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Evaluating the Automat Usage for Bottom Hemming Operation in Terms of Process Time and Quality

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Abstract: Apparel industry, which has a major impact on the world trade, has been struggling with a competitive environment with challenging conditions like the other labor-intensive sectors all over the world. Following the latest technological developments and efforts of keeping up with these activities would affect the operational efficiency in a positive manner. Therefore, being able to adapt these developments to the companies becomes of great importance in today's business world. This study investigates the operation of bottom hemming of casual trousers. Despite the fact that bottom hemming is not defined as a difficult process, it requires manual skills. The difficulty of controlling the cylindrical part of the bottom under the machine head (presser foot), especially for the narrow-bottomed trousers, may cause prolonged sewing process times and also some undesirable quality problems. In this study, bottom hemming operation is performed by using both classical method and recently developed bottom hemming automat, to highlight the comparison between the manual hemming of denim trousers and usage of automation for this process in terms of duration and quality. Thus, the advantageous method is defined, from the point of productivity (process time) and quality. In this study, it's observed that 33.34% time saving and eliminations of quality problems by using automat for bottom hemming operation.

Paça Kıvırma İşleminde Otomat Kullanımının İşlem Süresi ve Kalite Açısından İncelenmesi

Anahtar Kelimeler
Dikiş otomatı,
Otomat kullanımı,
Paça kıvırma,
Verimlilik,
Kalite

Özet: Dünya ticaretinde önemli bir paya sahip olan hazır giyim endüstrisi, dünyadaki diğer emek yoğun sektörler gibi zorlu koşullar içeren rekabet ortamı ile mücadele etmektedir. Teknolojik gelişmeleri takip etmek ve bu faaliyetlere ayak uydurmak operasyonel verimliliği olumlu yönde etkileyecektir. Bu nedenle, teknolojik gelişmeleri şirketlere adapte edebilmek, günümüz iş dünyasında büyük önem arz etmektedir. Bu çalışmada casual (günlük) pantolonlardaki paça kıvırma operasyonu incelenmiştir. Paça kıvırma işlemi zor bir işlem olarak tanımlanmasa da el becerisi gerektirmektedir. Özellikle dar paçalı pantolonlarda, makinenin (baskı ayağının) altında silindirik paçanın kontrol edilmesi zor olduğundan, dikim sürelerinin uzamasına ve bazı istenmeyen kalite sorunlarına neden olabilmektedir. Bu çalışmada, denim pantolonlarda paça kıvırma işleminin klasik yöntemle ve yeni geliştirilen otomatla gerçekleştirilmiş ve her iki yöntem; işlem süreleri ve kalite açısından karşılaştırılmıştır. Böylece, verimlilik (işlem süresi) ve kalite açısından avantajlı yöntem belirlenmiştir. Bu çalışmada, paça kıvırma işleminde otomat kullanımının % 33.34 zaman tasarrufu sağladığı ve kalite problemlerinin neredeyse yok edildiği görülmektedir.

1. Introduction

Apparel industry, which has a major impact on the world trade, has been struggling with a competitive environment with challenging conditions like the other labor-intensive sectors all over the world. Attaching importance to research and development activities and/or closer monitoring of the latest

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technological trends becomes quite important for the companies operating in the challenging competitive sectors to be able to pass a step forward compared to other rivals. Following the latest technological developments and efforts of keeping up with these activities would affect the operational efficiency in a positive manner. Therefore, being able to adapt these developments to the companies becomes of great importance in today's business world.

Considering the distribution of employees in the apparel industry to the departments according to the structure, about 80% of all employees are working in the production department [1]. Therefore, the adaptation of the technological developments should be started from the sections, where the number of employees and hence the time losses are high.

In order to reduce the production costs the labor force has to be facilitated. Therefore increasing the labor efficiency and decreasing the material costs should be performed. Moreover, the facilitation of the labor may be realized through the pursuit of technological advances, in other words towards automation. The use of automats enable the reduction in process time and standardization of quality of the conducted works, in parallel it facilitates the labor force, provides increase in the labor productivity and decrease in the overall costs. Sewing automats are defined as a system group that conducts a sewing process by itself through the pedal or button movement. This study investigates the operation of bottom hemming of casual trousers. Despite the fact that bottom hemming is not defined as a difficult process, it requires manual skills. Since the difficulty of controlling the cylindrical part of the bottom under the machine head (presser foot), especially for the narrow-bottomed trousers, may cause prolonged sewing process times and also some undesirable quality problems. In this study, bottom hemming operation is performed by using both classical method and recently developed bottom hemming automat. The bottom hemming automat minimizes labor intervention by synchronized operation of joint sensor, hemming hook, pullers, stretchers and sewing unit. This study highlights the comparison between the manual hemming of denim trousers and usage of automation for this process in terms of duration and quality. Thus, the advantageous method is defined, from the point of productivity and quality.

Many researches have been done using the chronometer method on previous studies. These studies content works studies by stopwatch using and automat usage.

Dal investigated about determination of process time on hip pocket sewing of denim trousers in 2010 by using comparative methods [2]. In 2014, İşler et al., studied about importance of MTM method on apparel production planning and made a comparative work study with stopwatch method [3]. Cömert and Kadem studied for sewing processes of two trousers with different fabric design by using stopwatch in 2015 [4].

Sewing Automats are self-working machine systems that operate a programmed sewing process after pedal or button movement. The apparel firms prefer sewing automats because of high speed and quality advantages. There are many studies that investigate trend of automat usage. The studies are given below about advantages of automat usage in apparel production.

In 1992, Paul and Dixon made a research namely “Advanced Automation for Shirt Collar Manufacturing” and this research and development involved the conceptualization, design and development of proof of concept shirt collar turning and pressing processes based on “double point turning and pressing” and their systems integration into a robot assisted apparel workstation. The research also involved a second activity to understand, design and develop technology which can temporarily fold and crease single ply shirt collar bands for continuous automated assembly of shirt collars and collar bands [5]. In 2004, Ünal et al., investigated in two different apparel firms to compare the usage of classical sewing machines and the usage of automat in terms of affordability [6]. In 2007, Yücel studied about fault types and fault analyzes. Yücel also recommended the usage of automat for several operations in apparel production to improve quality and decrease operation times [7]. In 2010, Güner et al., studied about fault analyzes in men’s shirt production line and they also recommended the usage of automat for several operations to decrease operation times [8]. In 1999, Choi and Ip used the RTM and the MTM element times as the basis of comparison and they discussed the feasibility of using a simple method based on the relationship between manual and robotic assembly times so that reasonable cycle time data were available for necessary planning and selection of appropriate assembly methods [9].

2. Material and Method

The bottom hemming operations of classical trousers are done with blind stitch machines while the same operations of casual trousers are done with lock stitch machines. The menswear denim trousers’ hems are chosen for this study as a sample of casual trousers. In this way it’s possible to investigate the efficiency of developed bottom hemming automat.

Lock stitch applications for bottom hemming are processed through the bottom hemming automat of Efatech PC-40V1 (developed by the company of Efatech located in İzmir, Turkey) and Juki DDL 9000 lock stitch machines for comparison.

Bottom hemming automat is based on cylinder bed lockstitch machine with addition of hemming unit, pullers, stretchers and electronic control units. This automat has a wide production range, from skinny leg casual trousers' bottom (28 cm circumference) to skirt bottom (110 cm circumference). Also, the hemming width can be set from 1 cm to 4 cm. Machine speed is controlled by foot pedal as classical sewing machines. Therefore, the production time is related with the operator's performance. The sewing processes start after the joint sensor sensed first side or inner side seam joint as shown Fig. 1. The sewing operation proceeds until the joint sensor sensed first side or inner side seam joint again. The number of joints must be entered by using electronic control panel to complete the all bottom circumference.

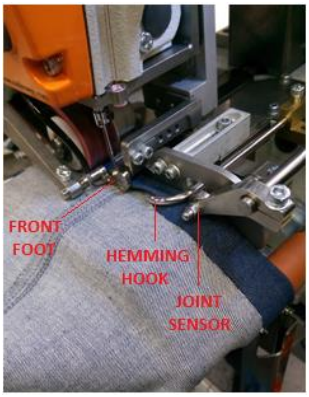

Figure 1. Bottom Hemming Operation [10]

Denim trousers consisting of 5% lycra-95% cotton, produced from fabric of 237 g/m2 and having a 40 cm bottom circumference is utilized for bottom hemming testing applications. Feed off the arm (Double Chain stitch) sewing machine is used for the inner side seam operations and 5-thread overlock stitch machine is used for side seam operations. Sewing thread of 105 Tex is used for the hemming process. Moreover, REFA (Reichsausschuss für Arbeitszeitermittlung) study forms are used during the work-study processes with chronometer.

This study demonstrates the comparison between the bottom hemming processes, conducted firstly by the manual-hemming and sewing with the lock stitch sewing machine (Fig. 2) and secondly by the automat (Fig. 3) developed specially for this purpose and used for placement of bottom on the automat, hemming and also sewing, in terms of process time and quality manners.

Figure 2. Lockstitch Machine

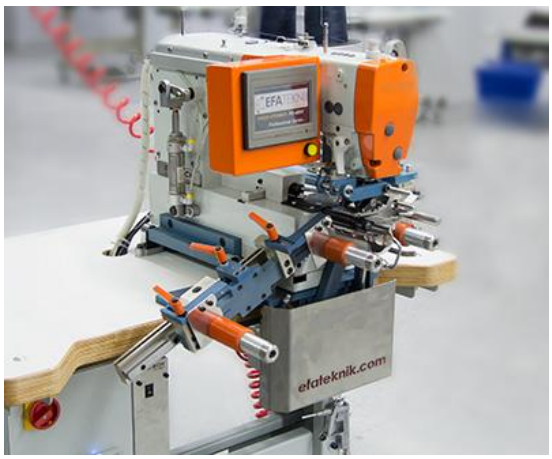

Figure 3. Efatech PC-40V1 Bottom Hemming Automat [11]

The time comparison is carried out through the work measurements with chronometer. The bottom hemming processes of denim trousers are carried out ten times for each method for the comparisons and work studies are taken in the meanwhile. Work study processes start by dividing the relevant work into the process steps. The productivity degrees of the relevant performance in each stage are predicted and periods are calculated with a stop watch. After then, average productivity degrees and average time are evaluated for each proceeding step. Thus, the basic time of steps are calculated. The basic time of steps are mathematically added, so the general basic time for the relevant work is calculated. During the work standard unit time calculation, the following standard unit time method is used (Fig. 4).

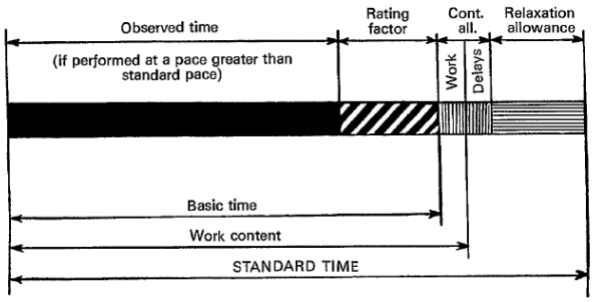

Figure 4. Standard Unit of Times Formula [12]

After basic time obtainment, fatigue allowance and relaxation allowance rates must be calculated in order to calculate the standard unit time [13]. For the clothing sector, the accepted fatigue allowance value is 7% of the basic time whereas relaxation allowance value is 10%. According to the formula; basic time, fatigue share and divider time values are summed up during the standard unit time calculation and the obtained time is equal to the unit time of the relevant work.

Bottom hemming operations are done after side and inner side seaming operations. Twin-401 coded (4 thread -2 needles 2 loopers) chain stitch is used for inner side seaming operation (Fig. 5a). 516 coded 5 thread overlock stitch is used for side seaming operations (Fig. 5b) and finally 301 coded lock stitch,

which is done with automat and classical lockstitch machine, is used for bottom hemming operations (Fig. 5c). 3 mm stitch length and 12 mm hemming width are set for bottom hemming operations. Bottom circumference is also kept constant for 40 cm.

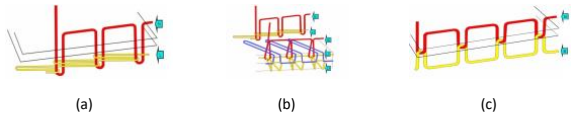

Figure 5. The used stitch formations (a) 401 Chain Stitch (b) 516 5-Thread Safety Stitch (401+504) (c) 301 Lockstitch [14]

3. Results

Different methods for the same purpose are utilized and work studies are taken during this process. The obtained time results are compared accordingly. Work study values used for the following calculations are obtained through the average values of the 10 pieces. The outputs gained as a result of the processes are also examined in terms of quality qualifications.

During the sewing processes, the work study was done on one trouser leg. Therefore, the following times show the average times of hemming, sewing and quickly checking and putting a bottom away. The obtained average times are shown on Table 1.

The times are obtained by stop watch during work study are shown in Table 1. The average times are obtained from manual process of bottom hemming and are obtained from automat process of bottom hemming. According to the obtained data; if a bottom hemming process was carried out in manual ways, it lasts in 8,28 seconds during "Bottom Taking, Hemming and Placing" steps. However, if it is carried out with an automat, it only lasts in 4,95 seconds due to the use of bottom hemming apparatus.

Furthermore, when the second process steps of both methods are compared it lasts in 9,48 seconds during manual bottom hemming and sewing process whereas it only lasts in 5,01 seconds if the same process is carried out with an automat.

In the last step of bottom hemming process (putting away step), similar times are measured with both methods.

The data of work study are obtained and Fig. 6 is formed according to the average times. The average results of work study for bottom hemming operations are shown in Fig. 6.

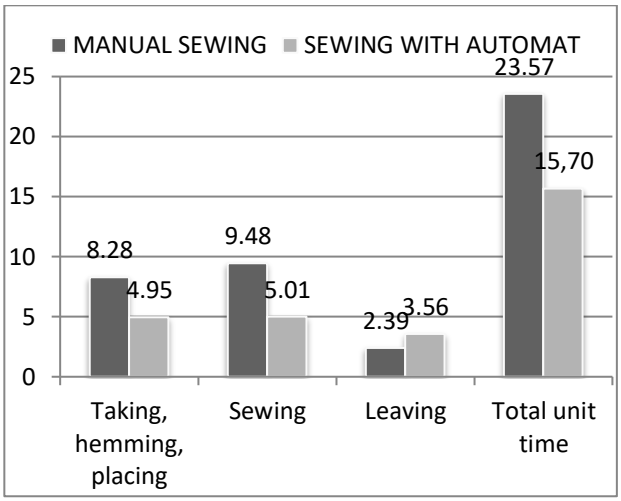

Figure 6. The units of times during bottom hemming processes

The work study processes during the sewing applications are carried out over one piece of bottom. Therefore, the following time values show the average time spent for the transactions of one bottom hemming, sewing, quick checking and leaving aside. The last columns show total unit time which is calculated basic time with addition relaxation allowance (%7) and work delays (%10).

Table 1. Manual and Automated Bottom Hemming Times

Manual Hemming Operation				Automated Hemming Operation			
Nr.	**Process level and measuring point**	**Quantity**	**Basic time (second)**	**Nr.**	**Process level and measuring point**	**Quantity**	**Basic time (second)**
1	Taking, hemming and placing the bottom under presser foot	1	8,28	1	Taking and placing the bottom under presser foot	1	4,95
2	Pressing the foot pedal Sewing the bottom hem End of sewing	1	9,48	2	Pressing the foot pedal Sewing with automat End of sewing	1	5,01
3	Putting away the bottom Taking another bottom	1	2,39	3	Putting away the bottom Taking another bottom	1	3,56
	Basic Time		**20,15**		**Basic Time**		**13,50**
	Relaxation Allowance (%7) =		**1,41**		**Relaxation Allowance (%7) =**		**0,90**
	Work Delays (%10) =		**2,01**		**Work Delays (%10) =**		**1,30**
	Unit of Time (Cycle Time)		**23,57**		**Unit of Time (Cycle Time)**		**15,70**

Figure 7. Failure types of manual bottom hemming operation and solutions with automat

In this context, performed measurements reveal that the unit time of manual bottom hemming is 23,57 seconds, while the unit time of the process conducted with the automat is 15,70 seconds. From this point of view, the time saving of 7,87 seconds for one unit, one bottom, is gained through automation used for the process in question (Table 2).

Table 2. The averages of the units of times during bottom hemming processes

Manual sewing operation	23,57 sec
Sewing operation with Automat	15,70 sec
Difference between manual and automated sewing operation per bottom	7,87 sec

When the units of times of the processes are examined, one can observe that the automat enables 33.34% of time reduction.

Moreover, some of the quality problems are likely to occur during the manual sewing of the bottoms, despite the usage of apparatus for the alignment.

The following failures, shown in Fig.7, during the manual sewing of the bottoms are encountered frequently:

- Bottom slipping: Slipping of the side joining and inner bottom stitches (non-overlapping)
- Wave effect as a result of the disproportionate stretching of the bottom
- Edge stitch width problem (non-equal distance to the edge)
- Non-overlapping of the reinforcement stitch [10].

These failures are likely to be reduced and even eliminated through the proper adjustments of the pulling and stretching settings of the automat. In this way, standardization may be achieved. Furthermore, the need of qualified personnel is eliminated for the process that requires special hand skills.

4. Discussion and Conclusion

New technologies content scientific research technologies. The advantages of these technologies can be proven by scientific methods such as this research. By using these technologies in production improving quality and decreasing production times are provided. The costs are reduced and the efficiency is increasing in this way. As a result, high efficiency can be achieved by using high technology and minimum labor force.

In this study 40 cm circumference bottom hemming production numbers are investigated. Daily (8 hours) production quantities are calculated with addition of taking and leaving times to sewing times. Product quantities are calculated as 1222 bottoms by manual sewing and 1834 bottoms by automat. Thus, decreasing production time increases efficiency and competitiveness.

As a result, automation for the processes performed in the sectors where the human factor is concentrated such as the apparel sector avoids quality problems caused by human and long production times. In this way, operations become easier for labor and also production times and costs are decreased.

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