.565	1,2%
Others	4.808	7	33.656	0,9%
Polyester	3.730	7	26.110	0,7%
Wool/Cashlook	4.003	5,45	21.816	0,6%
Bamboo	200	7,15	1.430	0,0%
Total	577.346	74	3.576.563	100%

For this reason, taking into consideration the raw material mixtures and the durations during the dyeing process, the most produced product mixture was determined as shown in figure 6. Regardless of the materials in the dyeing, since all of the processes are the same, the constraint to be taken into consideration when draining the value will be the amount of production. For this purpose, when analyzing the raw material quantities from the production quantities as a result of pareto analysis, 42.2% of the production made in the operation is finished with wool / pes, so the value of this material will be flowed and mapped (Figure 7). Improvements made as a result of this value stream can also be applied to all materials produced.

Figure 7. Pareto diagram of raw material quantities



3.2. Current Situation Analysis

To describe the flow of production briefly; yarn dyeing is the process of drawing dyeing work orders created by the production planning department according to the production requirements which come from the design of the fabric to form the desired fabric of the customer until the introduction to the semi-finished yarn holders for use in warp and weave operations as dyed yarn according to the dyeing termination date.

Figure 8. Dyeing section process supply histogram graph

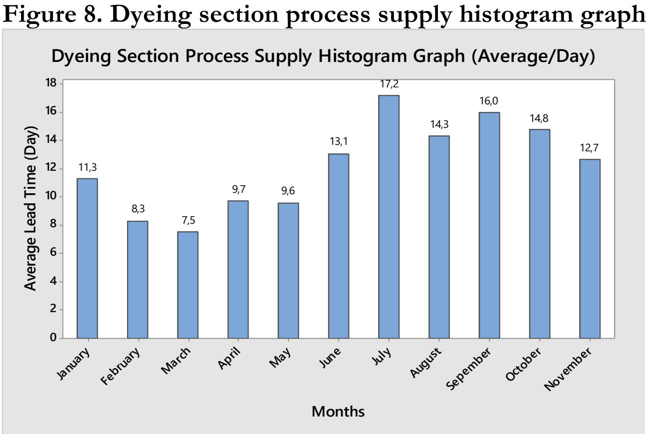
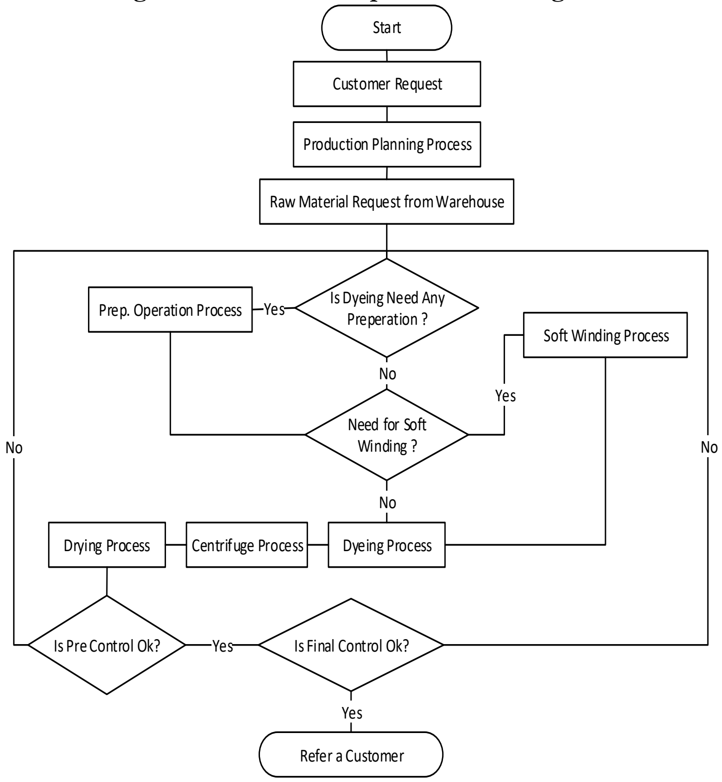


Figure 8 shows the results of the analysis of how much work orders in the dyeing process lasted from the raw material storage to the yarn storage. As a result of the analysis made, the adequacy of the process was tested by performing a qualification analysis on the actual yarn dyeing process times determined as 6 days.

Figure 9. Current state process flow diagram



Before the process capability analysis, it was analyzed whether the data set had normal distribution and the normal distribution of the data set was found appropriate (Figure 10). In order for businesses to achieve the desired level of quality, products must form within specifications that describe consumer expectations. For this, the ability of the production process to produce products that meet the specifications must be continuously examined.

Figure 10. Normality test chart of total process transition time

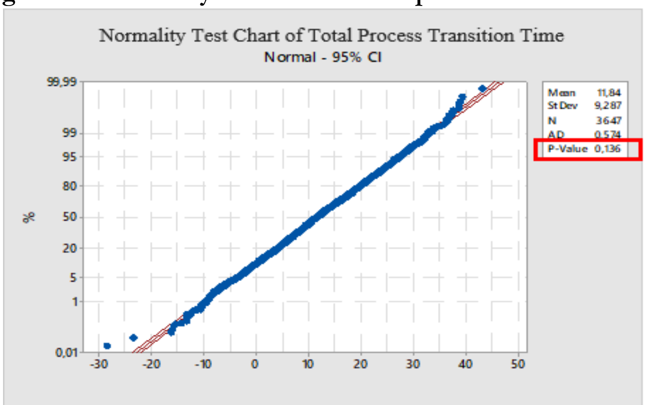
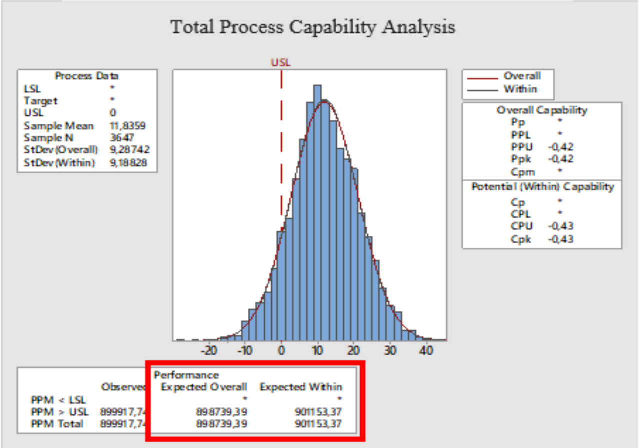
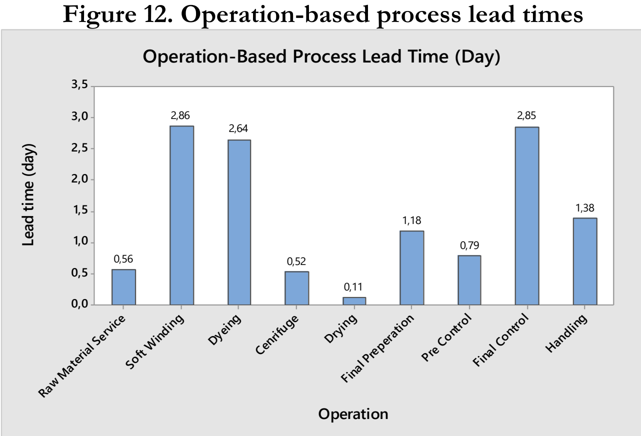


Figure 11. Total process transition time proficiency analysis



The degree of providing process specifications with process capability indices can be determined and the process can be continuously controlled and improved with the periodic calculation of the indices. The end result of the qualification analysis of the delivery times of the products expected by the customer at the end of the 6th day is shown in Figure 11. According to this, only 11,13% of the products requested by the customer are realized in 6-day objective. How long each job order lasts in the steps it processes during the dyeing process is illustrated in Figure 12, where operation-based process durations are analyzed.

Figure 12. Operation-based process lead times



3.3. Creating an Existing Status Value Stream Map

Considering the batch size of the product that the customer wants when creating the VSM; Takt time; 2,500 pieces of products are requested by the customer per day.

According to this request; The machine park used in the operation can be produced 24 hours from the technical point of view. The calculation will be based on this acceptance. According to this, the factory produces for a total of 86,400 seconds in three shifts a day and when calculated with the customer's desired 2500 units;

(Takt Time = (total work time used in the shift / customer demand per shift))

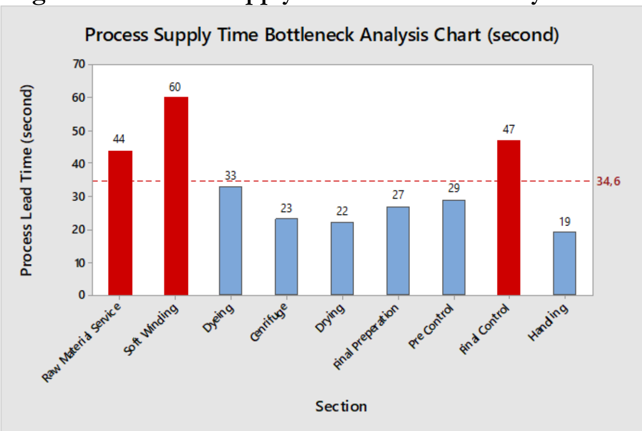
It was calculated as Takt Time = 86.400 / 2500 = 34, 56 sec.

According to this result, the customer demands 1 product every 34.56 seconds.

After the tact calculation, the operation steps and intermediate stocks were recorded by going through the process from the end to the beginning and the current situation value map was prepared by using the productivity figures

obtained from the automation system of the machines and equipment. When the current situation map is examined (Appendix-1), the current state value stream of the operator;
Value Added Time = 114 seconds
Process Supply Duration = 1.086.139 seconds (12.57 days)
Therefore, 99,989% of the value stream flows from activities that do not add value to the product, that is, from wastes. Based on these determinations, the customer demands 1 material in 34.6 seconds.

Figure 14. Process supply time bottleneck analysis chart

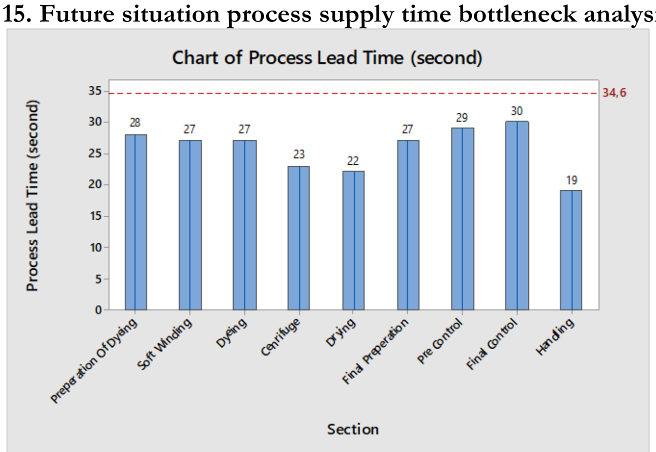


Accordingly, considering the durations of the operation steps, the following bottleneck analysis was carried out for the operations and the bottlenecks were determined as shown in Fig. 14 in order to create continuous flow. The value stream map team prepared the future situation map given in Figure 16 in accordance with the above findings.

3.4. Creating the Future Situation Map

The VSM team designed the future state of the value stream out of the current state map of the business. This phase was started by analyzing 16 major losses of each process in the production line. The records of the coil dyeing production were analyzed and necessary measurements were made. The process times are listed and the inter-operation pauses and stock quantities are determined. Features such as machine laboratories and other work stations have been studied and observed, and interviews with operators were carried out. After all the data obtained on the basis of these studies have been combined and analyzed, the present situation value stream map has been rearranged to remain only production-related components.

Figure 15. Future situation process supply time bottleneck analysis chart



It is necessary to add some new information not available in the VSM (Appendix-1) to improve production efficiency and process lead time within the enterprise. These include information on color preparation and reprocessing (for repair purposes) operations. At the bottom of the value map, lines indicating the potential for increased productivity were added (Appendix-2). Since production was being made in the business while the work was being done, healthy measurements and analyzes are based on the data in the past. The nine processes studied in the study have been identified as having the potential to increase production efficiency by identifying potential for high improvement in 3 of them. These fixations are indicated in the corresponding boxes in the lower corner of the table (see Appendix-2).

3.5. Improvement Studies

The SMED application for shortening the workout between the dyeing from the dyeing booth and the dyeing work to be done is done by ECRS analysis consisting of eliminate, combine, rearrange, simplify steps and was accomplished with a 10-step kaizen study. After the decision made, with the e-kanban application, the dyeing boiler spare reservoirs are hold ready, while the process continues, the yarn to be dyeed from the previous operation was pulled and kept ready to be placed next to the boiler in the boiler room and it was aimed to place the yarn to be dyeed when the dyed yarn was out and to reduce the duration of the type change from 36 minutes to 9 minutes.
In Figure 18 you can see the ECRS analysis.

Figure 18. ECRS analysis

ECRS ANALYSIS OF DYEING SECTION

Number	Explanation	Process Time (Minute)	Stopwatch Time	GANT	External Set-Up	Internal Set-Up S/T	Internal Set-Up SET	Walking	Bottleneck	Simplify	Combine	Eliminate	Rearrange	Action Number	Action Situation	Responsible	Date	Saving Time (Minute)	Saving (Try)	Cost (Try)
1	Waiting for the job to finish on the machine	00:03:10	00:03:10		X								X	1		Operator1	30.08.2017	10		
2	Purchase of spare water in the machine	00:00:50	00:04:00			X										Operator1	30.08.2017	24		
3	Waiting for water to drain	00:01:54	00:05:54			X										Operator1				
4	Boiler color output after water is drained	00:00:41	00:06:35			X										Operator1				
5	Picking up a bobbin from the machine	00:00:15	00:06:50			X										Operator1	15.09.2017	35		
6	Yarn peeling from Bobbin	00:00:28	00:07:18			X										Operator1	30.08.2017	0		
7	Drying of scraped yarn	00:01:30	00:08:48			X										Operator1				
8	Finding a color reference card	00:09:53	00:18:41		X							X		2		Operator1				
9	Taking dried yarn and controlling color	00:00:33	00:19:14			X										Operator1				
10	Termination of process to make color suited and winning	00:00:17	00:19:31			X										Operator1				
11	Winning the winner with crane	00:00:40	00:20:11			X										Operator1	30.06.2017	24		
12	Transfer of winches taken from a winch to a centrifuge	00:00:30	00:20:41			X										Operator1				
13	Picking up the empty machine with a crane	00:03:31	00:24:12		X							X		3		Operator1	30.08.2017	45		
14	Searching for coils to fill the empty machine	00:09:19	00:33:31		X							X		4		Operator1				
15	Machine alignment of found coils	00:02:51	00:36:22		X							X		5		Operator1	30.08.2017	15		
16	Cover closure	00:03:37	00:39:59		X							X		5		Operator1	30.08.2017	35		
17	Lifting of the full machine by crane	00:02:13	00:42:12		X							X		6		Operator1	30.08.2017	6		
18	moving the machine to the winner	00:01:19	00:43:31			X								7		Operator1	30.07.2017	37		
19	Controlling	00:00:51	00:44:22				X					X		8		Operator1	30.07.2017	134		
20	Beginning of the dyeing process	00:00:29	00:44:51				X							9		Operator1	30.08.2017	60		

After the analysis and improvement studies; The set-up duration which was scheduled to be downloaded to 9 minutes continues to take place with the average of 12 minutes and studies to reduce this time to a single figured minutes are also continuing (Figure 19).

Figure 19. Set-up losses before and after the Project

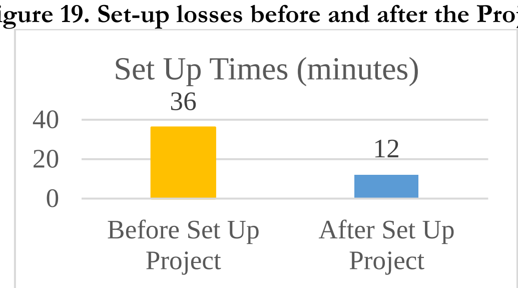


Figure 20 and Figure 21 show the control graphs of the critical performance parameters determined during the project period and after the project period according to the results of the improvement studies. As a result of the Kaizen studies, the duration of the procurement process for the dyeing section was reduced from 12.57 days to 7.12 days with the 5.4 day-improvement. Accordingly, a 43% improvement was achieved after the application of VSM. Another important parameter in terms of process improvement is the amount of customer delay caused by the dye house.

Figure 20 Process supply time control chart

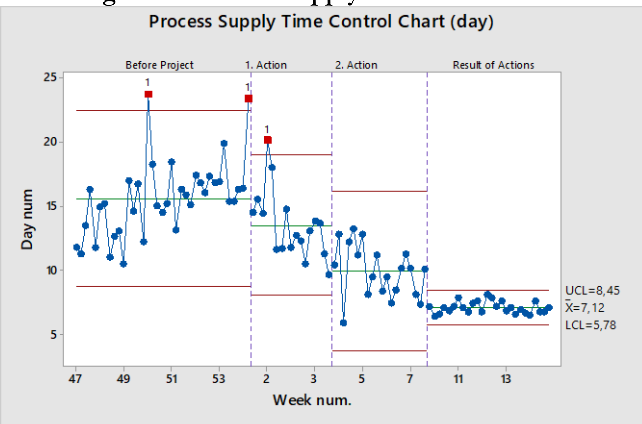
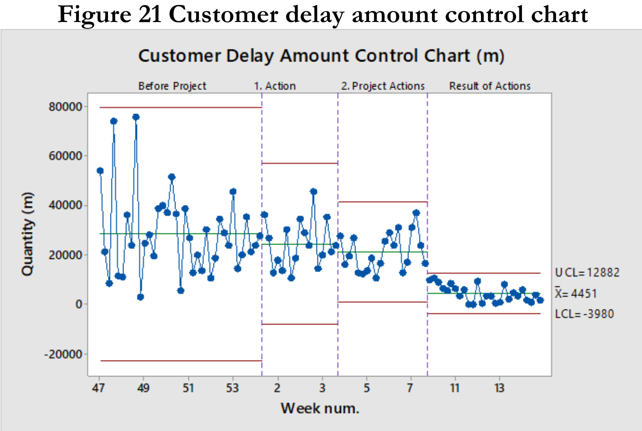


Figure 21 Customer delay amount control chart



The results of this parameter were given in figure 21. Accordingly, it appears that the changes made have caused an improvement by 5 times in the amount of delay.

4. Conclusion

The waste prevention precautionary approach brought about by the concept of lean thinking when considered together with the holistic view capability of value stream maps, emerges as an appropriate and important lean tool for production management. From this point of view, the scope of this study examines the use of value-flow maps in manufacturing companies for productivity efficiency studies. In the manufacturing process of a leading company in the textile industry in our country, the existing situation map and the future situation map were created and the activities which added value and wasted were determined and necessary improvements were made and the results were transferred with statistical analyzes. In this framework, a holistic VSM approach is presented, which includes the identification of production wastage, the selection of relevant improvement points, and the main steps of utilizing the enterprise's historical data, as well as the knowledge of its employees and the opinions of industry experts. It has been determined that the developed approach has been tested with an implementation study and is a practical and effective method. An improvement of 43% was achieved in the supply period after the application of VSM. Again, it was observed that the very high customer delay improved by approximately 500%. In future studies, it will be useful for the firm to develop the value-flow maps used in this study to include processes of suppliers and stakeholders to simplify the supply chain.

References

Abdulmalek, F., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value streammapping via simulation: A process sector case study. Science Direct , 223-236.

Alaca, H., & Bayraktar, C. A. (2010, Haziran). Değer Akış Haritalama Araçları ile Değer Zinciri Analizi: Beyaz Eşya Sektöründe Bir Uygulama. İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü.

Birgün, S., Gülen, K. G., & Özkan, K. (2006, 1). Yalın Üretime Geçiş Sürecinde Değer Akış Haritalama Tekniğinin Kullanılması : İmalat sektöründe Bir Uygulama. İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi, s. 47-59.

Bulut, K., & Altunay, H. (2016). Değer Akış Haritalandırma Yöntemi: Mobilya Sektöründe Bir Uygulama. Uluslarası Mühendislik Araştırma ve Geliştirme Dergisi, 48-55.

Byrne, A. (2015). Yalın Dönüşüm:Mal sahibinin el kitabı. İstanbul: Optimist.

Doğan, N. Ö., & Ersoy, Y. (2016). Hizmet Sektöründe Değer Akış Uygulaması: Bir Üniversite Araştırma ve Uygulama Merkezi Örneği. Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Dergisi, 103-116.

Dos Santosa, Z. G., Vieira, L., & Balbinotti, G. (2015). Lean Manufacturing and ergonomic working conditions in the automotive industry. Procedia Manufacturing 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences, AHFE 2015 (s. 5947 – 5954). Las Vegas, United States: Procedia Manufacturing.

Jia , S., Yuan, Q., Lv, J., Liu , Y., Ren, D., & Zhang, Z. (tarih yok). Therbling-Embedded Value Stream Mapping Method For Lean Energy Machining. Science Direct.

Jimmerson, C. (2010). Value Stream Mapping for Healthcare Made Easy. New York: Productivity Press.

Kaale, R., Vega, D., Messner, K., Eitel, D., Johnson, D., McKniff, S., & Snyder, K. (2005). Time Value Stream Next Term Mapping As a Tool to Measure Patient Flow Through Emergency Department Triage. Annals of Emergency Medicine, 46(3).

Kahrıman, M. (2013). Otomotiv Endüstrisinde Simülasyon BütünleÇik Değer AkıĢ Haritalama Uygulaması. Erciyes Üniversitesi Fen Bilimleri Enstitüsü.

Kasava, N. K., Yusof, N. M., Khademi, A., & Zame, M. (2015). Sustainable Domain Value Stream Mapping (SdVSM) Framework Application In Aircraft Maintenance: A Case Study. Procedia CIRP, 418-423.

Kennedy, F., & Huntzinger, J. (2005). Lean Accounting: Measuring and Managing The Value Stream. Cost Management, 31-38.

Kılıç, A., & Ayvaz, B. (2016). Türkiye Otomotiv Yan Sanayinde Yalın Üretim Uygulaması. İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi, 29-60.

Krajewski, L. J., Ritzman, L. P., & Malhotra, M. K. (2013). Üretim Yönetimi. Ankara: Nobel Akademik Yayıncılık Eğitim Danışmanlık Tic. Ltd. Şti.

Kumar, P. N. (2014). Analysing the Benefits of Value Stream Mapping in Mining Industry. International Journal of Innovative Research in Science, al Journal of Innovative Research in Science, 16668-16673.

Locher, D. A. (2008). Value Stream Mapping for Lean Development: A How To Guide for Streamlining Time to Market. New York: Productivity Press.

Maskell, B., Baggaley, B., & Grasso, L. (2004). Practical lean accounting : a proven system for measuring and managing the lean enterprise. New York: Productivity Press.

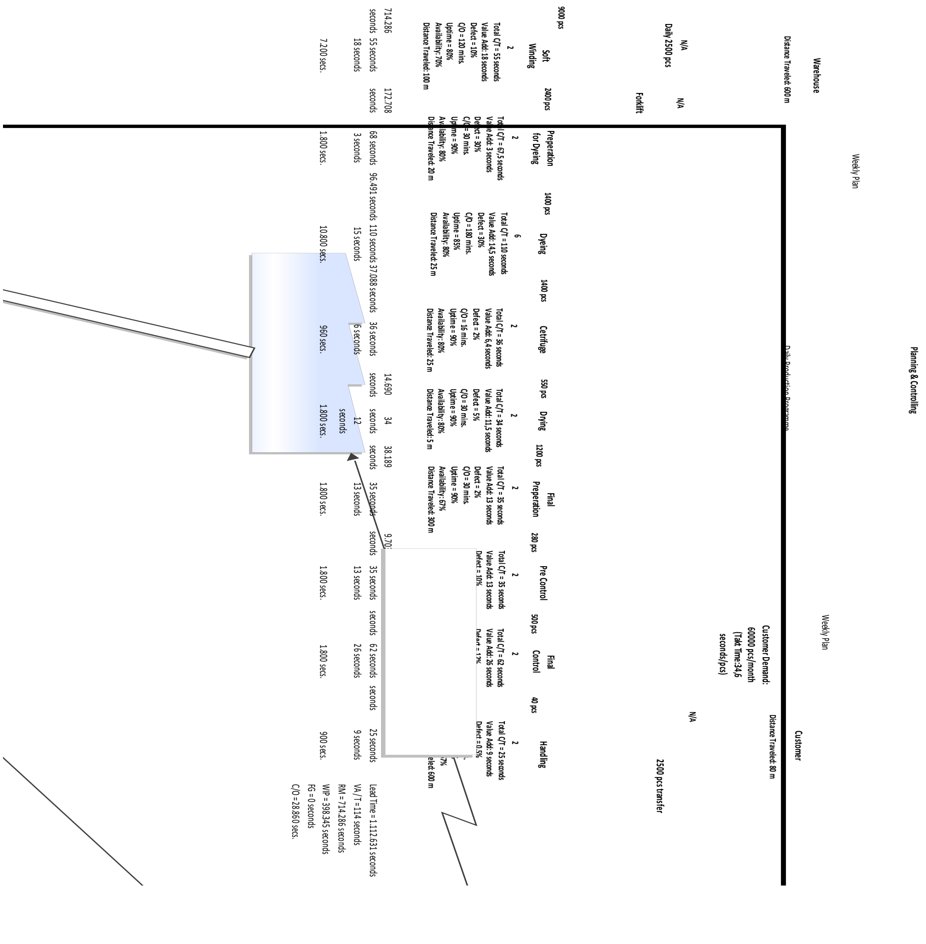
Matt, D., Krausea, D., & Raucha, R. (2013). Adaptation Of The Value Stream Optimization Approach To Collaborative Company Networks In The Construction Industry. Procedia CIRP, 402-407.

Musat, D., & Rodriguez, P. (2010). Value Stream Mapping Integration In Software Product Lines. Proceedings of the 11th International Conference on Product Focused Software, 110-111.

Nash, M. A., & Poling, S. R. (2008). Mapping the total value stream : a comprehensive guide for production and transactional processes. New York: Productivity Press.

Özkan, K., Birgün, S., & Kılıçoğulları, P. (2005). Müşteriden Tedarikçiye Değer Yaratma: Otomotiv Endüstrisinde Değer Akış Haritalandırma Uygulaması. İstanbul Ticaret Üniversitesi 5. Ulusal Üretim Araştırmaları Sempozyumu , 307-312.
Özveri , O., & Güçlü, P. (2015). Değer Akış Haritalamada Analitik Hiyerarşi Süreci (AHP) Uygulanması. Uluslararası Alanya İşletme Fakültesi Dergisi, 1-12.
Rampersad, H. K., & El Homsi, A. (2007). Tps-Lean Six Sigma: Linking Human Capital to Lean Six Sigma - A New Blueprint for Creating High Performance Companies. North Carolina: Information Age Publishing Inc.
Romero, L. F., & Arce, A. (2017). Applying Value Stream Mapping in Manufacturing: A Systematic Literature Review . Science Direct, 1075-1086.
Rother, M., & Harris, R. (2001). Sürekli Akış Yaratmak. Brookline: The Lean Enterprise Institute.
Rother, M., & Shook, J. (1999). Görmeyi Öğrenmek. Brookline: The Lean Enterprise Institute.
Shook, J., Marchwinski, C., & Schroeder, A. (2011). Yalın Kavramlar Sözlüğü. İstanbul: Optimist Yayınları.
Stadnicka, D., & Litwin, P. (2017). Value Stream And System Dynamics Analysis – An Automotive Case Study. Procedia, 363 – 368 .
Sullivan, W. G., McDonald, T. N., & Van Aken, E. M. (2002). Equipment replacement decisions and lean manufacturing. Robotics and Computer Integrated Manufacturing, 255-265.
Villarreal, B., Reyes, G. J., & Kumar, V. (2017). Improving Road Transport Operations Through Lean Thinking: A Case Study. International Journal of Production Research, 163-180.
Womack, J. P., & Jones, D. T. (2003). yalın düşünce. İstanbul: Optimist.

Appendix 1 Current State Map



Appendix -2 Future State Map