Available online at www.iujtl.com

JTL
Journal of Transportation and Logistics

İSTANBUL UNIVERSITY PRESS

DOI: 10.26650/JTL.2022.1088652

RESEARCH ARTICLE

Improving the Packaging Process of a Textile Company with Lean Production, Time Study and REBA Analysis

Dilara Muhacır[1], Muhammed İdris Aktaş[2], Eren Özceylan[3]

ABSTRACT

Today, companies have to use their resources in the most effective and efficient way in order to effectively meet the increasing competition and changing demands of the customers. Among prominent methods, especially in production, are lean manufacturing techniques, time studies, and ergonomic assessments, alongside being frequently encountered methods. Within the scope of this study, value stream mapping (VSM), time study, and Rapid Entire Body Assessment (REBA) methods were used in order to reach the desired daily shipment amounts using the resources efficiently in the packaging area of the Boyar Kimya textile company, Gaziantep. Firstly, the standard time of the operations was determined by the time study method. The time study method was carried out with the ProTimeEstimation program. Afterwards, the most produced product was selected, the value-adding (VA) and non- value-adding (NVA) operations in the packaging department were determined in detail, and the future state map was created by finding methods to reduce or eliminate NVA operations. The ergonomic evaluation of the working performance of the operators in the packaging department was made with the REBA method. As a result of each method, it has been observed that with the proposed improvements the daily shipment increased dramatically, and the risk levels of the operators decreased.

Keywords: Packaging process, yarn bobbin, time study, value stream mapping, REBA

Submitted: 16.03.2022 • **Revision Requested:** 12.05.2022 • **Last Revision Received:** 07.07.2022 • **Accepted:** 07.07.2022

[1] Dilara Muhacır, Boyar Kimya San. ve Tic. A. Ş. Gaziantep, Turkiye. E-mail: dilara.muhacir@boyar.com.tr ORCID: 0000-0003-4923-4652

[2] Muhammed İdris Aktaş, Boyar Kimya San. ve Tic. A. Ş. Gaziantep, Turkiye. E-mail: idris.aktas@boyar.com.tr ORCID: 0000-0002-7141-7984

[3] **Corresponding author:** Eren Özceylan (Doç.Dr.), Gaziantep University, Industrial Engineering Department, Gaziantep, Turkiye. E-mail: erenozceylan@gmail.com ORCID: 0000-0002-5213-6335

Citation: Muhacir, D., Aktas, M.I., & Ozceylan, E.. (2022). Improving the packaging process of a textile company with lean production, time study and REBA analysis. *Journal of Transportation and Logistics, 7*(2), 499-521. https://doi.org/10.26650/JTL.2022.1088652

1. Introduction

The textile industry is one of the sectors with the highest market share in the world and also in Turkey. The Turkish textile industry is a driving sector for the country in terms of providing added value, bringing foreign exchange to the country via textile exports, and creating a large labor- intensive workforce for the country (Gunduz et al. 2018). According to a 2018 survey provided by Istanbul Textile and Apparel Exporters Association,textile and related raw material exports represented 6.3% (10,509.682 USD) of total exports to Turkey. Due to its contribution to the national economy, Turkey must promote the textile industry in order to maintain high levels of production (Tokel et al. 2022).

As can be understood from the importance of textile industry, there is competition among textile companies. It is very important to use resources efficiently and in a planned way, especially in production areas, and to take steps to minimize costs. Today, companies realize the factors they want to achieve in order to ensure customer satisfaction and to prevail in the competition by using scientific materials and methods (Hodge et al. 2011). The main purpose of most applied scientific materials and methods is to increase the efficiency of resource use, to minimize waste, to increase efficiency and effectiveness, and to ensure customer satisfaction as the ultimate goal (Birgun et al. 2006). When the materials and methods used as solutions to the problems mentioned in the literature are investigated, it is understood that the most frequently used methods are lean production techniques. Lean production is a philosophy and way of thinking that aims to define and eliminate processes without added value and the kinds of activities that cause customer dissatisfaction and to minimize all kinds of wastes such as stock, excessive labor, error. Moreover, lean production requires being sensitive to customer needs and meeting the requirements at the right time by eliminating waste (Bhamu and Sangwan, 2014).

When considering lean manufacturing techniques, Value Stream Mapping is a technique commonly used to document, analyze and improve the flow of information or materials required to produce a product or service for a customer. The Value stream mapping process allows you to create a detailed visualization of all steps in your work process. It is a representation of the flow of goods from the supplier to the customer throughout your organization. A value stream map displays all the important steps of your work process necessary to deliver value from start to finish. It allows you to visualize every task that your team works on and provides single-glance status reports about each assignment's progress. The primary purpose of creating a value stream map is to show you where you can improve your process by visualizing both its value-adding and wasteful steps (Seth and Gupta, 2005).

Another method is the time study, which is very important for finding the standard time of the operations occurring in production and evaluating their performance. From the past to the present, standardization of the work done in any field and in the best way is a very important element in terms of efficiency. The main purpose of the work study is to measure the work done and, accordingly, to define the time required for the work to be done by evaluating the employee and the environment, the machine and many similar situations. Time study studies also require intensive use of techniques such as

performance evaluation in order to determine the working speed and establish a correlation between the working speed and the standard working tempo. In order to reach the standard performance levels, it is possible to reach the employees by using break periods at the appropriate working tempo. The standard time of the work to be done is the sum of the standard times required for all the components of the work to be performed after the additional break times are allowed, taking into account the repetition frequencies of the components. (Lukodono and Ulfa, 2017).

While companies aim to use their resources in the most effective way, they should pay attention to the use of labor, which is the most important resource. There are many studies such as Korkmaz et al. (2020) and Gajšek et al. (2021) in the literature that the operators performing the operations are affected by the physical weight of the work and that it affects productivity considerably. One of the risk assessment methods is The Rapid Entire Body Assessment (REBA). This method by Hignett and McAtemney analyzes peoples' postures while doing a job by giving numerical outputs. In the REBA method, a risk score is obtained by assigning numerical values for the risk, dynamic and fixed whole body movements caused by the work intensity that people are exposed to. This method provides a solution for musculoskeletal system disorders that occur in employees (Kee, 2021).

This study considers the Boyar Kimya Inc. textile company, which produces and dyes yarn in Gaziantep, because the company could not reach the daily shipment amount demanded in the packaging department. The main purpose is to determine the efficiency of the existing resources and carry out improvement activities.

Time study and VSM, which is a lean manufacturing technique, was used to evaluate the operations and resource use in the packaging area, taking into account the efficiency, effectiveness and productivity factors. Then, the Rapid Entire Body Assesment (REBA), which ergonomically considers the whole human body as one of the foundations of production resources, was applied. It is important in terms of the lack of studies in the field of packaging within the scope of the literature research and the comprehensive evaluation and presentation of the proposed improvements by using three different methods together. While the general content of the study consists of the mentioned scientific methods, the second part of the study consists of literature research.

The above tools have been enumerated in detail in the literature review in Section 2. The company and packaging process background are explained in Section 3 to understand the process clearly. The applications of VSM, time study and REBA and the findings are given in Section 4. The future scope of the study is also given as pointers for further research in Section 5.

2. Literature Review

In this section, a literature review on REBA, time study, and VSM methodologies is briefly given. Although these methodologies have a wide range of applications, mostly studies on logistics and packaging are reviewed in this section. Accordingly, some studies identified in the literature are given in Table 1 that focus on the applied methodologies and studied problems.

Table 1: Literature review on time study, VSM and REBA

Author(s)	Methodology	Key Words	Problem and Aim
Hignett and McAtamney (2000)	REBA	Postural analysis, manual handling, physical work load, hospital ergonomics.	This study includes ergonomic evaluations of nurses' working conditions. The aim of the study is to determine the risk status of the unpredictable working situation of the health workers.
Gören (2017)	VSM, simulation.	Value stream mapping, simulation, furniture industry, lean manufacturing.	An industrial application has been made in the furniture sector, where waste is high, by using value mapping and simulation techniques, which are lean manufacturing techniques.
Sevimli et al. (2018)	REBA, BAUA	Ergonomics, working conditions, ergonomic risk analysis, REBA, BAUA (Federal Institute for Occupational Safety and Health) .	The ergonomic risk assessment of the operators working in the packaging unit of a paddy factory is made with two different methods, REBA and BAUA, and evaluations are made according to the results obtained.
Tekin et al. (2018)	VSM	Value stream mapping, future state map, and product family.	The results obtained with the method aiming to prevent waste and reduce the amount of stock in a large enterprise with value stream mapping are evaluated in flour factory.
Emir et al. (2019)	REBA	Musculoskeletal System Disorder, Ergonomics, Simulation, NIOSH Lifting Equation AnyBody Modelling System	The ergonomic risk assessment is created by modeling the working environment in Solidworks. As a result of these analyses, considering that these working conditions harm employee posture and pose a risk of occupational diseases in the future, a robotic arm has been proposed to eliminate these difficulties.
Başak et al. (2019)	VSM	Lean manufacturing, kanban, VSM, Sinlge minutes exchange of dies, Genchi gembutsu.	The study aims to design the kanban system, which is a lean tool used to achieve Just-in-Time production in order to identify the problems with the value stream mapping to be made in the company process and transportation and then to cope with the problems with the data obtained.
Gutiérrez et al. (2020)	REBA	Musculoskeletal disorders, safety and health, biomechanics, physical load.	Worldwide studies of REBA ergonomic risk assessment are analyzed statistically and the most used areas and the evaluation of REBA risk scores in these areas are made. In the studies conducted in the field of textiles, it has been observed that the REBA risk level is above 11 points.
Uslu Divanoğlu et al. (2021)	Time study, 5S, Kaizen	Waste, productivity, lean production, 5S	Within the scope of this study, 5s and Kazien, one of the lean manufacturing techniques, were applied in the assembly unit of an automotive company and the process was analyzed with a time study within the scope of the study.
Doğan and Kama (2021)	VSM	Value stream mapping, Supply chain management, Lean manufacturing	This study aimed to reduce the non-value-added activities of operations that occur in the supply chain process of an enterprise with VSM, one of the lean manufacturing techniques.

Table 1: Continue

Author(s)	Methodology	Key Words	Problem and Aim
Kong et al. (2022)	REBA, RULA, OWAS	musculoskeletal disorders; observational technique; OWAS (Ovako Working Posture Analysis System); RULA (Rapid Upper Limb Assessment); REBA	In this study, the ergonomic evaluation of employees was evaluated based on three ergonomic techniques. As a result of the comparison of the three techniques at the end of the study, it was seen that RULA was the most frequently used method. While preparing this study, the authors scanned nearly 190 articles and studies on REBA, OWAS, and RULA.
This paper	Time study, VSM and REBA	Packaging process, yarn bobbin, time study, value stream mapping, REBA.	The evaluation of resources in the packaging area of a yarn manufacturing factory, efficiency analyzes and improvements with the idea of lean production are made using a time study, VSM and REBA. It is observed that the daily shipment amount increased, and the ergonomic risk level decreased in the packaging unit with the observations and the data obtained.

Based on the literature given above, no study is observed in which all three methods namely VSM, time study and REBA are applied to the packaging problem in the textile sector.

3. Case Study

In this section, information is given about the factory and the problem that occurred in the packaging process. Subsequently, the time study, which is applied to find a solution to the problem in the packaging process, is explained together with VSM and REBA applications.

3.1. Description of the Company

This study was carried out in a textile company that has a production center in the second organized industrial zone of Gaziantep and a central office in Istanbul. The company is a well-established company with half a century of production experience and has a market share as a yarn producer in the textile sector. In addition to yarn production, it also colors the yarn with five different dyeing types. The company consists of three departments. One of the departments is dyeing. The second department is synthetic yarn production. These synthetic yarns are mostly acrylic based products. The last part of the company is the fancy department where different forms are given to the yarn. This textile company has different types of yarns. These qualities are mostly acrylic, polyamide, polyester, viscose, cotton, wool and a combined mixture of all of these yarns.

3.2. Description of the Problem

The products brought to the packaging department of the textile company, which are fed from three different departments, pass through two bagging machines in this unit, pass the processes given below, and are sent to the finished warehouse to be shipped, or direct loading takes place gradually without waiting. In Table 2 below, monthly production amounts are given if the machines of three different parts of the factory are working 100%.

The daily working capacity amounts of the shipping unit for these products are drawn over the ERP (Enterprise resource planning) and tabulated. Table 3 below shows the monthly shipment rates of the last year.

Table 2: Capacity information

Dyeing	Industrial Yarns	Fancy Yarn
450 tons/month	550 tons/month	60 tons/month

Table 3: Monthly shipment amounts (kg)

Shipment start date	Shipment end date	Gross amount	Amount	Packing quantity	Gross Weight of a Sack	Net Weight of a Sack	Number of Days Worked in a Month	Average Daily Net Shipment Amount
1.01.2021	30.01.2021	375,412.65	358,243.85	9,762	38.457	36.698	26	13,778.6
1.02.2021	28.02.2021	417,582.50	397,028.10	14,159	29,492	28.041	26	15,270.3
1.03.2021	30.03.2021	492,854.25	468,325.25	17,018	28,961	27.519	30	15,610.8
1.04.2021	30.04.2021	410,774.60	389,812.65	14,916	27,539	26.134	26	14,992.8
1.05.2021	31.05.2021	383,343.10	363,069.15	13,871	27,636	26.175	26	13,964.2
1.06.2021	30.06.2021	527,910.80	500,605.10	18,497	28,540	27.064	28	17,878.8
1.07.2021	31.07.2021	345,271.35	327,901.10	12,330	28,003	26.594	26	12,611.6
1.08.2021	30.08.2021	390,114.45	370,840.45	13,381	29,154	27.714	26	14,263.1
1.09.2021	30.09.2021	466,389.30	443,754.60	17,539	26,592	25.301	26	17,067.5
1.10.2021	31.10.2021	361,321.50	343,790.44	12,915	27,977	26.619	26	13,222.7
1.11.2021	30.11.2021	401,898.30	381,551.40	15,303	26,263	24.933	26	14,675.1
1.12.2021	5.10.2892	362,601.70	345,366.70	13,234	27,399	26.097	26	13,283.3
Total		411,289.54	390,857.40		28,834	27.407		14,718.2

Another problem is the number of operators working in the shipping department. This number is 17 people in total. The fact that the number is so high and the desired level of shipment or packaging cannot be reached in the packaging/shipping department is another important point that bothers the business managers. Related to this, another factor is the physical intensity that the operators working in the packaging/shipping department are exposed to depending on the way the work is done. In the following illustration (Figure 1), a sketch of the operators' working areas and the packing/shipping department is given.

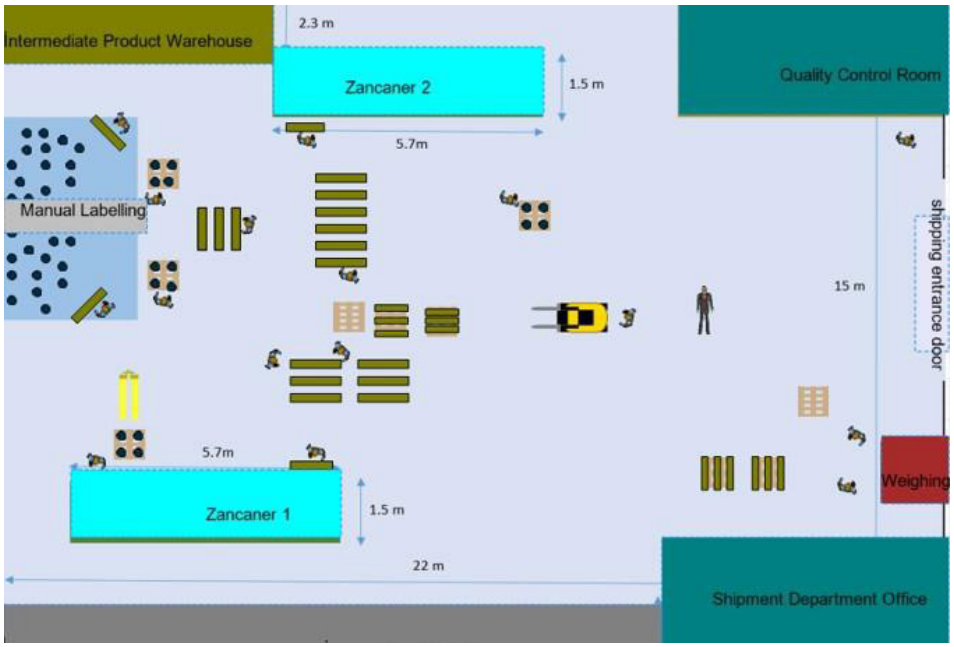

Figure 1. Packing/ shipping department layout

As can be understood from Figure 1, the shipping department cannot meet the incoming production amount at the desired level and creates a bottleneck. With the request of the company officials to improve the situation, first of all, the system was analyzed in detail, the inputs and outputs of the system were monitored in the process, a road map was created and improvement studies were carried out.

3.3. The Goal of the Study

In this study, the improvement of the packaging department in the production area of a textile company that sells yarn to the domestic and foreign markets was carried out. In this way, a series of studies were carried out that will cause the company to reach the requested amount of shipment. At the same time, one of the most important aims of this paper is to evaluate the work of the operators working in the packaging department within the framework of occupational health and safety, to minimize risky posture and to evaluate alternative results.

4. Application

In this section, the applications of the time study, VSM and REBA are provided, respectively.

4.1. Time Study

Firstly, the card containing the information of the product to be packed was sent to the packaging unit, then the labels that are required to be adhered to each coil were removed from the system at the request of the customer, and the operators brought the coils in pallets by the forklift to pack the product. Pallets with coils mostly consist of 240 coils. This situation differs according to the quality and rate ordered by the customer. While the forklift was bringing the product to the area, there was no problem due to delays, waiting or the narrow area. For this reason, the working area includes the process from the moment the difference lift leaves the product to the machine for processing until it is ready for shipment. In the flow diagrams given below, the processes that the product sees in the packaging area are given in order.

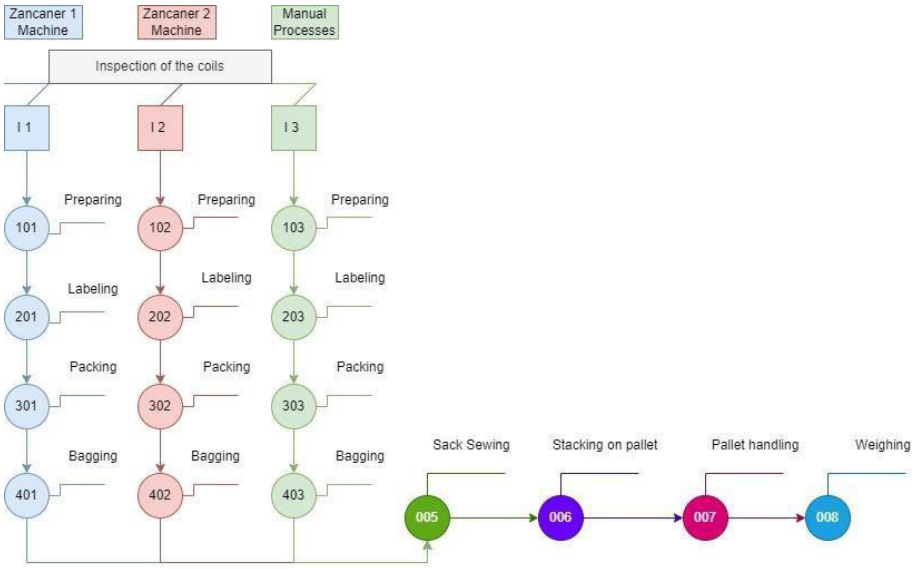

Figure 2. Operation flow chart of packaging/shipment department

As can be understood from the Figure 2, the incoming products were packed either on the machine or manually. The machines were manufactured by the Italian company Zancaner. The operations of the two are the same, but it has been understood as a result of the studies that they are different from each other, even if their speeds are on the basis of seconds. While doing the labeling process, the operator also makes inspections of the products. The reason for this is that if there is an unnoticed error in the yarn bobbin from the manufacturer, it is necessary to find these and inform the necessary units before the product is sent to the customer. What they are examining is further detailed by the color of the product. For example, the risk of volufil burn in the color we call white or optic is higher than other colors, and in this case, when the coil is labeled, it is rotated once and then the label is pasted and the next process is started. The features that operators look for during labeling are given in Table 4 below.

Table 4: Quality-control requriments

Quality-Control elements evaluated at the last stage	**Reasons**	**What is the measurement with?**
Moisture	Moisture content in cotton or mixed blend 60-70 Acrylic varieties 30-40-50	It is measured with a humidity device
Dirt-dust-stain etc elements	Flies, dust and dirt generated during the transport of the bobbins results in oil or dirt contamination of the machines.	By operator
Abrasion	It is known that the uneven distribution of the paint is basically caused by the technical and methodological problems that occur in the paint shop unit where the painting process was carried out.	By operators
Damaged status of volufil products	The heat value and the waiting time of the volufil machine according to the quality are not at the desired value and burning / yellowing / redness occurs in the coil.	By operator
Hard twists\ hard wraps	The tension or twist numbers of the products with volufil output are not at the desired level according to the quality or yarn count in the twisting machine.	By operator
Swelling states of volufil products	Inability to set the desired swelling level of the yarn in the volufil machine at the desired level while setting the machine.	By operators
Thinness-thickness	Occurrence of fineness-thickness errors due to weight or different errors in the processes to be processed after preparation, ring machine.	By operator

After labeling, packing and bagging processes are carried out by machine or manually, the products coming from these places are first planted, then stacked, transported to the weighing area and finally weighed and ready to be shipped. Apart from these processes, there are some jobs that the operators do from time to time, depending on the density. These transactions and their processing times are shown in Table 5 below.

Table 5: Other processes of packaging/shipment department

Other actions by operators	**Observed Time**
Curling the sack for filling	20 sn
Cutting sewing threads	300 sn
Transport of the finished pallet	7 sn

4.1.1. Time Study Tables of Each Process

Preparation Process: The first operation starts with the preparation process, which starts after 240 bobbins are brought by forklift. This process ends when the operator opens the gelatin on the coil. The time study table of the preparation process is presented in Table 6.

Table 6: Time study result of preparation process

Preparation (20 coils/sack)																
Kind of Value	Processes*	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
SVA	P1	4.16	4.16	4.16	95	95	95	3.95	3.95	3.95	1	1	1	3.99	3.99	3.99

* P1: Picking up gelatin from the coils on the pallet; *SVA: Semi value added; *VA: Value added; *NVA: Non value added; *PFD Factor: Allowance for personal time, fatigue, delay)

Labelling Process: It is the process of attaching the label with the name of the company, which is affixed to the cone of each coil at the request of the operator and the customer. Time study table (Table 7) of labelling process below.

Table 7: Time study result of labelling process

Labelling (20 coils/sack)																
Kind of Value	Processes*		Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)	
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
VA	P1	47.25	47.25	53.25	100	100	100	47.25	47.25	53.25	10	10	10	53	53	59.17
NVA	P2	15.75	15.75	17.75	100	100	100	15.75	15.75	17.25	10	10	10	17.5	17.5	19.72

*P1: Picking up and labelling the coil, P2: Dropping the coil into the machine

Packing Process: Each coil is gelatinized in the process. The time study result of packing process is presented in Table 8.

Table 8: Time study result of packing process

Packing (20 coils/sack)																
Kind of Value	Processes	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
VA	Packing	66	80	140	100	95	80	66	76	112	8	8	8	66	76	122.2

Bagging Process: It includes the process of placing and sorting each 20 gelatinized coils in a sack. Time study result of bagging process is presented in Table 9.

Table 9: Time study result of bagging process

Bagging (20 coils/sack)																
Kind of Value	Processes*	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
NVA	P1	0.33	0.33	0.35	100	100	100	0.33	0.33	0.35	12	12	12	0.38	0.38	0.4
NVA	P2	0.82	0.82	0.85	100	100	100	0.82	0.82	0.85	12	12	12	0.93	0.93	0.97
NVA	P3	0.93	0.93	0.97	100	100	100	0.93	0.93	0.97	12	12	12	1.06	1.06	1.1
VA	P4	76.92	76.92	80.83	100	100	100	76.92	76.92	80.83	12	12	12	87.41	87.41	91.85

*P1: Walking, P2: Sorting the sack, P3: Preparing the sack, P4: Arranging the coils in the sack

Sack Sewing Process: It is the process of sewing each sack one by one. There are two operators in total that perform this operation. According to the observed data, the prepared time study result is presented in Table 10.

Table 10: Time study result of sack sewing process

Sack Sewing (20 coils/sack)																
Kind of Value	Processes	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
SVA	Sack sewing	30	30	30	100	100	100	30	30	30	4	4	4	31.25	31.25	31.25

Stacking on Pallet Process: It is the process of placing each bag with its mouth sewn, 15 sacks on the pallet. This process' time study result in Table 11.

Table 11: Time study result of stacking on the pallet process

Stacking on Pallet (20 coils/sack)																
Kind of Value	Processes	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
NVA	Stacking on pallet	14	14	14	95	95	95	13.3	13.3	13.3	10	10	10	15.18	15.18	15.18

Pallet Handling Process: It is the process of transporting the sacks on the stacked pallet to the weighing area. The below table (Table 12) gives the results of the pallet handling process.

Table 12: Time study result of the pallet handling process

Pallet Handling (20 coils/sack)																
Kind of Value	Processes	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M	Z1	Z2	M
NVA	Pallet handling	3.13	3.13	3.13	95	95	95	3	3	3	10	10	10	3.29	3.29	3.29

Weighing Process: It is the process of weighing the sacks on the pallet brought to the weighing area and attaching the label containing the weight information of the product. There are two fixed operators that do the work. The related table (Table 13) gives the time study result of the process.

Table 13: Time study result of the weighing process

Weighing (20 coils/sack)																
Kind of Value	Processes*	Observed Time (sn)			Tempo (Rate)			Normal Time (sn)			PFD Factor			Standart Time (sn)		
		Z1	Z2	MZ	Z1	Z2	MZ	Z1	Z2	MZ	Z1	Z2	MZ	Z1	Z2	MZ
NVA	P1	2.75	2.75	2.75	95	95	95	2.61	2.61	2.61	10	10	10	3.3	3.3	3.3
NVA	P2	2.75	2.75	2.75	95	95	95	2.61	2.61	2.61	10	10	10	3.3	3.3	3.3
VA	P3	6.32	6.32	6.32	95	95	95	6.00	6.00	6.00	10	10	10	7.07	7.07	7.07
VA	P4	1.65	1.65	1.65	95	95	95	1.57	1.57	1.57	10	10	10	2.14	2.14	2.14
NVA	P5	2.53	2.53	2.53	95	95	95	2.40	2.40	2.40	10	10	10	3.07	3.07	3.07

*P1: Putting up the sack from the pallet, P2: Putting the sack on the scale, P3: Printing and labeling, P4: Weighing the sack, P5: Placing the sack on the pallet

4.2. Value Stream Mapping (VSM)

Value stream mapping is a lean manufacturing or lean enterprise technique used to document, analyze and improve the flow of information or materials required to produce a product or service for a customer (Behnam et al. 2018). The value stream mapping process allows organizations to create a detailed visualization of all steps in work processes. It is a representation of the flow of goods from the supplier to the customer throughout the organization (Rohac and Januska, 2015). In the following sub-sections, the application process of VSM in the company is described.

4.2.1. Selection of the Product Family

In addition to acrylic yarn production in the factory, as mentioned before, blends are made with products in different yarn or fiber forms in the production system. According to the data obtained from ERP, one of the institutional resource planning programs used by the factory among the units, the product with the most sales, that is, the most sold product, is selected, and Value Stream Mapping of this product is made in the packaging department.

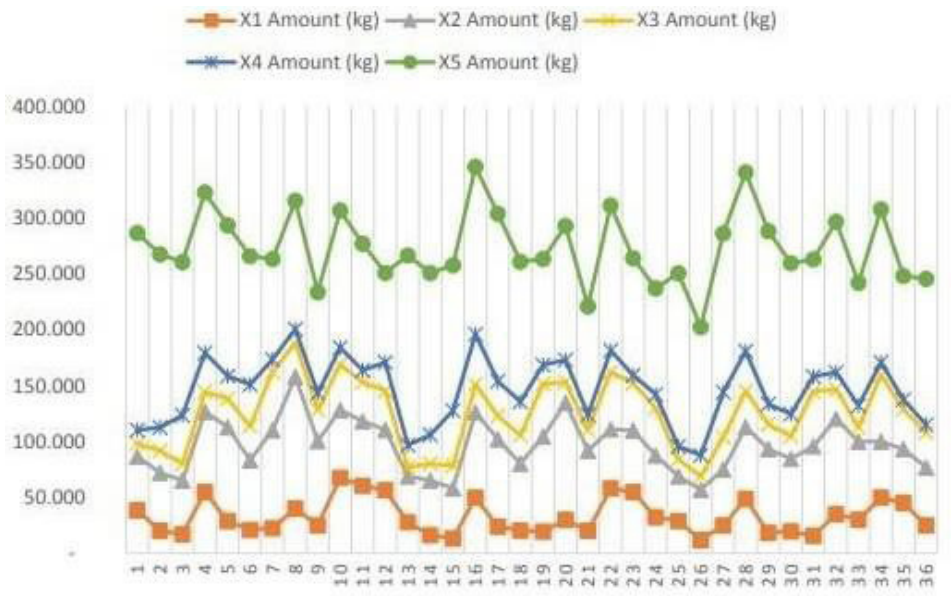

Figure 3. Top five products of the company

The graphic (Figure 3) above shows the top five different quality products that the factory sells. Value stream mapping will be done for product X1, which is in the first place. The processes that the X1 product sees in the factory before it arrives at the shipping department are as follows in Figure 4:

The flow chart (Figure 5) of the X1 product's textile production processes in the Boyar Kimya Factory.

The flow chart (Figure 6) given below briefly shows the route of the product in the factory.

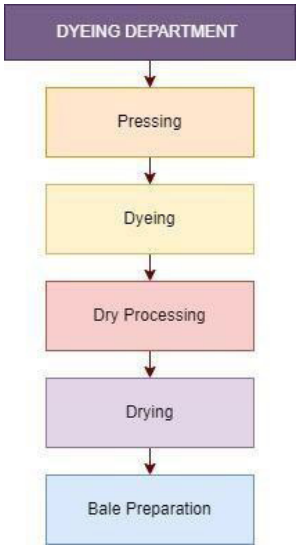

Figure 4. Processes of dyeing department

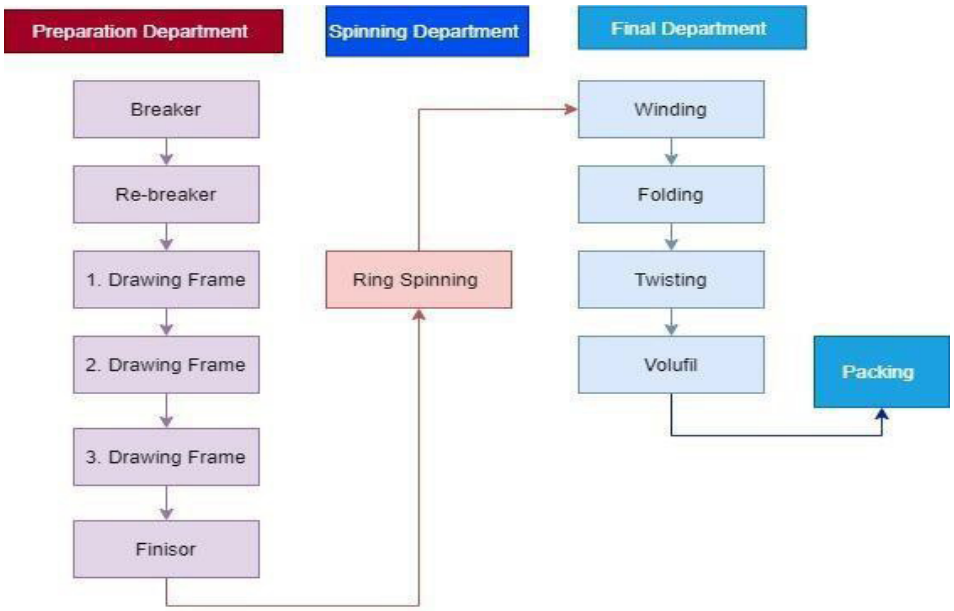

Figure 5. Production processes of the company

4.2.2. Current State

While creating the value stream mapping of the current situation, the cycle time values are determined by taking information from time study calculations. The values required for overall equipment efficiency (OEE) calculations are obtained as a result of multiple observations made in the field (Birgun et al. 2006). The next step is made with kaizens to eliminate waste, such as waiting and transportation, in the current state map. In the current situation map (Figure 7) given below, kaizen work has been applied in four places in total, and all these evaluations and the future situation map have been drawn in line with the proposed improvements.

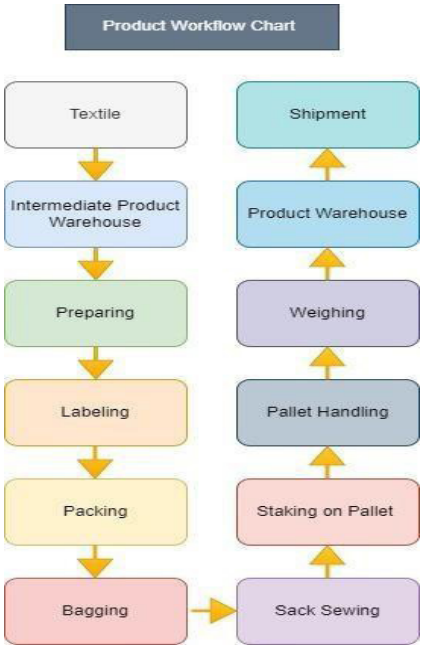

Figure 6. Product flow chart of packaging/shipment department

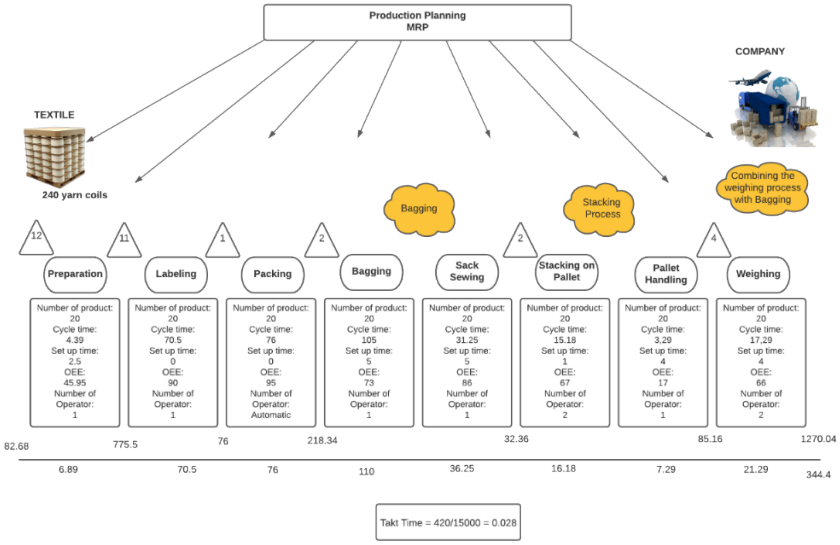

Figure 7. Value stream mapping of current state

4.2.3. Future State

Looking at the future state of VSM, some operations are eliminated while others are coming together. As a result of the evaluations made and the meetings held with the company managers, it was decided that the improvement activities would be evaluated by prioritizing their economy and applicability. The process that will occur with the purchase of the new packaging machine, which is one of the suggested improvements, has been schematized. With the newly purchased machine, weighing and bagging operations will be performed manually by the machine. At the same time, with the use of the conveyor system, which is another recommended improvement, the transportation operations will be carried out manually and there will be a decrease in both the number of operators and the total time.

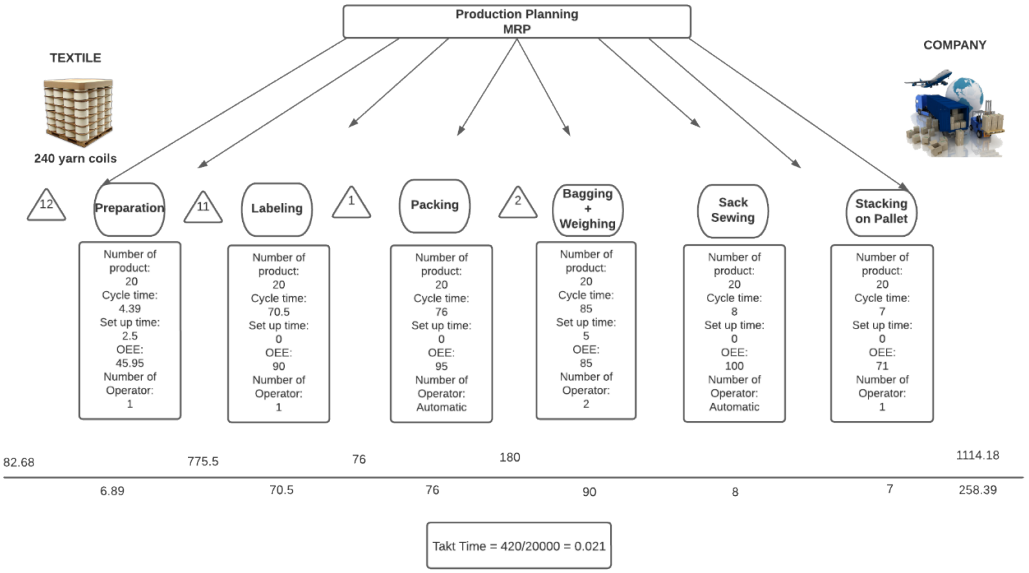

Figure 8. Value stream mapping of the future state

At the end of the VSM, there was a bottleneck in the bagging module. Also, in the weighing process, there were lots of unnecessary and NVA activities. By the VSM, two modules are coming together. With the value stream mapping technique, studies have been carried out to reduce or remove the bottleneck and non-value adding activities in the current situation. When the improvements made and their results are evaluated;

- The bagging process, which is defined as the bottleneck in the current situation map, is carried out in the same way as the weighing process and the module that can be integrated into the machine. In this way, the total cycle time has been reduced and the intermediate stock event has been eliminated.
- With the improvement proposed and implemented at the same stage, the pallet handling process between bagging and weighing has been eliminated. This resulted in a 7.29 second reduction in cycle time.
- With the new modules used, the automatic realization of the manual operations was ensured, and the number of operators was reduced to 5 with the improvements made in the operations in which 9 people worked in total.
- 20% reduction in cycle time and 25% reduction in Takt time was achieved with VSM.

4.3. REBA (Rapid Entire Body Assessment)

This method by Hignett and McAtemney (2000) analyzes the postures of people while doing a job by giving numerical outputs. In the REBA method, a risk score is obtained by assigning numerical values for the risk, dynamic and fixed whole body movements caused by the work intensity that people are exposed to. This method provides a solution for the musculoskeletal system disorders that occur in the employees (Esen and Fığlalı, 2013). First, limbs are separated as upper and lower parts in REBA, and then A & B tables are created (Hignett and McAtamney, 2000). The risk score of each limb is written as

determined. When the strain of the job on the implementer is evaluated angularly, if it is observed that there is compulsion, there are additional points accordingly. All determined score assignments are calculated based on body postures (Sevimli et al. 2018). In the study, the situations of operators working in five processes in total will be examined.

These processes are shown in Figure 9. Each process is also described in Figures 10 to 14, respectively.

Figure 9. REBA applied processes in the packaging department

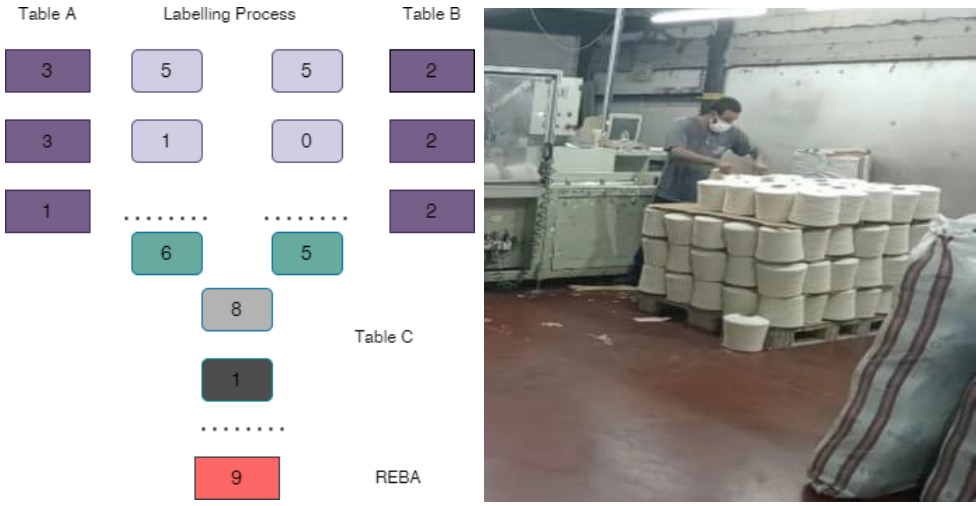

Figure 10. REBA result of labelling process

Figure 11. REBA result of bagging process

Figure 12. REBA result of sack sewing process

Figure 13. REBA result of carrying process

Figure 14. REBA result of weighing process

The scores obtained in Figures 10 to 14 above constitute the final stage of the REBA application. The ergonomic evaluation of the operator on the left of Figure 14 was made. The table in which the evaluation of the obtained scores will be made is as follows. Determining the degree of risk for the employees of the obtained scores is given as follows in Table 14:

Table 14: REBA action levels

REBA Levels	REBA Scores	Importance of REBA Result	Action Situation
0	1	Negligible	None necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very high	Necessary now

4.3.1. Results of REBA Application

As a result of this study, the risky process movements of the operators are determined and improved. Risky scores and actions levels of each process are determined in Table 15.

Table 15: REBA scores of all processes

Processes	REBA Score	REBA Action Levels
Labelling	11	Very high
Bagging	13	Very high
Sack Sawing	11	Very high
Carrying	12	Very high
Weighing	13	Very high

Considering other studies to eliminate postures or movements with high risks scores, one of the proposed improvements is the purchase of a machine with a bagging and weighing module. The REBA score evaluations before and after use of the new modules of the purchased machine made and the market evaluations of the machine in the improvement and optimization part of the paper are given in Figure 15.

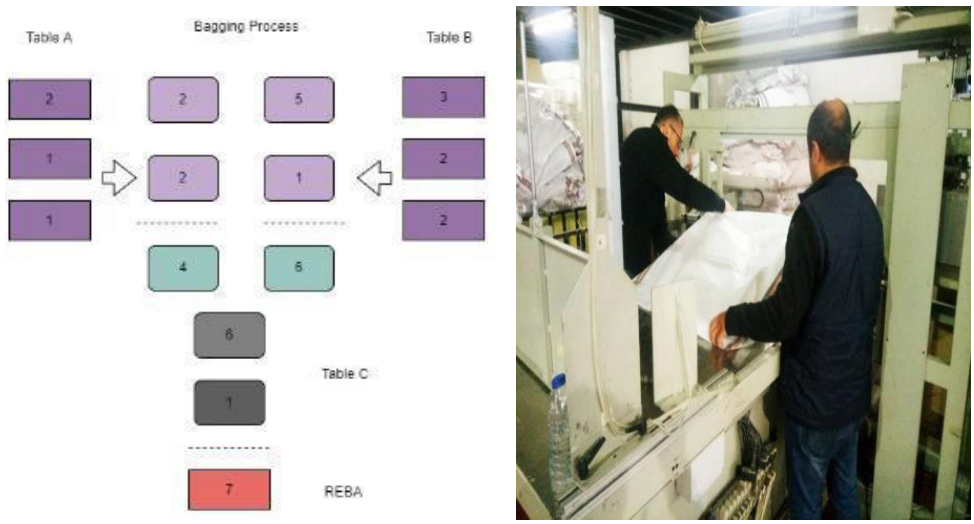

Figure 15. New REBA result of bagging process

Figure 16. New packaging machine in the bagging module

Table 16: Comparing result of REBA risk scores

Before using the bagging module	After using the bagging module
13 (Very High)	7 (Medium)

While Figure 16 represents the new process of the bagging module with the new purchased machine, a comparison of before and after the bagging process is given in Table 16.

As can be understood from the information given in Table 16 above, the REBA risk score obtained as a result of improvement is considerably less than the REBA risk sport obtained without improvement, which can be considered quite reasonable.

5. Results and Recommendations

As a result of the time study, each process time and the standard time of the work was determined. As a result of these determinations, it has been understood that some of the processes carried out are wasteful. It is suggested that instead of making unit-based improvements, the best recommendation to reduce the number of operators and to allow the operator to work in a semi-automated way without high risk as a result of the REBA score, is to purchase machines that are used in many factories.

At the beginning of the situations that make it necessary to buy a new machine, the operator must first feed for the labeling process. In the possible machines that can be examined, it is possible for the operator, who places the bobbins to the input chamber of the machine, to assign different tasks during the labeling and bagging processes that are carried out automatically by the machine. In this way, it has been understood that the number of two operators who only carry out the labeling and bagging operation and who are exposed to intense physical impact while doing this, can remain constant in only one operator, since they do jobs with less risk points.

Table 17: Comparing of two packaging machines

Metinoks Machine Parts	Unit Price (€)	Zancaner Machine Parts	Unit Price (€)	Differences of Price (€)
Jetstore	17,000.00	Rocstore	26,000.00	9,000.00
Packing	35,000.00	Rocpack	43,000.00	8,000.00
Labelling	5,500.00	Etkono	18,000.00	12,500.00
Jetbag	22,500.00	Rocbag/T	39,000.00	16,500.00
Sack Weighing Modüle	4,000.00	Automated weighing and labelling system for sacks	19,000.00	14,000.00
Sack Labelling	1,000.00			
Total	₺85,000.00		₺126,000.00	₺60,000.00

The price offers received from two popular companies and the unit prices and price differences of parts that can be assembled on a unit basis are given in Table 17.

Another suggestion is to have a unit-based integrated system for the two existing machines. Additionally, the use of a conveyor system where the flow will be provided for the transport operations, considering that the operator is physically exposed to heavy loads, can be an option. The operating speeds of the two machines in the current situation determined during the time study and the bottleneck parts are given in Table 18.

Considering Table 18, the speeds of the machines are not the same. The operators working on the two machines are also in a mixed working system and therefore should increase the speed of the Zancaner 2 reels bagging machine.

The high REBA scores indicate that the high bending ratio of the operators performing the bagging operation caused musculoskeletal disorders. The overview of the previous machine layout is illustrated in Figure 17. In order to minimize the risk, the height of the area where the packaged bobbins fall into the hopper for bagging should be raised to a level that does not prevent the serial flow of the bobbins and does not require any

Table 18: Speed of packing machine module

Machine Name	Time of Packing Process (sn)	Time of Bagging Process (sn)
Zancaner 1	66	79
Zancaner 2	80	79

extra energy. For manually ongoing labeling, pallets that go up as the weight decreases can be used.

As a result of the evaluations and market research, the Zancaner branded machine, which was within the structure of a closed factory, was purchased.

Suggestions were made to improve the operations in the packaging unit of a textile factory engaged in yarn production and dyeing. With these improvements, the shipment rates of the factory in the first five months of the year were examined, and the percentage of benefits are given in Table 19.

5. Conclusion

Within the scope of this study, the process in the packaging department of a textile company, which is a yarn manufacturer, was analyzed in detail. Lean production techniques were applied and improvements were made. The study was necessary because the resources used in the packaging department do not meet the desired packaging/shipping amount and the labor force is excessive and harmful to operators. A time study was the first method used to analyze the process in detail. The processes that took place first with the time study were determined respectively, and the standard time was determined for each process. This study was carried out with video recording with the ProTimeEstimation program. After determining the standard time of the processes, the cycle time and OEE calculations in the packaging department of a quality with the highest production were made with the Value stream mapping method, and the factors that did not add value were determined. Future state mapping, which is the last step of the value stream mapping method, was created to eliminate activities that did not add value. With the last method, REBA, the body postures of 17 operators working in the packaging department while creating certain processes were evaluated ergonomically and a risk score was created.

Alternatives and improvements were proposed to the determined processes, thanks to the data obtained from the three methods used. First, all processes were determined by the time study method, and each process was evaluated in terms of standard time and value, and it was used as a source for determining cycle times in value stream mapping. In both of these methods, it is suggested to use the conveyor system between the units as a solution to minimize the transportation process with the analysis of the process. With the use of the conveyor system, the operators who perform that operation will be able to perform operations that add other value, and the transportation time will be reduced, leaving its place to an autonomous process. Another suggestion is that the speeds of the two machines in the packaging unit can be adjusted according to the higher one, so that the bottleneck will be eliminated. The REBA risk score of the bagging process was 13, which is very risky. This problem is to raise the bagging module chamber to a level that minimizes the bending of the

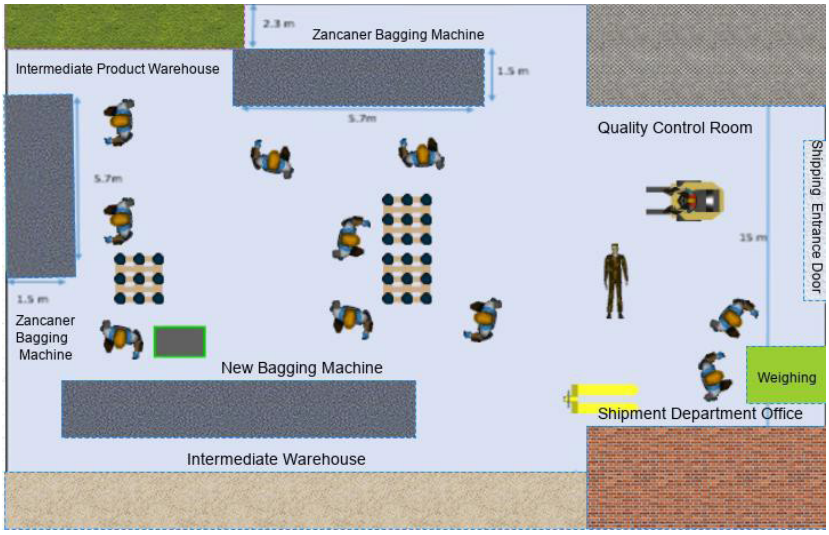

Figure 17. Overview of the old machine layout

Table 19: Comparing of shipment amounts between 2021 and 2022 years.

Shipment Amounts Of 2021			Amount	Shipment start date	Shipment Amounts Of 2022		Amount	Rate of Improvement (%)
Shipment start date	Shipment end date	Gross amount			Shipment end date	Gross amount		
1.01.2021	30.01.2021	375.412,65	358.243,85	1.01.2022	31.01.2022	450.774,60	425.812,65	18
1.02.2021	28.02.2021	417.582,50	397.028,10	1.02.2022	28.02.2022	583.102,00	490.069,15	23
1.03.2021	30.03.2021	492.854,25	468.325,25	1.03.2022	31.03.2022	590.895,70	567.605,10	21
1.04.2021	30.04.2021	410.774,60	389.812,65	1.04.2022	30.04.2022	545.271,35	451.901,10	15
1.05.2021	31.05.2021	383.343,10	363.069,15	1.05.2022	24.05.2022	490.114,45	478.840,45	31
Average Amounts		415.993,42	395.295,80	Average Amounts		532.031,62	463.445,69	17

operator. Another suggestion is that a pallet that goes up as the weight decreases can be used for the labeling process that continues manually. As a last suggestion, a machine with labeling, bagging, weighing modules and automation should be bought. In order to obtain this, price researches were made in the market and a new machine was purchased as a result of price-performance evaluations.

A new packaging machine, which can be described as the most impressive of the improvements proposed in this study, was purchased used with the assembly of its modules. The existing layout was redesigned with the purchase of the new machine, considering the efficient use of the area and the ease of movement of transport vehicles such as forklifts and pallet trucks. The implementation of other proposed improvements can be implemented in the future by continuous analysis of the current situation and the evaluation of changing conditions.

Peer Review: Externally peer-reviewed.
Conflict of Interest: Authors declared no conflict of interest.
Financial Disclosure: Authors declared no financial support
Author Contributions: Conception/Design of Study- E.Ö., D.M.; Data Acquisition- D.M., M.İ.A.; Data Analysis/Interpretation- M.İ.A., D.M.; Drafting Manuscript- D.M., E.Ö.; Critical Revision of Manuscript- E.Ö., D.M., M.İ.A.; Final Approval and Accountability- E.Ö., D.M., M.İ.A.

References

Başak, E.E., Yılmaz, I.S., Deniz, N. (2019). A lean manufacturing implementation in an industrial product manufacturer. Journal of Industrial Engineering, 30 (3), 157–172.

Behnam, D., Ayough, A., Mirghaderi, S.H. (2018). Value stream mapping approach and analytical network process to identify and prioritize production system's Mudas (case study: natural fibre clothing manufacturing company). Journal of the Textile Institute, 109 (1), 64–72.

Bhamu, J., Sangwan, K. (2014). Lean manufacturing: Literature review and research issues.

International Journal of Operations & Production Management, 34, 876–940.

Birgün, S., Gülen, K.G., Özkan, K. (2006). Yalın üretime geçiş sürecinde değer akişi haritalama tekniğinin kullanilmasi: imalat sektöründe bir uygulama. İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi, 5 (9), 47–59.

Dogan, N.O., Kama, A. (2021). Eliminating non-value-added activities in supply chain: A value stream mapping case study in the manufacturing sector. Niğde Ömer Halisdemir University Journal of Engineering Sciences, 10 (1): 91–99.

Emir, S., Akyildiz, M., Eker, C., Tufekci, S., Derici, M., Ocaktan, D. (2019). Ergonomıc risk analysis of employees working in the packaging department. Ergonomics, 2 (2), 126–130.

Esen, H., Fığlalı, N. (2013). Çalışma duruşu analiz yöntemleri ve çalışma duruşunun kas- iskelet sistemi rahatsızlıklarına etkileri. Sakarya Üniversitesi Fen Bilimleri Dergisi, 17 (1), 41–51.

Gajšek, B., Šinko, S., Kramberger, T., Butlewski, M., Özceylan, E., Đukić, G. (2021). Towards productive and ergonomic order picking: a multi-objective modeling approach. Applied Sciences, 11, 4179.

Goren, H.G. (2017). Value stream mapping and simulation for lean manufacturing: A case study in furniture industry. Pamukkale University Journal of Engineering Sciences, 23 (4), 462–469.

Gunduz, F.F., Gunduz, S., Dolekoglu, C.O. (2018). Cluster analysis of the EU countries in which Turkey has textile trade. International Journal of Economics and Financial Issues, 8 (5), 332–341.

Hita-Gutiérrez, M., Galain, M., Perez, M., Ferre A. (2020). An overview of REBA method applications in the World. International Journal of Environmental Research and Public Health, 17 (8), 2635.

Hignett, S., McAtamney, L. (2000). Rapid entire body assessment (REBA). Applied Ergonomics, 31 (2), 201–205.

Hodge, G.L., Ross, K.G., Joines, J.A., Thoney, K. (2011). Adapting lean manufacturing principles to the textile industry. Production Planning & Control, 22 (3), 237–247.

Kee, D. (2022). Systematic comparison of OWAS, RULA, and REBA based on a literature review. International Journal of Environmental Research and Public Health, 19, 595.

Korkmaz, İ.H., Alsu, E., Özceylan, E., Weber, G.W. (2020). Job analysis and time study in logistic activities: A case study in packing and loading processes. Central European Journal of Operations Research, 28, 733–760.

Lukodono, R.P., Ulfa, S.K. (2017). Determination of standard time in packaging processing using stopwatch time study to find output standard. Journal of Engineering and Management Industrial System, 5 (2), 87–94.

Rohac, T, Januska, M. (2015). Value stream mapping demonstration on a real case study.

Procedia Engineering, 100, 520–529.

Sevimli, M., Atıcı Ulusu H., Gündüz T. (2018). Pirinç paketleme işinde çalişanlarin çalişma koşullarinin ergonomik risk analizleri ile geliştirilmesi. Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 20 (1), 38–54.

Tekin, M., Arslandere, M., Etlioglu, M., Koyuncuoglu, O., Tekin, E. (2018). Application of value flow mapping to a big scale business. Engineering and Technology Management Summit, 300–311.

Tokel, D., Dogan, İ., Hocaoglu-Ozyigit, A., Ozyigit, I.I. (2022). Cotton agriculture in Turkey and worldwide economic impacts of Turkish cotton. Journal of Natural Fibers, doi: 10.1080/15440478.2021.2002759.

Uslu Divanoğlu S., Taş Ü., Pak E. (2021). Application of methodology of kaizen in assembly line in a production facility in the automotive sector. Journal of Polytechnic, 24 (4), 1533– 1541.

Kee D., (2021). Comparison of OWAS, RULA and REBA for assessing potential work- related musculoskeletal disorders. International Journal of Industrial Ergonomics, 83, 103140.

Seth, D., Gupta, V., (2005). Application of value stream mapping for lean operations and cycle time reduction: an Indian case study. Production Planning & Control, Vol. 16, No. 1, 44– 59.