

Evaluation of Embroidery Defects and Solution Proposals in Clothing Sector

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ABSTRACT

Nowadays, it has become more important to follow the latest developments concerning the clothing sector as staying up to date is likely to help us eliminate unnecessary expenditures and increase productivity. In order for companies to continue and expand their activities in ever-changing market conditions compared to their competitors, they need to make their own enterprises compatible with this emerging technology as much as possible by following the developing technology. In this study, the embroidery department of an exporting company was examined. More specifically, the embroidered products were carefully checked and faulty pieces were separated and classified according to the types of defects. The most critical defects were determined by means of Pareto analysis according to defect types and frequencies and an auxiliary apparatus was placed on the embroidery machine to prevent the defect in question. After the placement of the apparatus, the products were checked again. As a result of the calculations, the percentage of the defects in question decreased from 42.41% to 4.6%, and an improvement of 37.81% was achieved with the apparatus developed within the scope of this study.

1. Introduction

The success of all businesses competing in today's competitive global market is based on the ability to produce fast, high-quality and low-cost products. Successful companies provide a competitive advantage and follow their developing technology to adapt their production systems to this technology.

The "Fast-Fashion" effect of today's trains, low order quantities, short PLC (Product Life Cycle) effect, B2B (Business to Business) or B2C (Business to Consumer) businesses have made it imperative that customers' demands should be met quickly. For all these reasons, clothing companies need to move fast and turn towards high quality and low-cost products.

In the clothing industry which has a labor-intensive structure, various fluctuations in the quality of the products manufactured can be observed. These fluctuations might be caused by operator,

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machine, material or environmental factors on the production line. Poor quality means a product's incompatibility with existing demand. In order to eliminate the reasons for low quality, the root causes of low quality should be found and prevented by using various scientific methods.

Embroidery is defined as shapes and ornaments made with needle and yarns on surfaces such as fabric, mat leather and so on. Embroidery is an indispensable and unreplaceable technique in the clothing sector since it can bring an infinite variety of appeal to a garment. In parallel with this situation, the aim of this study is to detect and eliminate the faults that cause poor quality in embroidery. Accordingly, in a clothing company having an embroidery machine, all the flow entering and leaving the embroidery process were followed. The records obtained during the follow-ups were taken into account and the causes of poor quality were investigated and tried to be eliminated.

The following example studies have been carried so far about the method used in the study. In the Çakırkaya and Acar's study, the significance of the errors encountered in a production line was determined by the Pareto analysis of statistical process control techniques (Kara, 2018). In a study carried out by Ala and İkiz in 2014, the Pareto analysis was used in determining the fabric defects and their importance occurring in the weaving production process (Çakırkaya & Acar, 2016). In the study by Gjorgjevska et al., a model for total quality management in a textile company was tried to create with the statistical process control techniques. In the formation of this model, methods such as the failure mode and effects analysis (FMEA), the Pareto analysis and the cause and effect analysis were used (Ala & İkiz, 2015). In 2009, Kayaalp and Erdoğan identified the defects that occurred in a production line by using some statistical process control techniques. As a result of this study, it has been proved that stitch defects can be reduced by using statistical process control techniques in the clothing production line (Gjorgjevska et al., 2010). In a study conducted by Kara, the problems encountered in an aircraft assembly field were discussed. The Pareto analysis was used for the importance of the identified problems (Dengizler Kayaalp & Erdoğan, 2008). In a study conducted by Saçıkara (2006), ERP-enterprise resource planning installation in companies working actively at the international level was examined and the problems encountered in the installation of this system were analyzed statistically (Saçıkara, 2006).

2. Objective, material and method

2.1. Objective

In ever-changing market conditions, in order for the companies to continue and improve their activities compared to their competitors, they should be able to make their own businesses compatible with the developing technology as much as possible. In this direction, the aim of this study is to eliminate the defects encountered during the embroidery processes carried out by an exporting apparel company. For this purpose, examinations on the embroidery process and products coming out from the embroidery were made, and the defected parts were classified according to the defect types. Solutions that will enable the elimination of possible defects were developed, by finding the cause of the most common defects.

2.2. Material

The material of this study is the embroidery department of a clothing company. In order to collect data in this department, the products of the brand, which were subjected to the most embroidery process, were followed up for 3 months (12 weeks) and a total of 39000 products

were embroidered at this time. Types of defects encountered during production were determined and frequencies of these defects were calculated.



Figure 1. 18-head embroidery machine

2.3. Method

The defect types recorded during the analyzes in the study were prioritized with the Pareto analysis which is one of the statistical process control techniques. Then, on the most common type of defect, the fishbone diagram (Ishikawa diagram) which is a problem-solving technique, was taken to the roots of the defects and various improvements were made to minimize and eliminate this defect rate.

2.3.1. The Pareto analysis

The Pareto analysis is used to bring the focus to the highest importance in an alternative stack with many alternatives. This method, which provides the opportunity to analyze data statistically and presents data in this direction, is widely used by planners today. The Pareto analysis was put forward by Vilfredo Pareto (1848-1923) in the 19th century. It was claimed in this method that 20% of the population in the country is shared by 80% of all income and the remaining 20% is shared by 80% of the population (Çakırkaya & Acar, 2016). Today, this method is used to classify alternatives according to their importance and to make decisions in this direction. In other words, it is a method that enumerates alternatives from the highest frequency the lowest.

2.3.2. The fishbone diagram

The fishbone diagram is preferred to identify possible causes of problems or conditions. Based on the results obtained by using statistical methods, the reasons behind the occurrence of the event/situation can be reached and reveal the relationship between the results and the reasons that exposed them. Since the image of the generated diagram resembles a fishbone, this method is called a fishbone diagram (Çelikçapa, 1993). This diagram is a technique that reveals all the factors that cause an error or problem and inspires to find and improve the factor that most affects the outcome. The technique was developed by Japanese total quality specialist Kaoru Ishikawa (Ishikawa, 1991). Owing to this technique;

- The problem-solving process is more regular,
- Everything known and unknown about the problem is obvious,
- People with direct experience of the problem have an active role (Akşit, 1999).

3. Findings

The defects detected and the explanations of them are shown in Table 1.

Table 1.

The defects and their explanations

DEFECTS	EXPLANATIONS
1. Position	Unevenness due to placement (alignment) during insertion of the workpiece into the embroidery machine
2. Hole	Damage of the piece caused by multiple strokes of the presser foot on the piece
3. Oil Stain	Contamination and penetration of the machine oil on the piece due to the neglect of the embroidery machines
4. Yarn Winding	Additional embroidery to the same area due to embroidery design preparation
5. Application of different design	Embroidery of a different design on the piece
6. Needle Track	Using a needle which is not suitable for the fabric in the machine
7. Interlining Mistake	Use of an interlining not suitable for fabric

In the embroidery department of the company, faulty pieces caused by embroidery were detected in the products of a certain brand for 3 months. The types of defects obtained in these products are shown in Table 1. The rates of encountering the abovementioned defects are as shown in Table 2.

Table 2.

The defects and their frequencies

	Position	Hole	Oil Stain	Yarn Winding	Application of different design	Needle Track	Interlining Mistake
1. Week	32	21	1	10	18	3	18
2. Week	46	25	19	6	0	6	0
3. Week	38	26	6	2	0	11	0
4. Week	35	27	5	19	0	3	0
5. Week	36	26	9	26	0	6	0
6. Week	31	22	0	24	18	5	0
7. Week	48	21	9	5	0	8	18
8. Week	41	20	0	20	0	0	18
9. Week	38	18	0	18	0	0	0
10. Week	37	18	11	8	0	0	0
11. Week	35	28	6	2	0	2	0
12. Week	41	11	7	9	0	3	0
TOTAL	458	263	73	149	36	47	54

During the 12-week follow-up process, it was seen that the products whose embroidery was completed were brought to the company for quality control and all products whose embroidery was completed within that day were checked on the same day. Table 2 shows the number of products that do not meet the criteria and the type of defect they are classified as 2nd quality. After that, the Pareto analysis of all recorded defects was made according to the frequency of them. The data for the Pareto analysis are shown in Table 3.

Table 3.

The Pareto analysis data

Defect Type	Defect Count	Defect Percentage (%)	Cumulative Percentage (%)
1. Position	458	42,41	42,41
2. Hole	263	24,36	66,75
3. Yarn winding	149	13,79	80,54
4. Oil stain	73	6,76	87,29
5. Interlining mistake	54	5	92,29
6. Needle track	47	4,36	96,64
7. Application of different design	36	3,33	100

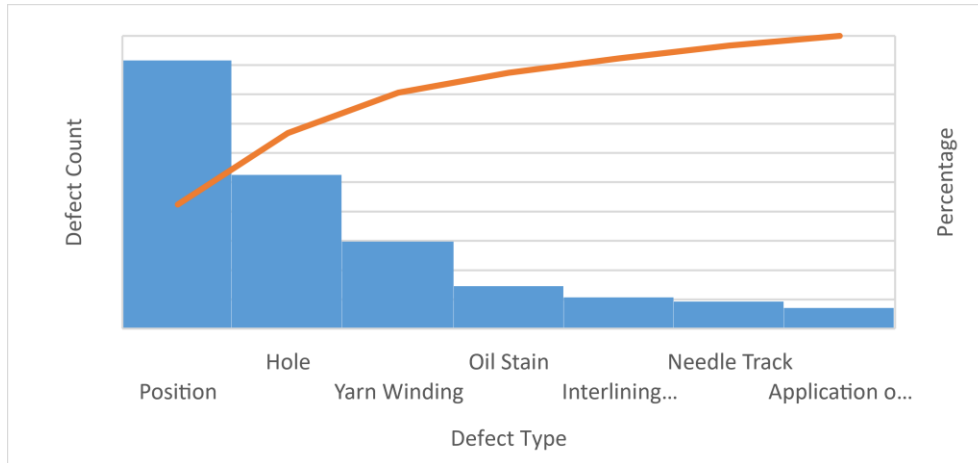


Figure 2. Pareto diagram

As can be understood from the Pareto analysis (Figure 2), in 7 defect classes, the position defect (42,41%) which is the misalignment of the embroidery placement, the hole defect (24,36%) which is the embroidery-borne hole formation in the main fabric and the yarn winding (13,79%) which is the extra yarn count in the same place of the embroidery design generate the 80,54% of the total numbers of the defects. As a result of the investigations on the embroidery process, it was determined that only 3 of 7 different defects could be prevented and 80,54% of total defects could be reduced. The position (Figure 3a), the hole (Figure 3b) and yarn winding (Figure 3c) defects are shown below.

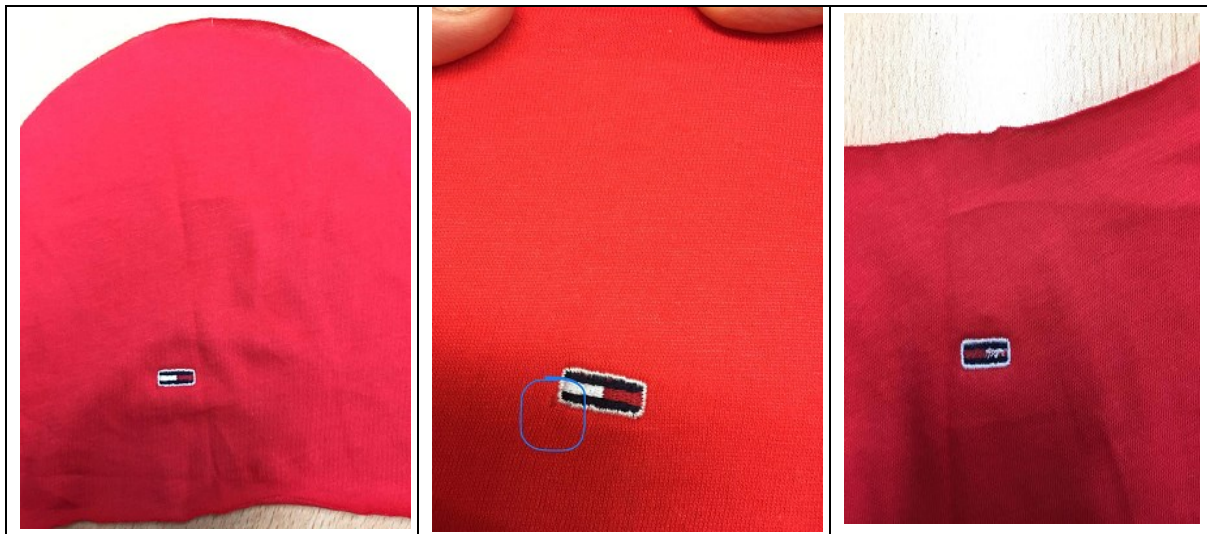


Figure 3a. The position

Figure 3b. The hole

Figure 3c. The yarn winding

In this study, the position defect which is the most encountered and the most important defect is discussed. In order to eliminate the position defect caused by the wrong placement of the embroidery design, the causes of this problem have been investigated first. Therefore, the fishbone diagram application was applied to this defect. The diagram obtained from this embodiment is as shown below.

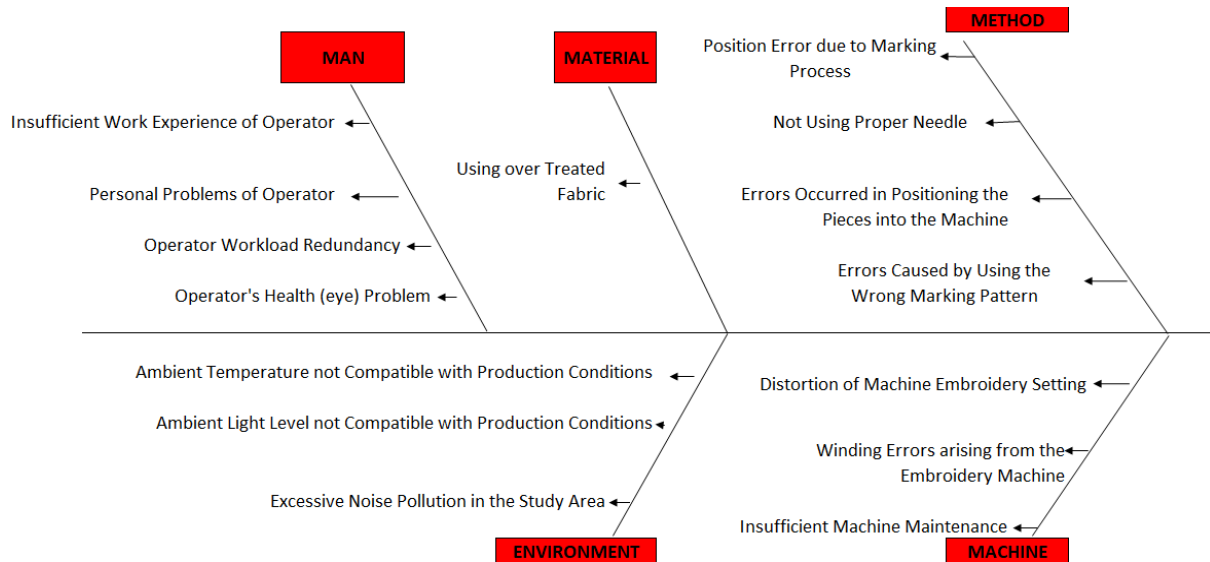


Figure 4. The fishbone diagram for the position defect

The fishbone diagram was prepared for the solution of the problem with the highest frequency detected. With this diagram, root causes of the problem of wrong embroidery position were investigated and man, material, method, machine and environmental causes and sub-causes of the problem were investigated. After the diagram has been created, in order to find out the root cause of the position problem, the reasons (sub-clauses) which have more share than others in the occurrence of this problem were discussed by brainstorming with academicians, unit managers, and operators and they are listed as follows.

- Operator workload redundancy
- Marking process
- Wrong positioning of the pieces into the machine

When these sub-reasons are examined, it is concluded that the position defect occurs mostly depending on operator and method. It is thought that the elimination of these sub-clauses will prevent the embroidery position defect. In order to eliminate this defect, it was decided that there should be a system on the embroidery machine where reference lines can be shown on the fabric so the operator can estimate the position and placement of the embroidery during operation. For this purpose, instead of manual and human-based methods such as hand drawing, it was decided to use a laser apparatus to eliminate the human factors and the errors associated with it and to make use of technologies adaptable to the textile sector (Figure 1). Accordingly, the laser apparatus needs to show reference lines (Figure 5) and the operator must take into account these lines and place the fabric to be embroidered.

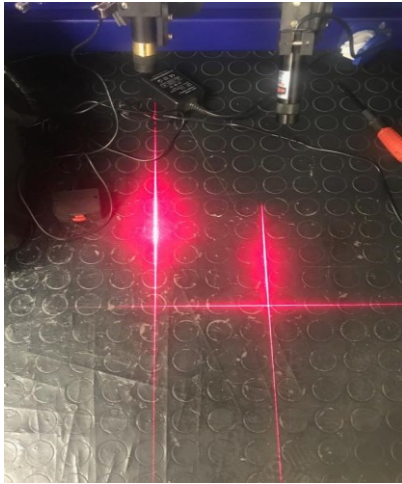


Figure 5. Reference lines of the laser apparatus

At this point, as a result of the examinations on the embroidery machine, it was decided to place a laser source at the rear level of the needle bar of the machine (Figure 6).

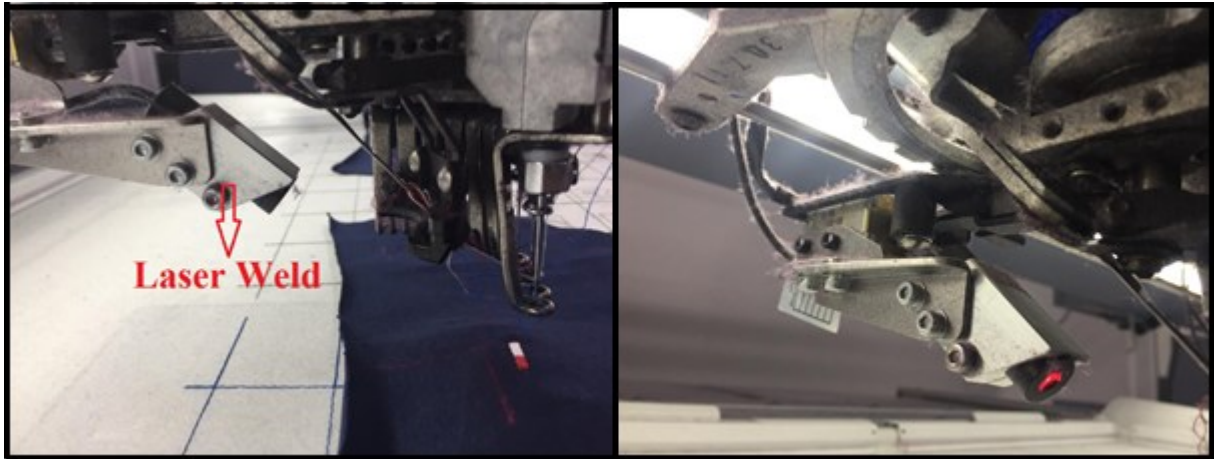


Figure 6. The laser welding

Thanks to the laser welding located behind the needle bar to prevent defects caused by the embroidery position, the operator performs an easier and faster alignment when placing the pieces to be embroidered on the machine. At the same time, defects in embroidery position are avoided. The images of the operator's placement of a piece in the new system are shown below (Figure 7).

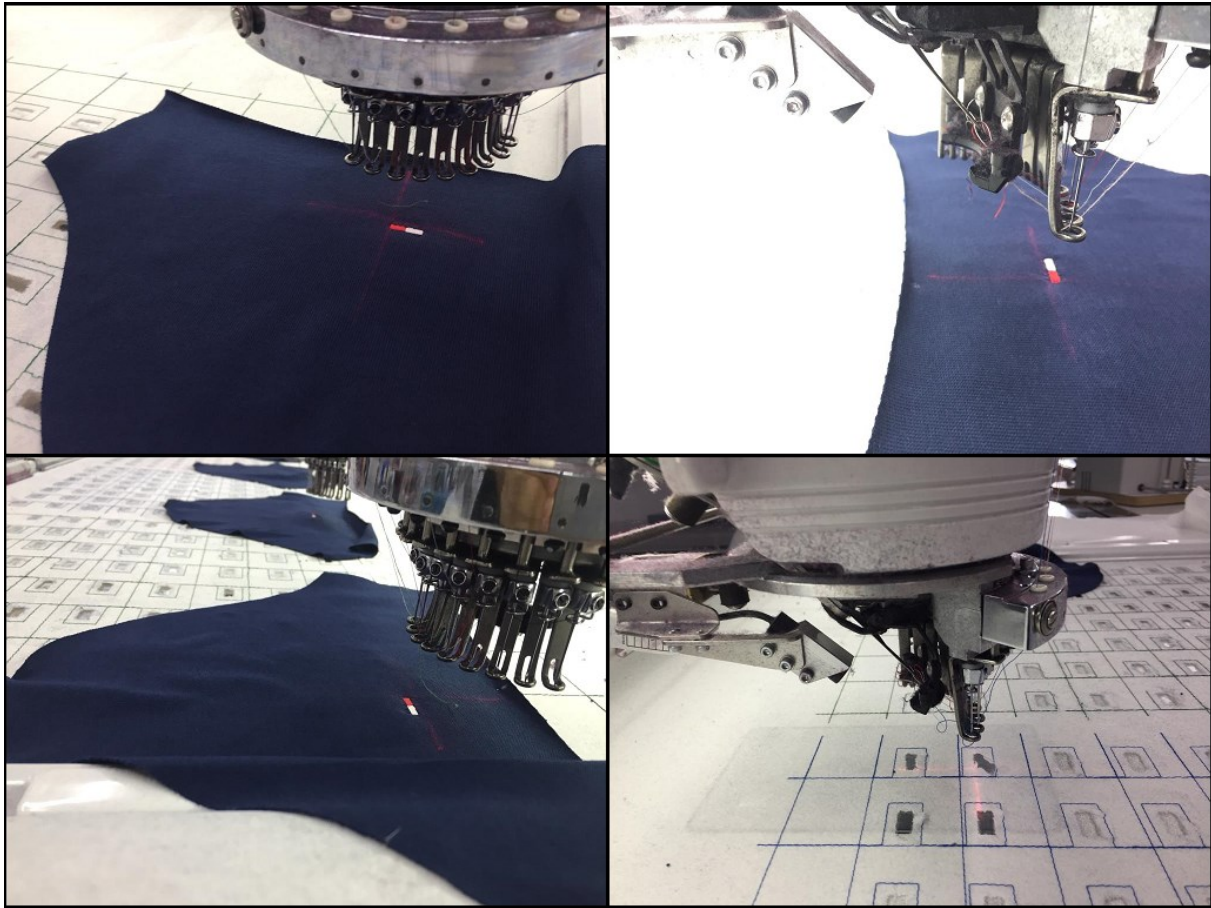


Figure 7. Images of embroidery with laser system

With the development made in the embroidery machine, the products to be embroidered with the same design which belong to a new order of the same customer were checked again. The new order products were monitored for 6 weeks and a total of 16100 products were examined. Faulty pieces were separated after the embroidery process and the defect types were recorded. These defect rates and their frequencies are shown in Table 4.

Table 4.

Defects detected and frequencies after laser application

	Position	Hole	Oil Stain	Yarn Winding	Application of different design	Needle Track	Interlining Mistake
1. Week	1	22	7	10	0	8	0
2. Week	4	14	9	17	0	5	0
3. Week	3	11	14	14	0	8	18
4. Week	2	20	5	12	0	5	0
5. Week	2	9	7	11	0	8	0
6. Week	1	10	8	10	0	7	0
TOTAL	13	86	50	74	0	41	18
%	4,6	30,5	17,7	26,2	0,0	14,5	6,4

When the data obtained after the quality control process from the embroidery products of the new order are checked, the percentage of encountering position defects decreased from 42,41% to 4,6% as a result of 6 weeks of monitoring. It was found out that 37,81% improvement was achieved with the laser apparatus developed within this study. Owing to the application of the laser system, the position defect, which has the highest encounter percentage in the previous 3

months, has been reduced to the lowest percentage. Since this defect cannot be completely eliminated (4.6%), it can be concluded that the position defect is not only caused by the operator's placement process, but also because of the fact that the textile surface is flexible, not stable (rigid), the position of it can shift or the operator may use careless operation despite using the laser system.

4. Conclusions and recommendations

Errors occurring within the scope of production processes decrease the quality level of the products, adversely affect the productivity of production and thus increase production costs. In order to improve the quality of the product obtained from a production line, it is necessary to eliminate the various defects detected in that production line.

In this research, the Pareto analysis, the fishbone diagram and brainstorming techniques, which are statistical process control methods and provide permanent solutions, are used instead of producing daily solutions in order to prevent the defects encountered during the embroidery process of a clothing company. The significance levels of the defects were determined on the frequencies of them, and the causes of the defects were grouped under the headings of human, machine, material, method and environment and detailed analyses were performed. The Pareto analysis showed that the most common one was the position defect. All the factors that cause this problem are shown collectively in the fishbone diagram. These factors were handled by the production team by brainstorming techniques and the point that should be developed to eliminate it was determined.

The development based on the laser application on the embroidery machine has been reduced by the percentage of position defect which was the most common one. It is impossible to avoid all of these and others that lead to product losses. However, it has been shown that by avoiding certain defects detected by statistical process control methods, their waste can be greatly reduced.

Suggestions presented as a result of brainstorming to eliminate other embroidery problems encountered in the scope of the study are as follows.

- Operator preparing the embroidery design should adjust the embroidery density and the number of strokes considering the construction of the fabric to be used. (For hole defect)
- Periodic maintenance and inspections of the embroidery machines should be carried out regularly under the supervision of skilled labors. (For oil stain defects)
- Operator should be sure that the embroidery yarn to be used matches the needle number. (For yarn winding error)
- Operator who prepares the embroidery design should give the embroidery operator a start confirmation for the relevant order. (For different design error)
- Operator should select a suitable needle for the fabric on the embroidery machines and check it before each and every operation. (For needle track error)
- Reduction of embroidery laser cutting interlining size. (For interlining error)
- Process control points should be created and hourly reports should be prepared and a team should be established to predict the errors. (For total quality manner)

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