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INVESTIGATION OF THE BIAS TAPE ROLL CHANGE TIME EFFICIENCY IN GARMENT FACTORIES

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Abstract:

In the ready-to-wear industry, bias tape is one of the many factors that affect the efficiency of the manufacturing process. In particular, the bias tape change period slows down production. The purpose of this study is to identify the effect of fabric length on the time of changing bias tape rolls. At most manufacturers, the bias tape is made by cutting an average of 1 m from the product's own fabric. In this study, the effect of bias tape fabrics cut into three different lengths on the manufacturing process was compared with three models. By producing bias tape for each model, the time spent on cutting the fabric, sewing, and changing the roll in the bias holder that feeds the lockstitch machine was calculated. It was revealed that the difference in fabric length affects the efficiency of the sewing process. Namely, it was found that the time spent on changing the bias tape roll decreased between 4.31 and 8.98%. Based on these findings, it can be said that the time efficiency can be increased by increasing the length of the fabric of the bias tape roll to be produced, and thus the production process could be accelerated.

Keywords:

Textile, fabric, bias tape, efficiency

1. Introduction

One of the main tasks of the industry is to reduce production costs, including the efficient use of resources and materials [1–3]. An important output of production indicators is the improvement of technical information, the application of modern scientific knowledge, the restructuring of technological processes, and process automation [4,5].

Today, the increasing competitive conditions in the ready-made garment industry force companies to produce their products faster and at lower costs [6,7]. It is important to solve the optimisation problems in which the garment industry is engaged in, to increase the efficiency of the company, and to reduce the time of application and the amount of consumption [8,9].

Factors that directly affect the calculation of the amount of fabric required for the production of a garment are the type of fabric, the model of the product, the dimensions of the product, etc. When all these parameters are taken into account, it becomes difficult to make accurate calculations and objectively determine the amount of the fabric [10]. Understanding fabric consumption is the most important factor in terms of production efficiency [11–13]. Fabric consumption is influenced by width and length dimensions. Hence, it should be estimated using mathematical calculations prior to actual marker making consumption [14]. Paşayev, in his study on reducing fabric waste in the production of ready-made garments, investigated the effect of production planning and marker planning on the cost of fabric [15]. Erdogan et al. found that when planning production in terms of fabric waste in garment production, determining the appropriate fabric width and length can significantly reduce fabric waste [16]. Pamuk and Yıldız, in their studies on the effectiveness of the marker planning, showed that the correct choice of fabric size in various outer garments ensures high production efficiency [17]. Yeşilpınar (2012) investigated the impact of different assortment plans on the number of units in the production of classic denim trousers, and showed that the size of the fabric used is important [18].

Although it is challenging to define a clear standard time for production processes, precision in measurements at each stage of production is essential to reduce costs and increase efficiency. Companies that plan, constantly review, and manage their production processes are more successful in increasing production efficiency [19]. Kurtul's research highlights the central role of planning in improving production speed, efficiency, and product quality in the ready-made garment industry, emphasising the indispensability of proactive planning initiatives [20].

In the field of garment production, Yücel and Güner conducted a study to elucidate the factors influencing sewing time. Their analysis included various operational variables such as reach distance, take-off distance, garment area, sewing length, sewing shape, number of sewing steps, fabric weight, and sewing machine rotation, culminating in the development of a unit sewing time equation. This equation serves as a valuable tool for more effective management and control of sewing times [21]. In addition, Upendra et al. developed a methodology for calculating laying and cutting times in the cutting departments of garment manufacturers. Using data collected on woven trouser patterns, they created a basic database of the laying and cutting processes, along with an analysis of time variations due to influential parameters. The resulting system facilitates the calculation of fabric cutting time based on parameters such as fabric type, layer height, and pattern shape, thereby improving operational efficiency [22].

Bias tape is of considerable importance in the garment industry, serving a variety of practical purposes such as edge reinforcement, aesthetic enhancement, and deformation prevention. Cutting bias tape is a critical step in the garment manufacturing process, typically involving pieces of fabric approximately 100 cm long that are sewn together to form a tubular structure before undergoing bias tape preparation using a cutting device [23]. The length of the resulting bias tape roll depends on the dimensions of the fabric used and the width of the bias tape produced. However, the frequent need to change bias tape rolls during the sewing process consumes valuable time and reduces workflow efficiency. Lengthening the bias tape rolls could potentially reduce the need for frequent roll changes, thereby reducing time wastage. To the author's knowledge, there is no empirical research in the literature on the time efficiency of bias sewing. Therefore, the primary objective of this study is to investigate the effect of the length of fabric used in the bias tape rolls on the efficiency of the manufacturing process.

2. Materials and method

2.1. Materials

In this study, cutting schedules were developed for different fabric lengths on three different models. The fabric was cut into different sizes and converted into bias rolls. The data collected were then analysed to determine the relationship between fabric length and time savings, providing comparative insights. As shown in Figure 1, different models were selected in terms of the shape and amount of bias tape. The bias is used on the collar, sleeve, and hem of the models. A cut order plan was used to more reliably determine the relationship between the data for the front, back, sleeve, and bias pattern markings that make up the model. The lengths and widths of the bias tapes for each model are given in Table 1.

Table 1. Lengths and widths of the bias tapes for each model

Models	Model A	Model B	Model C
Bias tape lengths (cm)	278	241	156
Bias tape width (cm)	3	3	3

2.2. Method

Tools, cutting equipment, and software play an important role in garment production. The role of the cutting equipment is to cut the material according to the shape quickly, efficiently, and accurately. In this study, the Lectra Modaris system was used in the process of pattern preparation and installation of the selected model (Figure 1). The pattern distribution process is carried out using the Lectra Diamino programme. In this respect, the pattern and assortment plan of the dress model was taken into account in the CAD programme of the design and pattern department. The first stage in the calculation of the model was to determine the initial data, such as the size composition and the number of products. The bias tape is not included in the pattern plan, its production is carried out on the cutting machine (Figure 2).

In this study, the bias tape was cut to three different lengths for each model. In order to accurately compare the effects of fabric length on different models, the same fabric width (150 cm) was used for all models.

To make bias tape, fabric of the desired length and quantity is prepared on a table for spreading and cutting (Figure 3) and converted into tubes by sewing on a lockstitch sewing machine.

The tubular fabric fed into the bias cutting machine is cut by a circular knife and automatically wound into a special bias roll. Bias tape cutting machines are used to cut strips of a specific width, ranging from 1 to 12 cm. The width used in the study is 3 cm.

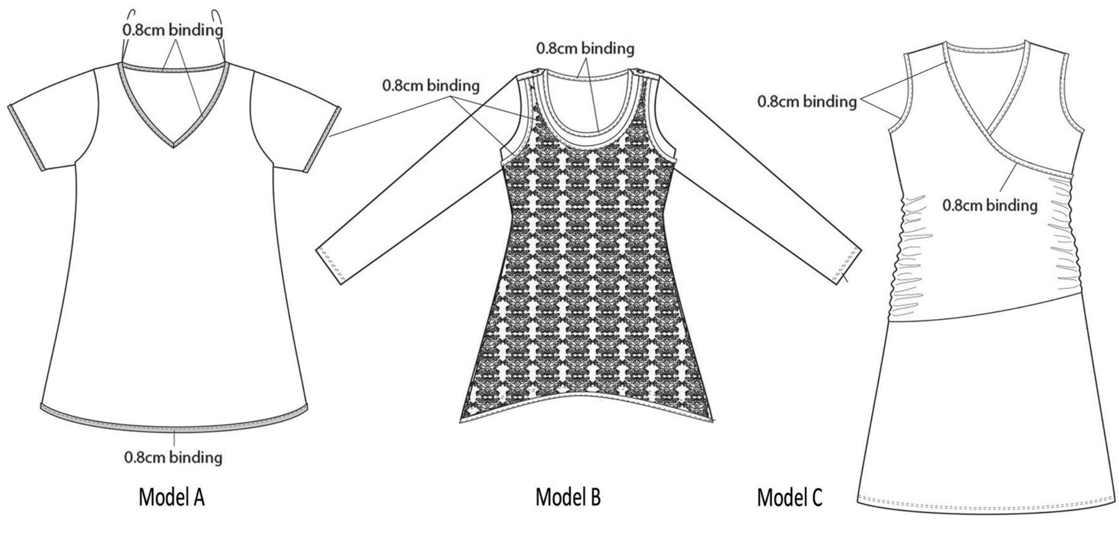

Figure 1. Technical drawing and markers of sample models.

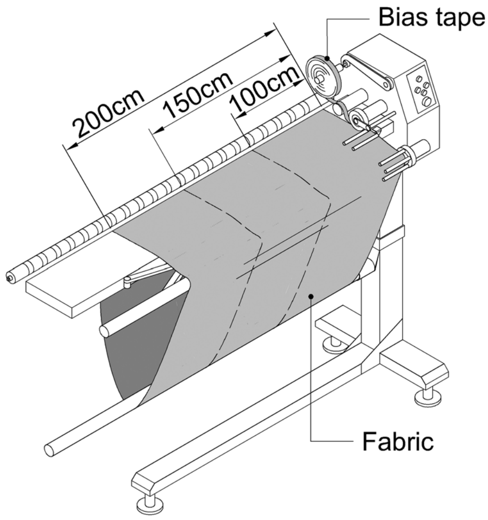

Figure 2. Fabrics of various lengths placed in a bias tape cutting machine.

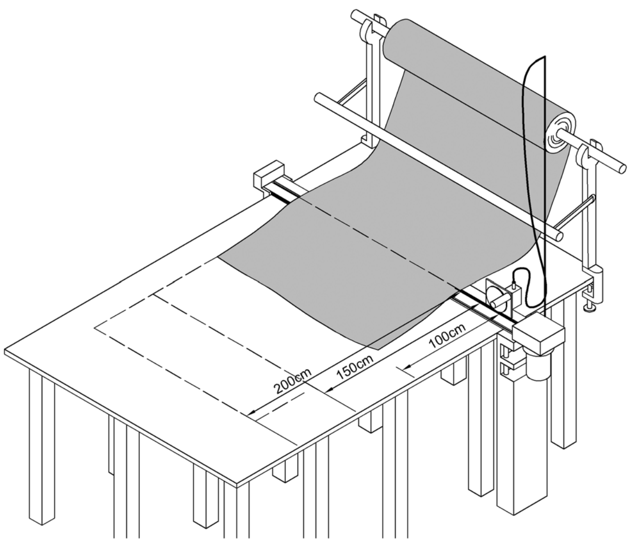

Figure 3. Fabric cutting in three different lengths (100, 150, and 200 cm).

From each piece of fabric, the length of the bias tape roll after processing on a cutting machine is calculated according to the following equation:

$$l = \frac{B(L - 2b)}{b}, \quad (1)$$

where B is the width of the fabric (in cm); L is the length of the fabric (in cm) (Figure 3); and b is the bias tape width (in cm). In this study, the bias tape width is $b = 3$ cm.

The results of equation (1) calculations are given in Table 2.

After the bias tape was sewn, the obtained bias tape rolls were placed on the holders and the bias tape sewing operations were started. Figure 4 shows an example of three levels of bias tape roll placement:

Losses and wastage that occur during the production and sewing of bias tapes are taken into account in the calculation of the cut order plan. In textile factories, the gaps between successive embroidery markers should not exceed 5 cm (Figure 5). This parameter is also taken into account in the calculations.

According to the fabric length L used in the production of bias tape, the number of rolls of bias tape to be used in the production of a batch of products can be calculated with using equation (2).

$$n = \frac{N(l_{av} + l_w)}{l}, \quad (2)$$

where N is the production amount of the model (Table 3); l_{av} is the average length of the sleeves, collars, and hems for all sizes to be produced (in cm) (Table 4); l_w is the bias tape waste between the parts sewn one after the other (in cm) (Figure 5); and l is the bias tape roll length (in cm) (Table 2). Accordingly, as the length of the bias tape roll increases, the amount of bias tape rolls decreases.
As a result of the calculations made using equation (2), the number of rolls of bias tape used in the production of the models is given in Table 5.

During the production in the factory, observations were made and time was recorded for each model produced. From the time measurements taken during the production of models A, B, and C, it was observed that the cutting (Figure 3), sewing, and positioning (Figure 2) process of each fabric used in the production of bias tapes took an average of $t_l = 15$ s; it was observed that the change in the bias tape rolls is carried out in average $t_b = 40$ s and the sewing of bias tape on one product is performed in average $t_p = 17$ s. In this case, the percentage of change in the production time by increasing the fabric length is calculated using the following equations:

$$x_{di} = \frac{(t_{Le} - t_{Ly}) \times 100}{t_{Le}}, \quad (3)$$

and the total bias sewing time for a batch of products can be determined using the following equation:

$$t_{Li} = t_p + n_{tot}(t_l + t_b), \quad (4)$$

Table 2. Bias tape roll lengths after the post-processing on a cutting machine

Model	Fabric width (cm)	Bias tape roll lengths		
		Fabric length 100 (l_{100}) (cm)	Fabric length 150 (l_{150}) (cm)	Fabric length 200 (l_{200}) (cm)
Model A	150	4,512	6,912	9,312
Model B	150	4,700	7,200	9,700
Model C	150	4,575	7,008	9,441

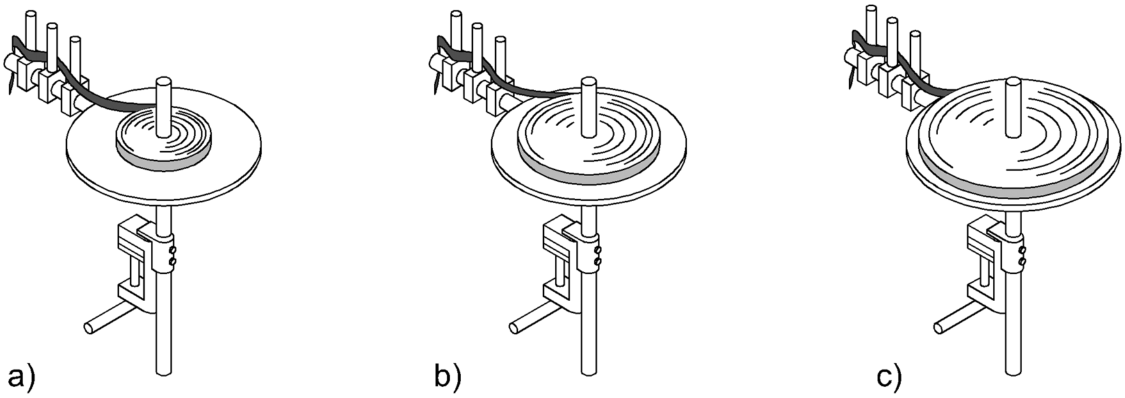

Figure 4. Bias tape roll placed on holder for lockstitch machine: (a) length 100 cm; (b) length 150 cm; and (c) length 200 cm.

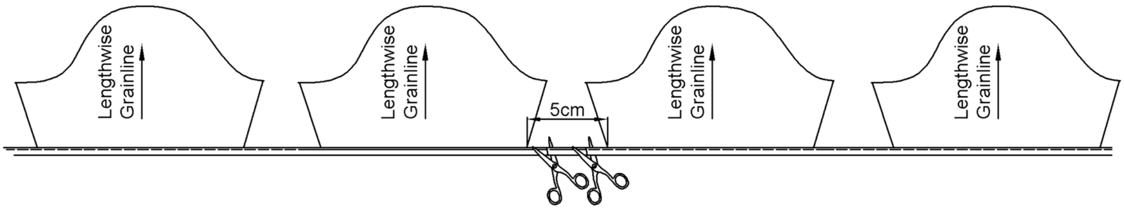

Figure 5. Sewing bias tape on the sleeves one after the other.

Table 3. Bias tape plan for the model

Model	Fabric width (cm)	Product amount (N)	Total bias tape length to be sewn on a product (cm)
Model A	150	207	274
Model B	150	180	271
Model C	150	264	202

Table 4. Dimensions of the areas where the bias tape will be applied in the models (cm)

Model	Size	XS	S	M	L	XL	XXL	XXXL	Average l_{av}
Model A	Armhole	34	35	36	37	38	39	40	37
	Collar length	67	67	67	67	67	67.5	67.5	67.14
	Hem	120	126	132	138	144	150	156	138
Model B	Armhole	28.75	30	31.25	32.5	33.75	35	36.25	32.5
	Collar length	121.6	125	128.4	131.8	135.2	138.6	142	131.8
Model C	Armhole	43.75	46	48.25	50.5	52.75	55	57.25	50.5
	Collar length	105.3	110	114.7	119.4	124.1	128.8	133.5	119.4

where x_{di} is the percent change in production time; t_{Le} is the time (min) required to sew a batch of fabric 100 cm long; t_{Ly} is the time (min) required to sew a batch of products from fabrics 150 or 200 cm long; and n_{tot} denote the sum of the amount of bias tape rolls. The calculation results are given in Table 6.

Based on these data, the relationship between fabric lengths and time savings and the change efficiency percentage of the bias tape rolls in the production process is clearly shown in Figure 6.

3. Result and discussion

In this study, the effect of the length of fabric used in the bias tape rolls in the textile industry on the productivity of the manufacturing process was investigated. To address it, a comparative analysis of three different garment models was carried out. The time required to change a roll of bias tape is one of the many factors affecting the production process. Also, it is known that the process of attaching the bias tape rolls to the machines slows down the assembly process of the markers. Therefore,

Table 5. Number of rolls of bias tape used in the production of the models as a result of the calculations made

Model	Fabric length *L* (cm)	Amount of bias tape rolls *n* (piece)			Total amount of bias tape rolls n_{tot} (piece)
		Armhole	Collar length	Hem	
Model A	100	3.85	3.31	6.56	≅14
	150	2.52	2.16	4.28	≅9
	200	1.9	1.6	3.2	≅7
Model B	100	3.3	6.02	—	≅9
	150	216	3.93	—	≅6
	200	1.6	2.92	—	≅5
Model C	100	5.02	5.63	—	≅11
	150	3.28	3.67	—	≅7
	200	2.43	2.73	—	≅5

Table 6. Percentage of decrease in the amount of changes according to the results obtained in the study

Model	Fabric length *L* (cm)	Total bias sewing time of a batch of products t_{Li} (min)	Change efficiency percentage of the bias tape rolls x_{di} (%)
Model A	100	71.48	0
	150	66.9	6.41
	200	65.06	8.98
Model B	100	59.25	0
	150	56.5	4.64
	200	55.58	6.19
Model C	100	84.88	0
	150	81.22	4.31
	200	79.38	6.48

the process of forming and using of the bias tape sewn from the fabric of the model to be made was comparatively studied on three different models, taking into account the different lengths of the fabric. To do this, first of all, fabrics of 100 cm length were used to make bias tapes of three different models, and measurements were made for sewing these fabrics from the edges and placing them in the edging machine. Then, the number of change bias tape rolls in the holder feeding the lockstitch machine was calculated according to the different lengths of the fabric (i.e. 100, 150, and 200 cm), and their effect on this time was studied.

As shown in Table 6, there is a clear correlation between fabric length and productivity percentage. From the results of this study, it can be seen that if the fabric length is 150 cm instead of 100 cm, time savings of between 4.31 and 6.41% can be achieved, and if 200 cm is chosen, time savings of between 6.19 and 8.98% can be achieved. This improvement means a noticeable increase in production efficiency throughout the manufacturing process. In addition, longer bias rolls allow smoother transitions between production runs, improving overall operational agility. The study showed that significant

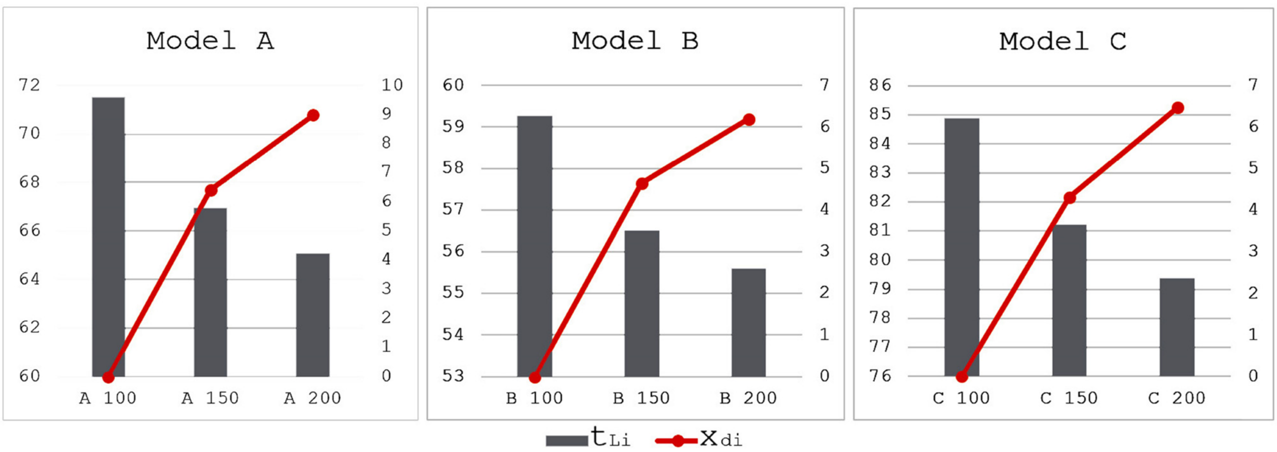

Figure 6. Comparing fabric lengths to total sewing time and the change efficiency percentage of bias tape rolls in production.

time savings can be achieved by extending the length of the bias tape roll during the garment manufacturing process. This also ensures that once the production of one model is completed, it can be quickly switched to the production of another model.

4. Conclusion

This study showed that the choice of fabric length when sewing bias tape affects the efficiency of the production process. As a result, as the length of the fabric increases, the length of the roll will increase, and therefore the number of rolls required for production will decrease. Thus, the time spent on changing rolls will be reduced and the continuity of the work process on the belt will continue more efficiently.

The findings underline the importance of optimising fabric length in bias tape preparation to improve manufacturing efficiency. By minimising the frequency of roll changes, manufacturers can reduce workflow disruptions and streamline production processes. By incorporating longer fabric lengths into production strategies, manufacturers can achieve tangible improvements in efficiency without compromising quality standards.

In conclusion, this study provides valuable insights into the relationship between fabric length and production efficiency in bias tape preparation, and emphasises the need for empirical research in this area. It is hoped that this research will contribute to a broader discourse on sourcing and production optimisation in the apparel industry.

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Conflict of interest: The author states no conflict of interest.

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