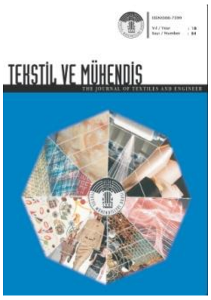
TEKSTİL VE MÜHENDİS

(Journal of Textiles and Engineer)



http://www.tekstilvemuhendis.org.tr

An In-Line Control Model Proposal Developed to Reduce Manufacturing Defects in Garment Industry Sewing Line

Hazır Giyim Dikiş Hattında Ki Üretim Hatalarının Azaltılmasına Yönelik Geliştirilen Bant İçi Kontrol Modeli Önerisi

Müslüm EROL

Bingöl University, Department of Textile Technology, Bingöl, Turkey

Online Erişime Açıldığı Tarih (Available online):30 Eylül 2021 (30 September 2021)

Bu makaleye atıf yapmak için (To cite this article):

Müslüm EROL (2021): An In-Line Control Model Proposal Developed to Reduce Manufacturing Defects in Garment Industry Sewing Line, Tekstil ve Mühendis, 28: 123, 208-218.

For online version of the article: https://doi.org/10.7216/1300759920212812306

Araştırma Makalesi / Research Article

AN IN-LINE CONTROL MODEL PROPOSAL DEVELOPED TO REDUCE MANUFACTURING DEFECTS IN GARMENT INDUSTRY SEWING LINE

Müslüm EROL*

Bingöl University, Department of Textile Technology, Bingöl, Turkey

Gönderilme Tarihi / Received: 02.03.2021
Kabul Tarihi / Accepted: 14.07.2021

ABSTRACT: This study was conducted in order to reveal the efficiency level of the 1/7 in-line control system (ICS) developed to determine the factors affecting the quality of the products produced in the garment industry sewing line and to reduce the defect rates. The production of a tights model produced from interlock fabric which contains 60% Pes, 35%Viscose and 5%Lycra was examined. During the first 12 days of production observation, the production flow has not been intervened. During the second 12-day experiment, the developed ICS was applied on the line. The products coming out of the band were checked according to the sewing control form and the error rates on operation basis and the effect of these errors on the cost were calculated. The defect rates on operation basis and the effect of these defects on the cost were calculated. One-way analysis of variance (Oneway Anova), Duncan test, correlation analysis and Paired Samples T-test were applied to the obtained data. According to the statistical results, it has been determined that the recommended ICS reduces the daily number of defective products by 81% and as a result, it provides a 77% reduction in the total defect related cost.

***Keywords*:** ICS, sewing defects, apparel industry, quality, statistical analysis.

HAZIR GİYİM DİKİŞ HATTINDA Kİ ÜRETİM HATALARININ AZALTILMASINA YÖNELİK GELİŞTİRİLEN BANT İÇİ KONTROL MODELİ ÖNERİSİ

ÖZET: Bu çalışma, hazırgiyim dikim hattında üretilen ürünlerin kalitesine etki eden faktörlerin tespiti ve hata oranlarının azaltılması için geliştirilen 1/7 bant içi kontrol sisteminin (İKS) verimlilik düzeyini ortaya çıkarmak amacıyla yapılmıştır. Örme kumaştan bir modelin üretim bandındaki üretimi incelenmiştir. Üretimin ilk 12 günlük gözlem sürecinde üretim akışına müdahale edilmemiştir. İkinci 12 günlük deney sürecinde ise geliştirilen İKS üretim bandında uygulanmıştır. Banttan çıkan ürünler Form D'ye göre kontrol edilmiş ve operasyon bazında hata oranları ile bu hataların maliyete etkisi hesaplanmıştır. Elde edilen verilere tek yönlü varyans analizi (Oneway Anova), Duncan testi, korelasyon analizi ve Paired Samples T-testi uygulanmıştır. İstatistiksel sonuçlara göre önerilen İKS'nin günlük hatalı ürün sayısını %81 oranında düşürdüğü ve bunun sonucunda toplam hata kaynaklı maliyette ise %77'lik bir azalma sağladığı tespit edilmiştir.

Anahtar Kelimeler: İKS, dikiş hataları, hazırgiyim endüstrisi, kalite, istatistiksel analiz.

***Sorumlu Yazar/Corresponding Author:** *merol@bingol.edu.tr*
***DOI:** https://doi.org/10.7216/1300759920212812306   www.tekstilvemuhendis.org.tr*

1. INTRODUCTION

In parallel with the developments in machine technology and the increase in the level of qualification of the workforce, the production capacity of garment industry has increased significantly on a world scale. There have been significant changes in consumer demands with the effect of fashion. Consumers want to buy different designs with low cost and high quality. On the other hand, manufacturers prefer to implement qualified quality control systems in order to work with high efficiency and almost zero-defect rates to respond to these demands. With the industrial revolution, the concepts of serial, quality and efficient product production have emerged. The serial and quality production approach pioneered by Taylor has developed with the efforts of important scientists such as Deming, Feigenbaum, Ishikawa, and Juran [1]. As there are many different definitions of the concept of quality, there are also different approaches in the literature between the concepts of quality control and quality assurance. Most of the time, business employees and managers cannot achieve the ideal production because they attribute different meanings to these concepts.

For this reason, all employees at the lowest and the highest levels should approach quality with the same motivation. It should become a way of life laid by the top management and internalized by the entire team. There is a quality understanding based on control in the classical production concept, whereas modern approaches have a system based on prevention, zero defect and only producing first quality products. The highest cost in the production of garment industry is the raw material costs, and then the sewing department comes second with a high rate of 20-30% of cost. Defect rates will increase due to the prolongation of operation times in the sewing department. Therefore, with the increase in repair rates, the product cost will increase. In studies on the factors causing sewing defects and their effects on the defect rates, it was stated that the quality of workforce and the type of operation are effective on the defect rates, but the effect of the machine type on the defect rates is low [2].

Kaya, who examined the garment business quality control system, determined that the sewing defects were around 38% and stated that he reduced the defect rates up to 9.6% through quality improvement studies [3]. In the study where the defect reasons and defect rates of the garment produced by using the statistical process control method were analyzed, it was determined that the problems were mostly labor-related. As a precaution, training of laborer is recommended [4]. According to another study using the same control system, it has been shown that it is possible to control the factors that cause sewing defects, and the daily defect rates and this control system can be easily applied especially in medium-sized enterprises [5-6]. Erol and Paşayev, in their study, where they analyzed the sewing department costs of five different firms that produce denim trousers, stated that sewing time, productivity, production culture and quality are factors that significantly affect costs [7].

A study has been carried out on the defects that occur in the men's shirt production line and how to minimize these defects. In this study, attention has been drawn to the need for systematic interim controls, and that workforce motivation and lack of education are important factors [8]. In addition, it should be clearly determined on the quality control procedure that which defects that are detected during controls on the production line will be second quality and which defects can be repaired. The product should be presented to the customer after a good documentation process and even after delivery, certain control processes should be included, and the quality should be increased [9-10].

The purpose of this study is to find out what are the defects in the products coming out of the garment sewing line. At the same time, the aim is to detect and fix these defects through in-band controls before the product becomes an end product, thus to reduce the second quality rates and costs.

The developed quality control system was applied to the sewing band of the enterprise where the study was conducted and one-way analysis of variance (Oneway Anova), Duncan test, Paired sample T-test and correlation analysis were applied to the obtained data. The performance of the proposed control system has been revealed by calculating the factors affecting the defect rates and the rates of the defects in the sewing cost. Although there are studies in the literature that determine the defect rates; there are no comprehensive studies about the model we propose and the effect of each defect on cost.

2. MATERIAL AND METHOD

2.1. Material

The study was carried out in an enterprise producing jersey garments. The research is a leggings model made of 60% Pes, 35% Viscose and 5% Lycra blended interlock jersey produced in the band of the enterprise. Band was the subject of investigation for 24 days. The first 12 days of the study were defined as the observation period and the next 12 days as the experimental period. Data on the causes of quality defects occurring in the sewing line, defect rates, effects of defects on costs and how to eliminate them were collected.

2.2. Method

Field research and statistical control methods were applied in the enterprise. There are only final control operations carried out and there is no in-band control system. During the observation process, the production flow and the company's own control systems are not intervened, and the data received were processed as they were. During the experiment, the recommended ICS was applied. The necessary forms were prepared, and implementation studies were made to apply the ICS. Since the research is carried out on the same line, there is no difference affecting the results in the workforce, machinery, equipment, physical space, and organizational structure. Since the only important changing parameter is the applied in-band control system, the error rates of this system and its effect on the cost have been revealed.

2.2.1. Production Method of Tights Model and Quality Control Stages

A total of 10 different processes are required in the sewing line in order to produce a tights model from interlock fabric. The model, whose production process was examined, is shown in Figure1 and the production process steps are listed below.

- Internal netting seam
- Front & rear netting
- Rubber measurement and cutting
- Rubber preparation
- Waist rubber application
- Waist hemming seam
- Leg regulation processes
- Hemming leg
- Waist zigzag seam
- Tag attachment

10 workers worked on the sewing line and realized the production. Three types of machines are used in the band: lockstitch sewing machine, overlock sewing machine and cover stitch sewing machine. Production was completed by using manual labor in 2 different operations that do not require the use of machinery. The controls were made in line with the instructions suggested by the ICS system.

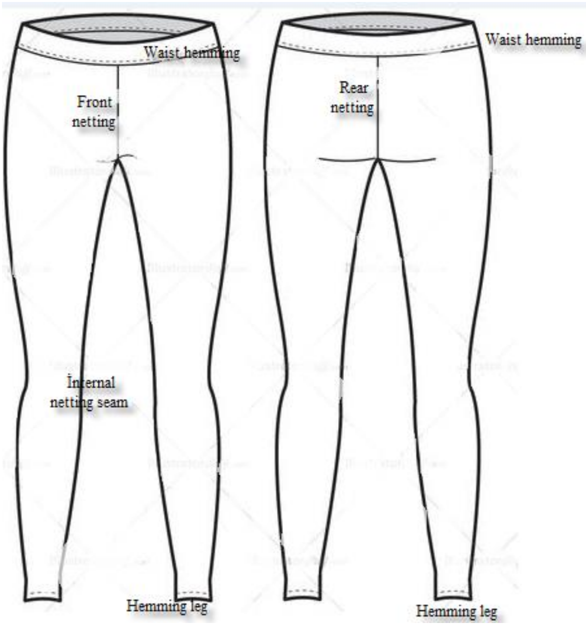


Figure 1. Technical drawing of the produced model.

2.2.2. Determination of Error Rates and Operation Times

The control process was carried out on the completed product at the end of the band. 75% of the daily produced products have been checked and only defects arising from sewing processes have been taken into consideration. Each defect detected after the control was written across the relevant operation in the designed control form (Form K).

At the end of the day, the number of defects in each operation was determined and the error rate was calculated by dividing the total number of defects by the total quantity checked. This process was monitored for a total of 24 days, including the observation and experiment period, and the data were transferred to the tables.

In order to determine the standard times of the operations, work-time studies were conducted within the band. The standard time was calculated by adding a 10% tolerance margin to the result.

2.2.3. Calculation of Operation Defect Costs

Order costing method is used for cost calculation. During the calculation of the unit cost of the product, raw material and labor costs are added to the order as they are. In order to calculate defective operation cost, an operating minute cost is determined.

Operating minute cost: It is calculated by the ratio of general production costs to the number obtained by multiplying the number of workers working in the band by the monthly working hours. The operation cost is calculated by multiplying the operating minute cost with the standard time of the operation. The daily defective product cost is calculated by multiplying the operation defect number with the operation cost [7]. In addition, the economy level of the system has been revealed by making calculations showing how much the implemented quality control system reduces the cost of defective products.

Monthly working time T_{mnt} ,[dk]: The number of monthly working days WD_{mnt},[day] is obtained by multiplying[days] by ST, [min] of the shift time.

$$T_{mnt} = WD_{mnt} \times ST \tag{1}$$

Operating minute cost FM_{mnt}: The general production expenses GPE are calculated by the ratio of the number of workers O working in the band to the number obtained by multiplying the monthly working time T_{mnt} [dk]

$$FM_{mnt} = \frac{GP}{O\ x\ T_{mnt}} \tag{2}$$

Operation cost = FM_{mnt} x Operation standart time (3)

Number of defective products per day=
Number of operation errors x operation cost (4)

2.2.4. Implemented 1/7 Inline Control System (ICS)

ICS was used for operator-based control on the sewing line. During the control operations Appendix 1: Form K was used. The each operator must be controlled at the first working hour of the day. 7 checks are made from the work done by the operator and if there is zero defect as a result of these 7 product checks, the next hourwork will not be checked. If there is 1 defect, the next hour is checked again. If there are 2 or more defects, the operator is stopped, and all products made during that hour are checked and defects are fixed. By means of the band manager, the operator is made to sew the product at the desired standards or if there is a problem caused by a previous process, it is ensured that a solution is found. The operator is changed when necessary. If there is a defect, the type of this defect and the reason are written in the explanation section in Form K for each operator. Then, every two weeks, operators with the highest number of defects should be determined and quality improvement studies should be carried out.

Appendix 2: Form D is used in the controls made on the basis of operation and this form has been prepared in a way to respond to all criteria specified by the customer in the sewing instructions. At the end of the band controls, at least 5 measurements should be checked for each size per day, and the number of controls of the operation should be increased when size defects out of tolerance are observed.

2.2.5. Statistical Analysis Method

The data were evaluated daily and based on defect rates. The effect of factors such as workforce, machine and operation type on error rates were statistically investigated. IBM SPSS Version 22 program was used in the analyzes. Significance level was taken as $\alpha = 0.05$. One-way analysis of variance (One-way ANOVA) test was applied for each factor to determine the effect of factors on the defect rate dependent variable. In addition, Correlation analysis was conducted in order to determine what kind of relationship exists between variables. Duncan Test was used to determine the groups among the factors with differences. In addition, Paired Samples T-test was applied to determine whether the applied control system had a significant effect on defect rates and cost data.

3. RESULT AND DISCUSSION

As a result of the researches conducted in band for 24 days, the results showing the band arrangement of the leggings model produced, the names of the operations, the equipment used, the operation standard times, the operation unit cost, the total cost of the defects made on the basis of the operation and the daily defect rates are shown on Table 1 for the observation process and on Table 2 for the experimental process.

The production was carried out using a total of 10 operations and three different machine groups. During the production of the leggings an overlock machine has been used for internal netting, front & rear netting and putting rubber on the waist. A Lock stitch sewing machine is used for rubber preparation, waist zigzag and tag attachment operations. After attaching the rubber to the waist and leg by using a hemming machine the production is completed. Sewing process was carried out using manual workers for rubber measuring and cutting, and leg arrangement. The unit production time of all these processes has been measured as 4 minutes.

In the researched band, it was analyzed how the control system, which was developed only without interfering with the workforce, machine equipment, band order and band flow, changed the defect rates and the cost incurred due to the defect. The Oneway ANOVA method was used to determine whether there were any defects due to the qualification of the operations both during the observation process and during the experiment, and the results are given in Table 3.

Accordingly, the relationship between sewing processes and defect rates was found to be significant. Differences can be seen in defect rates depending on the operation. Post-Hoc multiple comparison Duncan test was applied to determine in which operations the defects were seen more. Duncan results of the observation process are given in Table 4.

Accordingly, the operations were divided into 4 groups considering the defect rates and according to the 12-day monitoring results; leg regulating process was the least defect-prone operation with an average of 0.0325% defect rate. This operation is followed respectively by measurement and cutting of rubbers with 0.0433% defect rates, tag attachment with 0.0542% defect rates, and waist hemming with 0.1658% defect rates. Putting rubber on the waist of leggings was the most defect-prone operation with an average defect rate of 0.4008%. Front & rear netting with 0.3208% defect rate, hemming with 0.3108% defect rate, and the rubber preparation with 0.2542% defect rate have been the operations with the highest defect rates.

Duncan results of the 12-day test period using in-line control system are given in Table 5. Accordingly, the error rates are divided into 2 groups. The defects in rubber measurement and cutting processes and leg regulation processes have been reduced to zero. The operations, which are tag attachment with 0.0108% defect rate, rubber preparation with 0.0325% defect rate, waist hemming with 0.0325% defect rate and waist rubber application with 0.0542% defect rate have been completed with the least error rates.

During the observation process, while there was a defect rate of 0.4008% in the waist rubber attachment process, the defect rate decreased to 0.0542% after ICS was applied. This improvement is seen in all operations significantly. During the experimental process, the maximum defect was detected at 0.0875% in waist zigzag seam and hemming leg operations. This operation was followed by front & rear netting and internal netting.

During the first 12-day observation period in which production was monitored, a total of 187 errors were made on the basis of all transactions. During the experiment, this number dropped to 36 in total. After the application of the ICS, an average of 81% decrease was observed in the number of Daily errors, as a natural consequence of this, there was a significant decrease in error-related costs.

Table 1. Line observation period, the total cost of the defects made on the basis of the operation and defects rates on operation basis

Order number	Name of the operation	Equipment	Standard time (min.)	Operation cost (TL)	Total cost of the defects made (TL)	Day 1 defect rate	Day 2 defect rate	Day 3 defect rate	Day 4 defect rate	Day 5 defect rate	Day 6 defect rate	Day 7 defect rate	Day 8 defect rate	Day 9 defect rate	Day 10 defect rate	Day 11 defect rate	Day 12 defect rate
						OBSERVATİON PERİOD											
1	İnternal netting seam	O	0.547	0.197	4.33	0.80	0.27	0.40		0.13	0.27		0.27	0.13	0.40	0.13	0.13
2	Front & rear netting	O	0.537	0.193	5.60	0.40	0.53	0.13	0.13	0.40	0.53	0.13	0.27	0.53	0.13	0.40	0.27
3	Rubber measurement and cutting	ML	0.102	0.037	0.15	0.13		0.13					0.13		0.13		
4	Rubber preparation	SM	0.201	0.072	1.66	0.13	0.13	0.13		0.13	0.40	0.27	0.13	0.40	0.53	0.67	0.13
5	Waist rubber application	O	0.602	0.216	7.79	0.67	0.27	0.40		0.27	0.53	0.13	0.40	0.67	0.80	0.40	0.27
6	Waist hemming seam	CS	0.501	0.180	2.70	0.13	0.27	0.13	0.13	0.13	0.40	0.40	0.27				0.13
7	Leg regulation processes	ML	0.411	0.148	0.44	0.00	0.13	0.13							0.13		
8	Hemming leg	CS	0.601	0.216	6.05	0.40	0.53	0.13	0.13		0.67	0.27	0.27	0.40	0.13	0.40	0.40
9	Waist zigzag seam	SM	0.176	0.063	1.39	0.13	0.27	0.13	0.27	0.27	0.00	0.13	0.40	0.53	0.13	0.67	
10	Tag attachment	SM	0.331	0.119	0.60	0.13	0.13	0.13	0.13						0.13		
	TOTAL		**4.0**	**1.44 TL**	**30.71 TL**												

SM- Lockstitch Sewing machine, O- Overlock sewing machines, CS- Cover stitch sewing machine, ML- Manuel labor

Table 2. Line experimental period, the total cost of the defects made on the basis of the operation and defects rates on operation basis

						EXPERİMENTAL PERİOD											
Order number	**Name of the operation**	**Equipment**	**Standard time (min.)**	**Operation cost (TL)**	**Total cost of the defects made (TL)**	**Day 1 defect rate**	**Day 2 defect rate**	**Day 3 defect rate**	**Day 4 defect rate**	**Day 5 defect rate**	**Day 6 defect rate**	**Day 7 defect rate**	**Day 8 defect rate**	**Day 9 defect rate**	**Day 10 defect rate**	**Day 11 defect rate**	**Day 12 defect rate**
1	İnternal netting seam	O	0.547	0.197	1.377	0.13		0.13		0.13		0.13	0.13		0.13	0.13	
2	Front & rear netting	O	0.537	0.193	1.545		0.13		0.13	0.13	0.13		0.13	0.13	0.13	0.13	
3	Rubber measurement and cutting	ML	0.102	0.037													
4	Rubber preparation	SM	0.201	0.072	0.217					0,13		0,13			0,13		
5	Waist rubber application	O	0.602	0.216	1.082	0.13		0.13						0.13		0.13	0.13
6	Waist hemming seam	CS	0.501	0.180	0.540			0.13				0.13	0.13				
7	Leg regulation processes	ML	0.411	0.148													
8	Hemming leg	CS	0.601	0.216	1.729	0.13	0.27				0.13		0.13	0.13		0.13	0.13
9	Waist zigzag seam	SM	0.176	0.063	0.506			0.27	0.13	0.13		0.13	0.13	0.13		0.13	
10	Tag attachment	SM	0.331	0.119	0.119												0.13
	TOTAL	-	**4.0**	**1.44 TL**	**7.11 TL**												

SM- Lockstitch Sewing machine, O- Overlock sewing machines, CS- Cover stitch sewing machine, ML- Manuel labor

While the total cost of defect was 30.71 TL during the observation process, the cost decreased to 7.11 TL during the experiment (Table 1 and Table 2). This result showed that the costs due to defects decreased at a high rate of 77%. The rates of defects arising due to the operation during the observation and experiment processes are shown in Figure 2. Again, in these two processes, the results of the cost analysis made based on repair operations or time losses caused by operational defects are shown in Figure 3.

Table 3. ANOVA analysis of the effect of the operations on error rates in the observation and experimental period of the line.

		Sum of Squares	df	Mean Square	F	Sig.
Observation period	Between Groups	1.783	9	.198	7.014	.000
	Within Groups	3.107	110	.028		
	Total	4.890	119			
Experimental period	Between Groups	.143	9	.016	4.356	.000
	Within Groups	.400	110	.004		
	Total	.543	119			

Table 4. Duncan test results showing different treatment groups according to the observation period defects rates of the line.

		Subset for alpha = 0.05			
Operations	N	1	2	3	4
Leg regulation processes	12	.0325			
Rubber measurement and cutting	12	.0433			
Tag attachment	12	.0542			
Waist hemming seam	12	.1658	.1658		
İnternal netting seam	12		.2442	.2442	
Waist zigzag seam	12		.2442	.2442	
Rubber preparation	12		.2542	.2542	.2542
Hemming leg	12		.3108	.3108	.3108
Front & rear netting	12			.3208	.3208
Waist rubber application	12				.4008
Sig.		.078	.061	.329	.052

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 12.000.

Table 5. Duncan test results showing different treatment groups according to the experimental period defects rates of the line.

		Subset for alpha = 0.05	
Operations	N	1	2
Rubber measurement and cutting	12	.0000	
Leg regulation processes	12	.0000	
Tag attachment	12	.0108	
Rubber preparation	12	.0325	.0325
Waist hemming seam	12	.0325	.0325
Waist rubber application	12	.0542	.0542
İnternal netting seam	12		.0758
Front & rear netting	12		.0867
Hemming leg	12		.0875
Waist zigzag seam	12		.0875
Sig.		.055	.055

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 12.000.

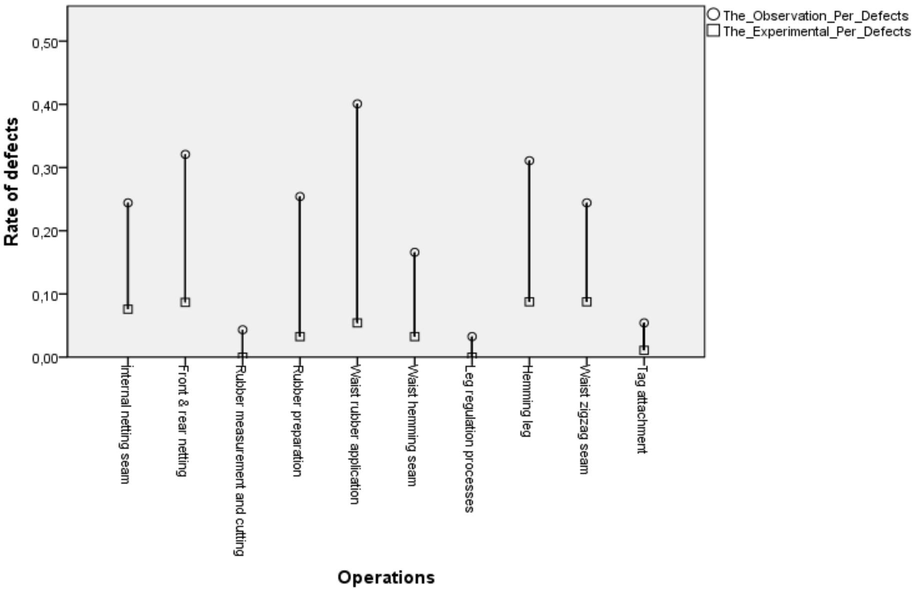


Figure 2. Defective rates according to operations during the observation and experiment period

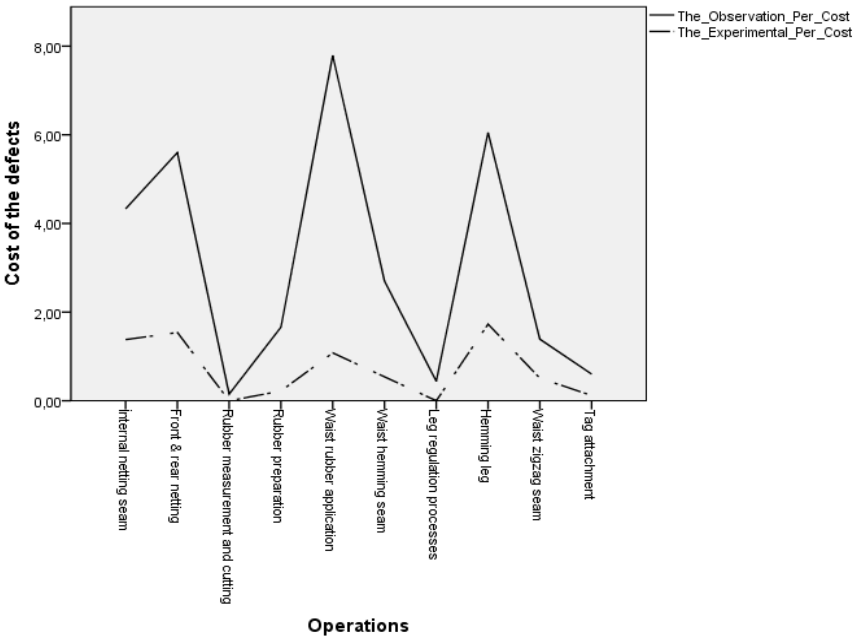


Figure 3. Cost of defective product in Observation and Experimental periods

The Paired Samples T-test was applied to determine which confidence interval of the difference between the error rates before and after the in-band control system is applied to the production in the band is important. Accordingly, there is a moderate correlation between the averages, which can be expressed with a correlation coefficient of 0.513 (Table 6 and Table 7).

It is possible to express the significant relationship between the defect rates before and after the application of the control system on the band production line and the difference between these defect rates with the "t" value. Here, the effect size value was calculated to obtain information about the severity or size of the significant difference. The effect size is found with the ratio of the calculated “t” value to the square root of the unit number “N”. If this value is between 0.8 and 1, the difference is interpreted as large. Based on the data in Table 8, the effect size was calculated to be 0.902. This value indicates that the difference between defect rates before and after control is large. As a result, the control system developed was successful and effective in reducing the defect rates significantly.

Table 6. Relationship of observation and experimental period defects rates with respect to Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	The observation period defect rates	.2071	120	.20272	.01851
	The experiment period defect rates	.0467	120	.06753	.00616

Table 7. Relationship of observation and experimental period defects rates with respect to Paired Samples correlation

		N	Correlation	Sig.
Pair 1	The observation period defect rates & The experiment period defect rates	120	.513	.000

Table 8. Paired Samples T-Test result of observation and experiment period defect rates

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	The observation period defect rates The experiment period defect rates	.16033	.17775	.01623	.12820	.19246	9.881	119	.000

4. CONCLUSION

Before the application of the ICS in the band of the enterprise, an average of 16 defective products were produced per day, after the application of the ICS, the number of daily defects decreased by 81% which corresponds 3 on average. With the reduction of defects, cost reductions varying from 68% to 100% depending on the operation were detected, and a 77% reduction in total defect cost was achieved.

It has been observed that the type of operation has a significant effect on defect rates and costs, and the defect rates differ as the process changes. Also, according to Duncan test results; waist zigzag, leg hemming, front & rear netting and internal netting operations are determined as risky operations where mistakes can be high. It has been recommended that control systems focus specifically on these specific operations. According to the results of the Paired samples T-test, it was revealed that there was a statistically significant difference between the error rates on the basis of the operation before and after the control system was applied and the developed ICS system served the purpose as expected. It has been determined that it is extremely important to establish quality assurance departments that will ensure that pre-sewing, in-line and end-of-line controls are carried out systematically in enterprises in order to increase the competitiveness level of the garment industry, and to make production with less defects and lower costs.

REFERENCES

1. Strategic Quality Management, Malcolm Baldrige and European Quality Awards and ISO 9000 Certification: Core Concepts and Comparative Analysis.
2. Kaya, S., Erdoğan, Ç., 2008, *A research about factors whıch cause qualıty defects ın apparel plants at the sewıng department*, Textile and Apparel, 18 (2), 135-141.
3. Kaya, S., 2001, *Quality control in apparel.* İzmir: Ege University Textile and Apparel research application center publication.
4. Duran, C., Çetindere, A., 2012, *Analysis of product faults with statistical process control techniques at a facility operating in the apparel industry*, Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 21: 233-254pp.
5. Erdoğan, M., Kayaalp, İ, D., 2009, *Decreasıng sewıng defects by usıng statıstıcal process control methods ın the apparel factory,* Textile and Apparel, 19 (2), 169- 174.
6. Pavol, G., 2015, *Continuous Quality Improvement by Statistical Process Control. Proceedings of Business Economics and Management 2015 Conference*, Procedia Economics and Finance, 34 (2015), 565-572.
7. Erol, E., Paşayev, N.,2014, *Analyzıng productıon cost of small and medıum sızed enterprıces ın terms of sewıng department productıon condıtıons*, Textile and Apparel, 24(1): 134-140.
8. Akgül, M., 2006, *Desıgnatıng qualıty charesteristics and preparing quality directions in producing of male shırt (Master's thesis)*, Marmara University Institute of science and technology, (Order number: 185156) İstanbul. pp.198.
9. Dereli, T., Baykasoğlu, A., 2003, *Quality and its implications to life,* Ankara: Nobel publishing and distribution. pp.352.
10. Efil, İ., 2016, *Total quality management,* Bursa: Dora publishing and distribution. pp.542.

APPENDİX 1. In line Control Form (Form K)

IN LİNE CONTROL FORM

Line: Order No: Date: **FORM K**
Client: Controller:
Model:
Colour:

OPERATOR NAME	OPERATION	EQUIPMENT	SHİFT TİME 08:00/09:00	09:00/10:00	10:00/11:00	11:00/12:00		13:00/14:00	14:00/15:00	15:00/16:00	16:00/17:00	TOTAL DEFECT	COMMENTS

REMARKS:

APPENDIX 2. Sewing Information Form (Form D)

SEWİNG INFORMATİON FORM

Line:	Order no:	Date:	**FORM D**
Client:		Controller:	
Model No:			
Colour:			

	OK	**NOT OK**		**MUST BE**
Is there an deffect on fabrıc?			……...	
Does the fabrıc have staıns?			……...	
Are the front and back panels symmetrical?			……...	
Is the thread bobin color correct?			……...	
Stitch per cm must be correct			……...	
Is the content and location of brand tag correct?			……...	
Is the tag insertion thread number correct?			……...	
Is the washing instruction in the right place?			……...	
Is the size tag in the right place?			……...	
Is the label contents correct?			……...	
Is the seam width sufficient?			……...	
Is the rubber width correct?			……...	
Is the coverstitch spacing correct?			……...	
Is the hem width correct?			……...	
Is rear net stitching correct?			……...	
Is front net stitching correct?			……...	
Is inside hemming leg correct?			……...	
Is the waistband correctly fitted?			……...	
Is the hemstitching in the waist and hems correct?			……..	