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Consumption Optimization of Materials and Accessories Used in Ready-to-Wear Sector

Hazır Giyimde Kullanılan Malzeme ve Aksesuarların Tüketim Optimizasyonu

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Abstract

Competitive advantage and sustainable growth in the ready-to-wear sector hinge on enhancing productivity. Typically, production in this sector employs an intensive approach with the contract manufacturing model. The practice of outsourcing production based on customer demands by textile companies and suppliers in Turkey directing orders to cost-advantaged outsourcing firms may result in overbuying and wastage issues in crucial processes such as material and accessory procurement and inventory management. This study aims to mitigate material and accessory losses by replacing manual cut order plan (COP) calculations with software solutions. Comparative analysis of real production data indicates that the software outperforms manual calculations, leading to a significant reduction in wastage. The findings underscore that manual calculations are prone to substantial errors, while the adoption of software not only helps companies avoid material losses but also saves valuable staff time. Furthermore, these insights can contribute to future software development endeavors by shedding light on the extent of wastage caused by erroneous calculations across various materials and for different ready-to-wear models.

Keywords: Productivity, Ready-to-wear, Software, Accessories, Reducing waste.

Öz

Hazır giyim sektöründe rekabet avantajı ve sürdürülebilir büyüme, hazır giyimde verimliliği artırmaya bağlıdır. Bu sektörde üretim, genellikle fason üretim modeliyle yoğun bir şekilde sürdürülmektedir. Tekstil firmalarının müşteri taleplerine göre fason üretim yapması, Türkiye'deki tedarikçi firmaların maliyet açısından avantajlı fason işletmelere sipariş yönlendirmesi, malzeme ve aksesuarların alımı ve stok yönetimi gibi süreçlerde fazla alım ve israf sorunlarına neden olabilir. Bu çalışma, manuel asorti raporu hesaplamalarının yerine yazılım kullanarak malzeme ve aksesuarların kayıplarını azaltmayı amaçlamaktadır. Gerçek üretim verileri üzerinden yapılan karşılaştırmalar, yazılımın manuel hesaplamalardan daha verimli olduğunu ve israf miktarını önemli ölçüde azalttığını göstermektedir. Bulgular, manuel hesaplamaların büyük hatalara neden olduğunu ve yazılımın firmaların maddi kayıpları önlemesine ve personel zamanından tasarruf etmesine yardımcı olduğunu ortaya koymaktadır. Ayrıca, elde edilen bulgular, farklı modeller için yapılan hatalı hesaplamaların çeşitli malzemelerde israf miktarını ortaya koyarak gelecekteki yazılım geliştirme çalışmalarına katkıda bulunabilir.

Anahtar Kelimeler: Verimlilik, Hazır giyim, Yazılım, Aksesuar, Atık azaltma.

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1. Introduction

The apparel sector is a dynamic industry under pressure to adapt rapidly to changing fashion and consumer demands. Gaining a competitive advantage and achieving sustainable growth in this sector is closely linked to increasing productivity. Efficiency in apparel means more effective use of production processes, resources and labor. Increasing productivity is a critical factor not only to reduce costs but also to achieve sustainability goals (Eser et al., 2016). Productivity focuses on evaluating how the resources used in production are used effectively (Güner and Yücel, 2014). Fast fashion and short product lifespans increase the volume of discarded accessories, compounding the waste problem (Stanescu, 2021; Niinimäki et al., 2020; Shirvanimoghaddam et al., 2020). Therefore, any improvement in the production process will positively affect productivity (Güner, 2005).

Apparel companies make contract manufacturing in the quantity demanded by the customer (Özbek and Esmer, 2022; Arslan, 1987). Brand owner firms work with suppliers when placing orders. The supplier company in Turkey gives the orders it receives to subcontracting companies which are more advantageous in terms of cost (Arslan, 2013). In order to meet these production needs, purchasing takes place, which can sometimes cause a problem with over-purchased materials leading to additional costs. The purchase of surplus materials is inevitable, but by accurately determining the amount of material to be purchased in advance, the amount of surplus material can be minimized.

Once a particular item is determined to be surplus, it is the responsibility of the purchasing unit to dispose of it. In managing this process, the purchasing unit communicates surplus records to other units, including necessary product data such as quantity and value (Smith, 1956). In this context, in addition to purchasing products, the purchasing unit also plans the units in which surplus materials can be consumed (Chunawalla, 2008). Therefore, the purchasing unit undertakes the task of managing the evaluation or disposal of surplus materials in the most efficient and effective way. Disposing of unused materials is a beneficial decision for the company in many ways. This is because the disposal of these materials not only helps to compensate for the financial loss to some extent, but also helps to save on maintenance costs, free up space in warehouses, eliminate clutter in warehouses and reduce the cost of storing materials (Muller, 2002). On the other hand, there are some risks in the disposal of surplus products. Due to the continued operational consumption of manufactured products, the organization may need to repurchase them in the future. Therefore, excessive liquidation of these materials may force the company to organize re-purchase. This requires a choice between the proceeds from the sale and the reduced cost of storing the materials and the potential cost of repurchasing (Willoughby, 1999). Companies should take into account the potential future need for surplus materials when making any disposal, or units should firmly decide that these materials will no longer be used (Pham, 2018).

Chunawalla (2008) identified the following ways to dispose of surplus materials through different channels: distribute to other parts of the company; return to the supplier; sell through the purchasing department; sell to employees; or donate. One way to dispose of excess materials is to return them to vendors. However, factors such as the return period, the condition of the material and price changes have an impact on this process. Holding surplus for a long time can lead to a loss of value due to deterioration in quality or obsolescence. External sales are initiated when internal units are unable to transfer surpluses or return them to suppliers (Smith, 1956). Surplus products can also be sold to dealers, other firms and even to company employees. Obviously, there are various difficulties in dealing with surplus materials, and given the extra time and energy required of staff to deal with them, the most important point to emphasize is to ensure that the quantity of materials needed is initially determined accurately and purchased in the required quantity.

In general, when determining the amount of material needed, calculations are made by taking into account the size distribution of the model to be produced in the asorti report (COP) (Alsamarah, 2021). In most enterprises, this distribution is organized through the COP. This document includes the calculations of 1 or more lozenge layouts. These manual calculations become very difficult when the number of sizes is large, the number of production between sizes varies greatly, and the total number of products to be produced is very large. Considering such data, it is not easy to save fabric by making an optimal pastal laying plan. In these calculations, the amount of fabric consumption per product is determined. When the consumption amount of a product is calculated and the customer requests a certain number of this product to be produced, fabric and accessories are purchased against the consumption value. The calculations to determine the consumption are done manually, based on estimates or based on the values of similar models sewn before. Therefore, without precise data, the margin of error in calculating the fabric required for production and the accessories to be used in its sewing can be quite high.

In order to avoid such material wastage, some researchers have developed software that makes more accurate calculations. For example, Tatman's (2021) research compared the traditional sample production method, which is widely used in the garment industry, and the virtual sample production method, which adopts digital workflow, in terms of fabric, labor, accessories and consumables costs and production time. The study found that the use of digital workflow resulted in a significant reduction in labor and consumables costs. In addition, Doğan and Pamuk (2014) examined the relationship between woven fabrics of different thicknesses, stitch types and sewing steps in order to reduce the cost of sewing thread, which is widely used in the apparel industry. In this context, they created regression equations to calculate the amount of sewing thread consumed and converted these calculations into a computer software. This software helps to avoid thread waste by accurately calculating the amount of thread consumed for a given sewing zone with known stitch length, fabric thickness and number of stitch steps. Nowadays, there are software (e.g. Form1, Optitex Cutplan, Geminicad Cut-planner) that can generate automatic assortment reports (Arsoy and Aslan, 2023; Optitex, 2023; Gemini, 2023). This type of software generates the optimum pastal laying plan with the data entered, which saves fabric by reducing the number of fabric plies. Thus, the deficiency in fabric rolls (fabric relaxation) (Kalkancı and Kurumer, 2017) is partially eliminated and the requested number of products can be produced.

Shehata stated that detailed cost analysis of accessories is critical in the product design and cost optimization process, and that costs can be reduced through appropriate design and technical solutions (Shehata, 2024). In previous studies, optimization calculations were generally performed for basic material types such as fabric and yarn (Dogan and Pamuk, 2014; Kalkancı and İhsan, 2018; Eren and Pamuk, 2019; Jaouadi et al., 2006). However, many other materials and accessories are used during production, such as zippers, labels, caring labels, hangers, eyelets and buttons, and there is a need to determine how much of these are wasted due to miscalculations in production in order for companies to be more sensitive in taking precautions. To the best of the author's knowledge, there is no previous study that has done a comprehensive calculation for these types of materials and accessories.

Therefore, the aim of this study is to determine the amount of reduction in material losses in case of optimization of the materials to be purchased by calculating the COP of the product to be produced with software. For this purpose, manual COP calculation and material and accessory data of the actual products produced in a textile company were obtained and the material consumption amounts obtained from the calculations made with the COP computer software were compared.

2. Materials and Methods

2.1. Materials

Since fabric and material calculation is usually done manually in textile production, errors in these calculations can lead to wastage of products. For this reason, this study uses Form1, a computer software developed by Arsoy and Aslan (2023), which can calculate the required amount of fabric by making an optimum assortment report for a desired number of products by taking into account the number of products, fabric quantity, and size distribution information. The values obtained with the software are compared with the actual production data of a textile company to calculate how much product waste occurs. For this purpose, information on 10 models whose production could not meet the demanded number of products was obtained from the textile company and the analysis was carried out with these data (Figure 1).

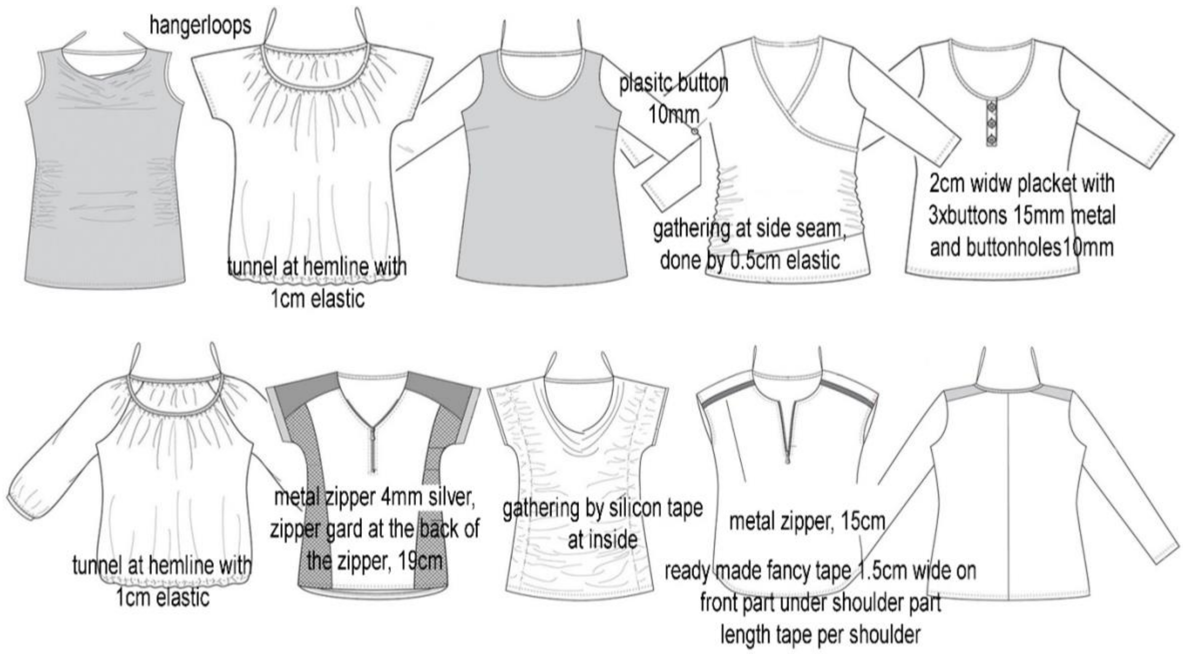

Figure 1. Technical drawings of produced models.

2.2. Methods

In this study, Form1 and Lectra Diamino marker planning software were used to re-analyze the number of products produced in the factory due to fabric shortages and to investigate how much of these shortages can be eliminated. First of all, the ply, length and consumption data based on the COP calculated manually in the factory were obtained for 10 different models. In order to show how the calculations are made through an example, the calculations of Model 1 are made below. The manually prepared COP of the completed Model 1 is given in Table 1. Table 2 and 3 shows the results of the recalculated COP of Model 1 using software.

Table 1. COP of the manufactured model 1, calculated manually in the factory.

MODEL 1									
Fabric width: 1.48 m	Total number of products to be produced: 1184								
Size	44	46	48	50	52	54	56	Layers	Length, m
Amount	124	185	288	252	165	124	46		
Marker 1	4					4		31	3.93
Marker 2			4	4				63	3.84
Marker 3		4			4			42	3.84
Marker 4							4	12	3.30
Marker 5		4						5	1.88
Marker 6			4					9	1.91
178 products will be produced					Calculated fabric, m				592
					Fabric in stock, m				503
					Remaining fabric, m				- 89
					Consumption				0.50

The calculated fabric is equal to the sum of the multiplication of the layers and lengths for each size:

$$\sum_{i=1}^{n} k_i * l_i \quad (1)$$

Where n is the number of markers; k_i is the layer of the i -th marker; l_i is the length of the i -th marker.

The following equation is used for the remaining fabric after consumption and production:

$$C = F/P \quad (2)$$

$$R = S - F \quad (3)$$

Where C is the consumption value, F is the calculated fabric, P is the total number of products to be produced, R is the fabric remaining after production, S is the fabric in stock.

Looking at this data, according to the manually calculated plan, the fabric in stock was 89 m less and 178 products could not be produced. However, when the optimum calculation is made with the software, it is seen that actually all of the products can be produced and the fabric in stock is 59.41 m excess. In other words, the amount of consumption decreased from 0.50 to 0.37. Therefore, it is clear that a lot of materials and accessories were wasted for 178 products when production was made according to the calculations made at the beginning (Table 4).

3. Findings and Discussion

In the research, ten different models with incomplete production processes were analyzed (Figure 1). The examined models were produced in a ready-to-wear production line, encompassing all stages from raw fabric to the finished product. Typically manufactured using a mass production method, these models were sewn under a piecework workflow system (classical production line). When the manual calculation and software calculations are compared (Tables 2 and 3), it is seen that 6 models can be produced completely when the software calculation is used, and the underproduction in the other models can be reduced to a great extent.

Table 2. Fabric usage in meters.

Model	Fabric amount	Fabric Required (Manual Calculation)	Fabric Required (Software Calculation)	Remaining Fabric (Manual)	Remaining Fabric (Software)
1	503	592	443.6	-89	59.4
2	2997	3292	2969	-295	28
3	250	470	355	-220	-105
4	389	424	388	-35	1
5	256.7	297	270.4	-40.3	-5.7
6	1084	1118	1053.4	-34	30.6
7	112	121	97.69	-9	14.3
8	1392	1496.5	1432.4	-104.5	-40.4
9	1720	1788	1720.4	-68	-0.4
10	1752	1787.5	1682.7	-35.5	69.3

Table 3. Incomplete Production.

Model	Incomplete Production (Manual)	Incomplete Production (Software)
1	178	0
2	267	0
3	338	212
4	38	0
5	50	8
6	38	0
7	29	0
8	124	47
9	81	1
10	28	0

The list and number of accessories purchased for each model and stored in the warehouse without being used is shown in Table 4. A total of 1171 products were produced incompletely in the sewing of 10 models. This number was reduced to 268 with 973 metres of fabric saved by the software. These results show that if the software calculation is used in the COP, 903 of the missing products can be produced and it is possible to use most of the material in Table 4 that is exposed to storage.

Table 4. Number of materials and accessories that are not used and can be produced by saving for each model.

Accessories	**Unused Accessories Total**	**Saved Accessories per model**										**Saved Accessories Total**	**Savings Percentage**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
5000 m Bobbin, pieces	23.13	2.8	3.5	3.2	0.9	0.9	0.4	0.9	1.4	1.6	1.0	**16.6**	**71.7**
Price label	663	178		125			38			80	28	**449**	**67.7**
Care label	391		267						77			**344**	**88.0**
Size label	117				38	42		29				**109**	**93.2**
Brand label	124								77			**77**	**62.1**
Collar label	831		267	125	38	42		29		80	28	**609**	**73.3**
Caring label	742	178		125	38	42		29		80	28	**520**	**70.1**
Hanger	2108	356	534	250			76		154	160	56	**1586**	**75.2**
Elastic band (1 cm width), meters	287		251				36					**287**	**100.0**
Elastic band (0.5 cm width), meters	16.5				16.5							**16.5**	**100.0**
Silicone strip (0.5 cm width), meters	164								101.7			**101.7**	**62.0**
10 mm polyester button	676			250								**250**	**37.0**
15 mm metal button	250					210						**210**	**84.0**
Standard tag pin (65 mm)	38						38					**38**	**100.0**
Standard tag pin (25 mm)	447			125						80	28	**233**	**52.1**
19 cm metal zipper	29							29				**29**	**100.0**
15 cm metal zipper	81									80		**80**	**98.8**
Zipper protector	110							29		80		**109**	**99.1**
Decorative tape (1.5 cm width), meters	33									33		**33**	**100.0**
Clip for attaching label	38				38							**38**	**100.0**
Sticker	88				38	42						**80**	**90.9**

4. Conclusions and Recommendations

In order to eliminate the waste of materials and accessories resulting from the manual calculation of the COP in textile companies, this study has shown the differences resulting from the calculation with the software. To do this, data was collected on 10 models actually produced and the amount of material and accessories left in stock after production was determined. More accurate calculations were then made using the software to determine how much product could be produced with the fabric in stock. When the manual and software data were compared, it was found that many products that could not be produced as a result of the manual calculation could actually be produced as a result of the software producing a more efficient as-built report. In other words, while all models were incompletely produced between 28 and 338 units by manual calculation, it was calculated that 6 of these products could actually be fully produced using the software and the incomplete production for the other 4 models would be between 1 and 212 units. Therefore, this study has shown that when the COP is produced using the software, the use of materials and accessories in stock for these models will increase and the amount of waste will be greatly reduced.

The results of this research show that manual calculations made in factories can lead to high rates of error and result in a large number of accessories and materials being left in factory stores unused. If it is not possible to reuse these materials, the company suffers financial losses due to these materials. Storage of these materials in warehouses is a problem because they take up space and cause wear and tear on the product in the long term. Disposing of leftover materials requires extra staff time and energy. Therefore, as shown in this study, the use of computer software, such as Form1, to carry out the calculations for the COP, which takes many parameters into account and makes precise calculations, instead of manual calculations, provides a significant optimization in the use of materials. By correctly estimating needs and using materials with maximum efficiency, companies can avoid both financial losses and save staff time and energy.

Another contribution of this research to the field is that it comprehensively reveals the amount of waste caused by incorrect calculations for different models in a real production process for many types of materials and accessories such as buttons, labels, hangers, elastic bands, eyelets and zips. It is anticipated that this data and knowledge will pave the way for future studies in this area and provide new foundations for software development.

Statement of Conflicts of Interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

The author declares that this study complies with Research and Publication Ethics.

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