An Application of SMED and Jidoka in Lean Production

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Abstract. Rapid developments in information communication technologies have caused radical changes in all areas of society. This change has led to changes in the lifestyles of individuals and of the ways and modes of doing business of enterprises. It is possible for businesses to be able to survive and compete with the right product, at the right place, the lowest cost and meeting customer demands and expectations. Increased competition, customer orientation resulting from changing customer expectations and demands have also changed the manufacturing systems and methods. Businesses have had to use sustainable flexible production methods and techniques which quality-focused, cost-effective and the least wasteful in order to meet customer demand expectations.

Identification of problems, prevention of mistakes, identification and solving of related problem areas and high preparation times are important problems in manufacturing. Automatically detecting faults and stopping the system makes the process more reliable by reducing the need for physical controllers. Reducing the preparation time can save the waste of waiting time. Many methods and techniques are used to remove wastes which are the basic philosophy of lean manufacturing. Jidoka is the detection of faults in the production process and SMED is shortening of preparation times. Jidoka provides an opportunity to automatically detect the system when an abnormal situation occurs for the machine or operators and to stop the production by detecting the fault. Thus, high-quality products and productivity increase are achieved by producing faultless products, increasing quality, preventing the breakdown of machines, tools and equipments and making processes safe. Large productivity increase can be achieved by avoiding waiting wastage with the SMED. The aim of the work is to create high quality products in production and raise awareness about productivity and to make the manufacturing systems safer by shortening waiting times by stopping and detecting the faults in the production system with jidoka and SMED method as a means of lean management and lean manufacturing. In this context, SMED and Jidoka techniques were applied on called ''vals ball'' in flour factory which operating in Turkey ISO top 500 industrial companies. Successful results were obtained regarding the applied jidoka and SMED techniques.

Keywords: Lean manufacturing · SMED · Jidoka

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1 Introduction

The production systems have gone through many changes until today. The main reasons for this change can be explained by the changing and developing environmental factors. It is expressed about changing and developing environment that changes in customer demands and requirements, increase in competition with globalization, development of information communication technologies, increasing world economy and environmental sensitivity. Businesses have been affected by these changes and have had to adapt. Businesses have achieved efficiency and efficiency increase especially by changing production and management systems. Otherwise, there will be no competition possibilities. Today, when the leading firms in the sector are examined it is seen that they are the ones that best implement the new production approaches [1].

Businesses are aware of the production techniques that will provide them a competitive advantages in a highly competitive environment. In this context, lean production techniques are at the forefront in terms of the least cost, zero waste, zero stock, zero defect products and quality products for businesses. Lean thinking is everything that does not offer any benefit to the user of the product or service and customer does not agree to pay the extra price. For this reason, all kinds of waste (stocks, waiting time, unnecessary jobs, faults, overproduction etc. must be eliminated. Lean Production aims to minimize the cases that do not add value with its basic structure. All of the tools used to reduce or remove losses in this direction. Jidoka which is one of the lean manufacturing techniques has taken many advantages such as giving the operator the authority to stop the line and solving problems by identifying them, providing that the machines can control the product, gaining ability to stop automatically or give the necessary signals in case of an abnormality, seperation of operator workforce and machine operations and managing multiple machines. Smed is also one of the lean manufacturing techniques which is a big contributor to the realization of JIT (just in time) production. Smed provides flexibility and agility in manufacturing. This technique opens the way to increase production efficiency and to produce with small batches by shortening time spent on model change [2].

2 Lean Manufacturing

Toyota is the first practitioner of lean production. This approach has emerged on a trip to America made by Taiichi Ohno with Toyota executives who form the basis of the Toyota production system. Their aim was to develop production systems to compete with American companies. In those days there were mass production systems developed by Henry Ford in America which still in use today. This system was based on the principle of quality control after production in batches. This system has not been adopted by Taiichi Ohno. Instead, a new production system called the Toyota Production System which started in the 1960s and lasted until the end of the 1980s which emerged in relation with Japan's postwar economic conditions. The so-called lean production system is based on the multiplicity, diversity and flexibility in production which based on competition in global markets instead of product-based strategy. Lean manufacturing basically

defines Japanese manufacturing techniques as an alternative to mass production and represents a holistic transformation in manufacturing [3, 4].

Lean production aims to produce with minimal waste by using less energy and less raw material. All elements that do not add value to reduce wastage in lean production need to be removed from production by separating from production. Lean systems need permanent improvements to improve productivity and reduce waste [2]. Lean production system tries to progress on its way by creating a customer-focused flexible structure with zero inventory, zero time loss, zero work loss, zero wait, zero unnecessary movement, zero stationery jobs and expenditures, zero defective production, zero excess process loss and zeroing all other waste items that do not create value.

The concept of lean manufacturing has been used for the first time in the book by Womack, Jones and Ross (1990) "The Machine that Changed the World". They expressed it as a way of thinking style rather than production style and emphasized as a holistic system approach to the creation of a culture of which all of the individuals in the organization should develop their activities continuously [5]. It can be said that the birth point of lean production is the lean thought. Its simplest sense, it refers to the use of available resources in the most efficient way to prevent wasting and to eliminate all unnecessary things. Lean thought is a system that aims to manage efficiently by eliminating unnecessary details with overall viewpoint [6]. In other words, lean production can be defined production with minimum resource, shortest time, cheapest, least waste and faultless product by using flexible manufacturing processes in accordance with customer demands [7].

Although this system was called lean production, Taiichi Ohno expressed it as "Full-Time Production", Shiego Shingo "Non-stock Production System" and Japanese experts and researchers expressed the term "Toyota Production System". In some literature, these terms are still used and are also referred to as "Synchronous Production System". Although the company which called ''Toyota Motor Company'' first developed and implemented this system and later the other companies contributed to the development and dissemination of the system and the system exceeded Toyota's boundaries [8].

3 Scope and Goal of Lean Manufacturing

Lean thought is the idea of reaching a lean production system, a lean company and a lean value chain. The goal of lean thinking is to focus on the production of resources and work that will affect the product and to capture wealth by eliminating wastes rather than changing the center of interest and eliminating the value of the management. It is a production system which carries no unnecessary elements such as fault, cost, stock, labor, development time, production area, wastage, customer dissatisfaction. The main strategy of lean production is to improve the quality, cost and delivery performance by increasing the speed and decreasing the flow time. Lean production is a system that uses time and resources to create value-added activities that shape the material or information that transforms the customer in the direction of customer needs, but distinguishes activities that do not add value to the product in line with customer needs and that do not

create added value. It aims to increase customer satisfaction by focusing on the concept of value by eliminating all elements that cause wastage.

The most striking difference between mass production and lean production is their purpose. Serial producers admit themselves a limited target which expressed as "good enough. This means defect products at acceptable level, acceptable stocks at the maximum level and low standardized products. Doing better will cost a lot of money or exceed people's natural abilities according to their ideas. On the other hand, the lean producers are precisely aimed at perfection. Such as constantly reduced costs, zero defective products, zero stock and the endless variety of products. Of course no lean producer has reached this utopia and perhaps it will never reach it. But the endless search for perfection will continue to produce with a surprise change [9]. According to Womack and Jones, lean manufacturing is a process of a number of activities. Purposes of lean production system;

- Accurately determine the value of the product and to increase this value,
- Define the value chain for each product and remove the activities that cause the wastage (zero inventory, zero time lost, zero work lost, zero wait, zero unnecessary move, zero stationery jobs and expenses, zero defective production, zero excess process loss, eliminating all other waste items),
- Ensuring product flow without any interruption,
- Ensuring pulling value customer from the manufacturer,
- Achieving excellence and making it sustainable.

4 Lean Manufacturing Principles

According to [10], we can briefly summarize the principles of the lean production system aimed at preventing waste as five steps. These are; determining a value for a particular product, determining the value flow of each product, providing uninterrupted flow of value, ensuring for customer pulls the value from the manufacturer and pursue excellence.

4.1 Value

Value is concept which critical exit point for lean thinking. Value can only be defined by the last customer and only when expressed form of a particular product (a goods or service and usually both) that meets customer needs at a certain price and certain time. The value is created by the manufacturer. This is the cause of the existence of the producers when viewed from the customer's point of view. It is still very difficult for manufacturers to correctly define the value due to many reasons. So simple thoughts; it must begin with a conscious experiment in order to fully define the value of concrete products that include concrete capabilities which offered at concrete prices through dialogue with concrete customers. The way to do this is to ignore existing assets and technologies and to rethink the on the basis of company's product lines, focused team which have strong company [10]. From a lean manufacturing perspective, the concept of value can be defined solely and exclusively by the customer and is a measure of

whether the product can meet customer needs in terms of price and other characteristics. The source of pleasure and appreciation that customers appreciate when buying the finished product is the definition of value they make. Manufacturer who create value from the customer's point of view. For this reason, making production of manufacturers will be more productive according to customer's definition of value.

4.2 Value Flow

The value for the customer is created by means of value flows. Thus, businesses make money through value flows. The main purpose of lean is to focus on value flow processes. As value flow processes are perfected, more value can be created for customers and more can be gained. Value is created in the process of value flow, at the same time wastage is the place where it emerged. By focusing on value flows, waste can be identified and action plans can be developed to eliminate wastage. Value flows must be mapped to determine everything that hampers waste and flow. Recovery efforts must be initiated to eliminate the waste and increase the flow in the value flow [11]. A value flow is a sequence of concrete actions required to achieve a particular product (a product or service, or both) and is achieved through three critical management functions in each business. These; problem solving task process which begin from concept to detailed design and engineering to product and market in process, information management task process from the start of order to detailed delivery through to delivery and the process of physical transformation from raw material to completion of the product to the delivery of the customer. Determining the entire value flow for each product (in some cases for each product group) is the next step in lean thinking. This step which companies rarely test, but brings out large quantities muda.

A value flow can be defined as any value-added and non-value-adding activities needed to deliver a particular product or service to a customer. All products with similar characteristics and qualities are produced in a value flow. It can be said that a value flow consists of all products that have the same route throughout the business. Lean businesses determine value flow so they can organize and manage businesses around them to increase the value they provide to customers. As the value flow for lean businesses becomes the primary organizational necessity, it follows that the income table of the operator is organized in the same way [11].

4.3 Flow

The next step for lean thinking is in order when the value is fully defined, value flow chart for a given product is fully prepared and the steps leading to the wastage are eliminated by the lean business. This is a breathtaking step in the real meaning. After that, it is to provide the flow of the steps that create value. However, this step requires a full restructuring. After World War II, Taiichi Ohno and Shigeo Shingo decided that the real issue was to provide a steady flow of production of dozens or hundreds of small parties rather than millions. This creates the general situation; because the vast majority of human needs reflect these modest rivers, not huge rivers. Ohno and his team have often succeeded in constant flow of small quantities of production by learning to change

tools quickly to switch from one product to another without the assembly line and bringing the machines to "right size" (miniaturization). In this way, while the object being manufactured is in continuous flow, different types of processing steps (mold, painting and assembly) are made next to each other in succession.

4.4 Pull

The first visible effect of moving from departments and parties to product teams and product flow is striking drop in process from concept to market, from the sale to delivery and the raw material to reach the customer. When the flow system was passed, the product design period is completed within a month instead of years, taking order can be reduced hours and the usual physical product total transaction time can be reduced minutes or days [10]. The pulling sytem does not produce any products or services in the stages without customer demand at the next stages [12].

4.5 Excellence

Perfection is a simple journey that is not the last point. In this respect, it is necessary to see the concept as "continuous improvement". There is a principle "doing the right job at once" instead of "doing the job right way" in the basis of lean thinking. Perfection is an unlikely goal to be fully attained since wastage can not be totally destroyed. In this case, the real goal should be to ensure the process at the highest performance point and improve value continuously. The concept of zero defect which seen as the key to excellence is an approach that prevents them from happening instead of finding and getting the wrongs. From in this regard, zero defect should not be perceived as merely a defect in products but should be considered as a concept covering all functions of the business. It should not be forgotten that a product was manufactured without defect but was not sold on time could lead to various wastes due to stock cost, depreciation, etc. [12].

5 Lean Manufacturing Techniques

All lean production techniques try to eliminate waste by their own techniques [13]. Applications of lean manufacturing are very important both in the businesses which are to be designed using lean thought principles in the phase of establishment and in the classical type businesses where the lean production transition is planned. When a lean thinking system is created in newly established businesses, future losses, many cost items and many possible problems can be avoided at the very beginning. The adoption and implementation of lean manufacturing techniques within the businesses is an important factor in achieving the objectives of the business [14]. There are many techniques used in lean production. These lean production techniques;

- Value Flow Mapping
- Kaizen
- Individual Suggestion System
- Jidoka

- Poka-Yoke
- Standard Business
- Total Productive Maintenance
- 5S
- Cellular Production
- Heijunka
- Visual Factory/Visual Management
- Kanban And Pulling System
- SMED
- Hoshin Kanri

5.1 Jidoka

The basic idea of the lean manufacturing system is to completely remove waste. One of these ideas is Jidoka [15]. Jidoka is a system that enables the machine or operators to be automatically detected when an abnormal situation occurs and to detect the fault then stop the production [16]. Jidoka which is handled by automation and used as autonomy that aims to stop when there is a fault in production. It tends to increase the efficiency of its equipment with the participation of all of its employees [17]. Autonomy is a mechanism that prevents the flow of faulty parts. Even if a fault occurs during production, each member must be able to obtain the specific information required to keep progressing within the program schedule.

It is a technique which involves the jidoka quality control function in the Toyota system. This is because the jidoka prevents the pass of defective parts from the production line. When a manufacturing fault occured, stopping of production line will prevent to intervene to problems immediately, taking measures and repeating similiar faults.

- The reduction in the number of labor force resulted in a reduction in costs, the design of mechanisms that automatically allow the benchs to stop when a production fault occurs, or when the specified quantity of production is reached, significantly reducing the number of workers following the operation of the looms (zero labor loss).
- The increased ability to adapt to demand changes enables autonomous elimination of excess inventories by virtue of all benches producing only faultless parts and automatically reaching the desired quantity of production (zero inventory).
- It will ensure timely production and rapid adaptation to demand fluctuations (Zero waste of time).
- Incorporation of workers into the problem-solving process has led to the development of a business culture of human respect. Thus, the development of culture of human respect accelerates their intervention and improvement efforts during a problem in the production process (zero labor loss).
- No inspection of damaged parts or machines by other operators (Zero excess process loss, Zero waste of time).
- Reduction of scrap/return ratio (zero false production) [18, 19].

As a result, Jidoka stops the machine prevent from recurrence when there is an fault. It is also an extremely important element in terms of preventing the growth of the

problem and showing whether the work has progressed in its normal course. This concept has been adapted to the production lines and workers as well as the machines at Toyota. This means that the worker will stop the band without hesitation when he sees any abnormality. Jidoka allows to identify all the abnormalities that occur in the production band and also prevents faulty production.

5.2 SMED

SMED (Single Minute Exchange of Dies) is one of the lean production techniques which based on performance enhancement by optimizing the necessary times in transitions among products in production together with changing patterns in a single minute [20]. The most important constraint factor on the ability of companies to produce with small parties is the job setting period that occurs during mold change. Rapid mold changing and quick set-up operations make it possible to remove trial production from the ground and make small-batch flexible production. This need is made possible by the fact that the machines work more efficiently in order to react quickly to changing market demands and that the stations achieve high OEE (Overall Equipment Efficiency). Shingo has developed the SMED methodology which a pioneering approach in order to achieve small-batch, flexible production systems. Shingo's technique involves both the necessary theorem for setting operations and the practical applications needed to bring the setting operations to under 10 min. The most important step of Shingo's method is to separate the internal setting operations that can be executed while the machine is turned off from the external setting operations that can also be performed while the machine is running. The SMED technique is applied in three stages;

In stage 1; Almost all adjustment operations are performed after the completion of the previous production, so the activities carried out to correct this situation and reduce the set-up period should be separated as offline and online manufacturing activities. Offline manufacturing activities can be completed before the end of the previous product production. Online manufacturing activities can be carried out after the production of the previous party is completed. Thus, the set-up time is limited only by the in-process time. According to [21] only providing this improves between 30% and 50% of the setting.

In stage 2; It focuses on the activities carried out when a mold is removed or a new mold is attached on the machine being worked on. Efforts focus on converting online activities out of manufacturing, that is, to be done during the time when the production of the previous party is in progress. These efforts can reduce the total settling time by up to 90% with the initial changes.

In stage 3; Arrangements and improvements are made by examining both internal setting activities and external setting activities to the smallest detail. The second and third stages need not be made separately but can be made almost simultaneously. It has been shown separately, analyzed and applied to be seen two separate concepts [21, 22]. Thanks to the SMED technique, the preparation time is shortened and the following benefits are achieved thanks to the rapid production of varieties;

- Ability to produce small batches with reduced mold change times (zero waiting loss, zero stock)
- Flexible production and on-time delivery capability (Zero waste of time)
- Less inventory due to working with smaller parties (Zero stock)
- Needs less operating capital
- Quality production with better mold maintenance (zero defect production)
- More regular stocking area (Zero stock)
- Rapid product variety and labor saving (Zero labor loss)
- Increased production (Zero unnecessary process loss).

6 Advantages of Lean Manufacturing

They are directly beneficial to quality because the customer focuses on the concept of value and is a quality-focused approach. In addition, there is a great contribution to the speed and duration of developing new products at the point of shaping the system based on customer needs. Many benefits are obtained with lean system as follows [23–25];

- Increase in product quality,
- Decrease in production period,
- Production with less work functions,
- Increased on-time deliveries,
- Increase in income,
- Reduced costs,
- Increase in labor productivity,
- Decrease in stocks,
- Increased productivity in production,
- Increase in flexibility,
- Increased efficiency in field use,
- Reduced vehicles and tools requirement,
- Increase in machine productivity,
- Prolonged healthy relationships with suppliers.

7 Methodology

Today businesses need a structure that is flexible and adaptable in an increasingly competitive environment. Businesses need to have the best mix of products in the shortest possible time, at the required quality level, with minimum wastage, zero fault, minimum inventory and cheapest structure to be able to cope with competition and to sustain existence. For this, it is necessary to keep up with the dynamic structure of the age to be open to changes and innovations. Therefore businesses have to adapt new systems, techniques and technologies to their own structures. Otherwise they will be left behind in the race. In this work lean production system was explained and SMED and Jidoka of which lean manufacturing techniques was applied in a flour factory. The aim of the work is to create high quality products in production and raise awareness about

productivity and to make the production systems safer by shortening waiting times by stopping and detecting the faults in the production system with jidoka and SMED. In this context, SMED and Jidoka techniques were applied and analyzed in flour factory. In our work, the company was analyzed with a lean manufacturing perspective and detailed interviews were conducted with face to face interviews with the authorities.

7.1 SMED Application

It was observed that the SMED technique will be applied changing of vals ball and the work was performed at this point. In this context vals cylinders are used for grinding wheat. The cleaned and having rested wheat is cracked with the help of cooled steel cylinders called vals. Grinding of the flour does not occur only one vals. This is done step by step every time. it is sifted and the thin parts are separated and thick parts are ground again. The average time for changing the ball is 104 min on average. Figure 1 below shows an example of a vals cylinder. The SMED technique is known in 3 stages. These stages was presented below.

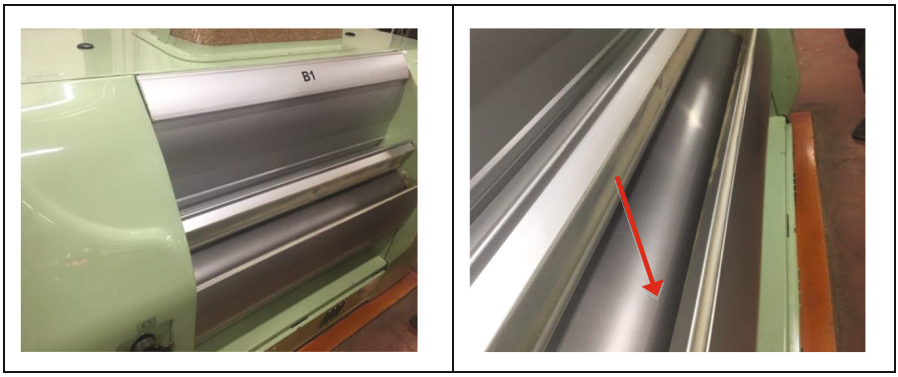

Fig. 1. Vals cylinder

7.1.1 Separation of Internal and External Adjustment Works

In stage 1; almost all adjustment operations are carried out after the completion of the previous production, so the activities carried out to correct this situation and reduce the set-up period should be separated into external (offline) and internal (online) activities. External activities can be completed before the production of the previous product is finished. Internal activities can be carried out after the production of the previous party is completed. As seen in Table 1 below, the work done first by changing vals ball was analyzed with the order and time. As seen in Table 1 below, a total of 19 jobs are performed in turn during roll ball change and all of them start after the production stoppage and the work done is divided into internal and external works and the first stage of SMED technology is realized. As shown in Table 1, 4 actions are external. These tasks can be performed without stopping production, while others are internal which can be performed after production is stopped.

Table 1. Vals ball replacement duration and classification

Order	Action	Time	Internal/External
1	Stopping the factory	–	–
2	Opening the vals safety switches	10 s	Internal
3	Opening the vals cover	5 s	Internal
4	Rescuing vals balls from motor belts	8 min	Internal
5	Disassembling belt pulleys which on the vals	12,5 min	Internal
6	Disassemble the mechanism attached to the cannon	15,5 min	Internal
7	Separation of ball bearings by hydraulics	9 min	Internal
8	Setting up the vals cannon	3 min	External
9	Taking the ball out of the vals	2,5 min	Internal
10	Transfering of old ball to maintenance area	8,5 min	Internal
11	Loading carrier vals ball by lift	2,5 min	External
12	Taking it to elevator	2,5 min	External
13	Taking vals ball from the elevator to the point of change	3,5 min	External
14	Placing the vals's teeth in the correct direction	2 min	Internal
15	Fixing vals ball to vals	11 min	Internal
16	Attaching pulley between vals and motor	5 min	Internal
17	Placing straps to provide movement between ball and motor	12,5 min	Internal
18	Greasing the bearings over the ball with grease	2 min	Internal
19	Ensuring that the motor rotates in the right direction by closing the vals caps and placing safety switches	4,5 min	Internal

7.1.2 Externalization of Internal Adjustment Works

In stage 2; concentrates on the activities carried out when a mold is removed or a new mold is installed on the machine being worked on. The efforts here focus on transforming in manufacturing activities to out of manufacturing that is to be done in time for the production of the previous part. These efforts can reduce the total setting time by up to 90% with the initial changes. All of the work applied to changing the vals ball was already performed as an internal time since it was already done after the factory stopped. In order to convert 4 actions which can be realized as external work in stage 1 into external work that is production can be done without interruption. Action order has been changed as seen in Table 2 below.

As shown in Table 2 below, when the vals cannon car is installed and the new vals ball is loaded with the carrier with lift and the transfer of the vals ball to the vals ball exchange point is carried out in the first 4 processes in turn, the process of going to the former cannon maintenance area it has become a spontaneous external action.

Table 2. New ranking of actions made with Vals ball replacement

Order	Action	Time	Internal/External
1	Set up the Vals cannon	3 min	External
2	Loading carrier vals ball by lift	2,5 min	External
3	Taking it to elevator	2,5 min	External
4	Taking vals ball from the elevator to the point of change	3,5 min	External
5	Stopping the factory	–	–
6	Opening the vals safety switches	10 s	Internal
7	Opening the vals cover	5 s	Internal
8	Rescuing vals balls from motor belts	8 min	Internal
9	Disassembling belt pulleys which on the vals	12,5 min	Internal
10	Disassemble the mechanism attached to the cannon	15,5 min	Internal
11	Separation of ball bearings by hydraulics	9 min	Internal
12	Taking he ball out of the vals	2,5 min	Internal
13	Transfering of old ball to maintenance area	8,5 min	External
14	Placing the vals's teeth in the correct direction	2 min	Internal
15	Fixing vals ball to vals	11 min	Internal
16	Attaching pulley between vals and motor	5 min	Internal
17	Placing straps to provide movement between ball and motor	12,5 min	Internal
18	Greasing the bearings over the ball with grease	2 min	Internal
19	Ensuring that the motor rotates in the right direction by closing the vals caps and placing safety switches	4,5 min	Internal

7.1.3 Final Improvements and Regulations in Interior and Exterior Setting Actions

In the final stage, both the internal setting activities and the external setting activities are examined and refined to the finest detail. With the operations in the middle pulley screws holding the cupboard, on the belts and on the other side of the ball on the pulley and the trigger belt on the other side, the joints in the process, i.e. simultaneous work applications and 16,5 min savings have been achieved. In Fig. 2 below, the vals ball straps and pulleys are visible. The change occurring after the application of the smed technique is shown in Fig. 3 below.

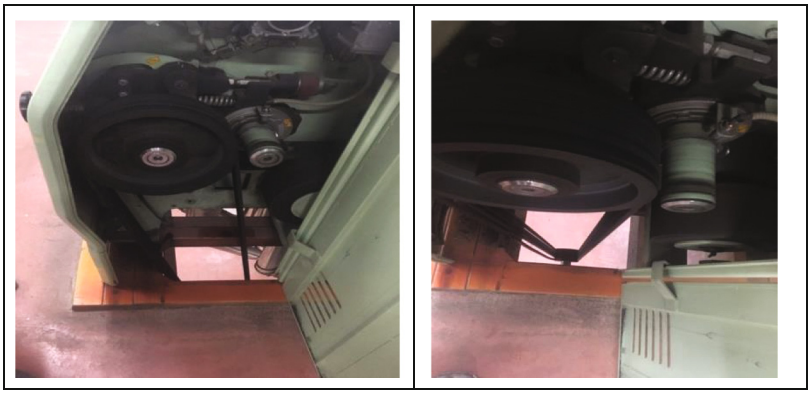

Fig. 2. Vals ball strap and pulleys

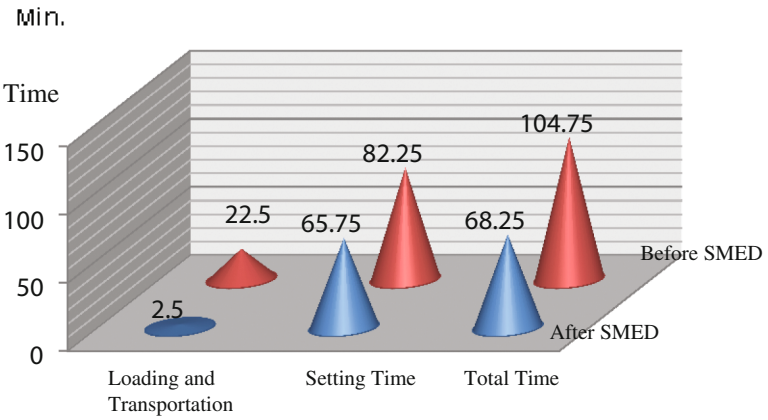

Fig. 3. Vals ball exchange time chart

As can be seen in Fig. 3, the loading and carrying jobs are reduced from 22.5 min to 2.5 min, the setting and assembly jobs reduced from 82.25 min to 65.75 min, the total time from 104.75 min to 68.25 min and zero wait wastage of lean production contributed to zero unnecessary process goals.

7.2 Jidoka Application

The jidoka method which is a system that enables the machine or operators to automatically detect and stop production/machine when an abnormality occurs. Jidoka technique was applied the production line part which called the vals tube. Figure 4 shows the warning signs that are not available in the existing system and integrated into the system through the application process.

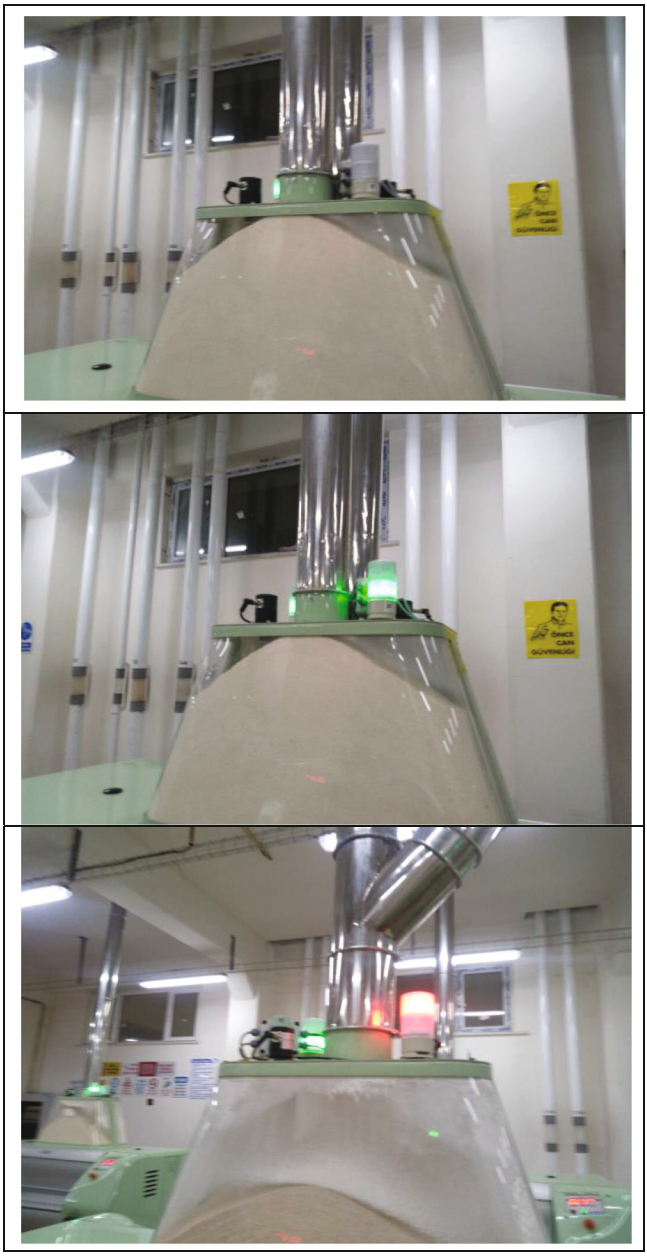

Fig. 4. Vals tube warning ındicators (Color figure online)

As seen in Fig. 4, when the nonstandard value occured on vals tube, the warning lights are activated and the process has the opportunity to intervene by operator. This means that the vals tube is working when the lamp turns green. When it flashes green,

the vals is full. when the red flashes, the vals tube stops. when the red light flashes, the vals is off. Thanks to these indicators, the operator has been able to intervene when an abnormal situation has occurred and by preventing the faulty production, contributing to defect production and zero time loss goal of lean production as well as zero labor loss point required for quality control and corrective actions.

8 Results and Conclusion

Lean production will never come to end because of the principle of excellence. There are always better improved systems, processes and techniques. In this context, it is necessary to carry out lean operations including in businesses equipped with high-tech machinery and information technology. In today's world where change has accelerated, both national and global competition has increased and customers have become more conscious and selective, the continuity of their work of leaning and progress towards excellence have become a crucial issue. At this point, the basic logic underlying the lean manufacturing practices is to focus on value and zero stock, zero time loss, zero work loss, zero wait, zero unnecessary movement, zero stationery works and expenditures, zero defect production, zero excess process loss.

In our study, durations of loading and transporting were reduced from 22.5 min to 2.5 min, adjustment and installation duration were reduced from 82.25 min to 65.75 min and total time duration reduced from 104.75 min to 68.25 min with the smed technique. Thus, zero wait wastage of lean production contributed to zero unnecessary process goals. In this context, the application of the SMED technique results in 36.5 min. (Zero labor loss) and more production (Zero waste of time) by contributing production to the earned time. With the application of the jidoka technique, light indicators were added to allow the operator to intervene when any abnormality develops in the process of the vals tupe process. Thus, faulty production is prevented and lean production contributes to zero defect production and zero time loss goal as well as zero labor loss at the point of labor saving required for quality control and corrective actions.

Planning and carrying out of the other lean techniques as well as smed and jidoka techniques will enhance productivity. An individual recommendation system should be set up to ensure full participation of employees and maximum benefit from employee skills. It is very important to incorporate employees into the system with full participation so that lean work can be implemented. However, it is very important and necessary for these administrations to support these applications. It is imperative to ensure discipline at the point of sustainability to standartize of the new system after lean applications have been done. It should be given importance to lean transformation studies in order to strengthen Turkey's global competitiveness in quality and cost-axis and for strong businesses. In this context, training and informing activities about lean techniques should be carried out in cooperation with business, university, industry and trade chambers.

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