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ANALYSIS OF TRADITIONAL TURKISH CLOTHING PATTERN FORMS: 3D VIRTUAL APPLICATIONS

GELENEKSEL TÜRK GİYİM KALIP FORMLARININ İNCELENMESİ; 3D SANAL UYGULAMALAR

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Abstract

When examining the pattern shapes of traditional Turkish garments, it is evident that a different technique was used compared to modern methods. It has been observed that instead of round cutout forms in patterns at areas like the armhole, neckline, waist, and crotch, triangle or square pieces were added, and straight cuts were made. This pattern-making method's impact on the fit of the garments and their functional contribution to freedom of movement is the subject of investigation. To reach conclusive results in the study, pressure,stretching and tension tests in various positions were necessary. Since trying these processes to traditional garments with significant cultural value is not feasible, the application was carried out using digital twins of the garments. For this purpose, üçetek, a traditional women's garment from the Tavas district, was chosen. Using field scanning methods, a technical form has been created. These measurements and pattern forms were replicated exactly and used to prepare patterns in 3D-software. The fabric and other materials of an original and historically dated üçetek were used as samples and dressed on an avatar in the 3D software. Movements specific to the upper body, such as arm and waist movements, were applied to the üçetek and göynek, while movements influenced by the crotch form were tested for the şalvar. As a result of the research, it was observed that pattern cutting facilitate ease of movement in garments. It can be stated that these garments are ergonomic and functional, allowing daily movements to be performed with ease.

Keywords: 3D Fashion Design, Pattern Round Cutout Forms, Computer-Aided Pattern Design, Traditional Costumes, Digital Twin

Öz

Geleneksel Türk giysilerinin kalıp oyuntu formları incelendiğinde, günümüzden farklı bir teknik kullanıldığı göze çarpmaktadır. Kol oyuntusu, yaka oyuntusu, bel ve ağ kısımlarında oyuntu formu yerine parça eklendiği ve düz kesim yapıldığı gözlenmiştir. Bu kalıp hazırlama yönteminin, giysilerin vücuda uyumu ve ergonomik açıdan hareket serbestisine etkisi araştırmanın konusudur. Çalışmada doğru sonuca ulaşılabilmesi açısından farklı pozisyonlarda esneme germe denemeleri yapılmıştır. Kültürel değeri olan eski giysilerde bu işlemlerin uygulanması mümkün olmayacağı için; uygulama giysilerin dijital kopyaları ile gerçekleştirilmiştir. Bu amaçla Denizli ili Tavas ilçesi geleneksel kadın giysisi olan üçetek (henteri) giysisi seçilmiştir. Alan taraması yöntemi ile üçetek(elbise), göynek ve şalvar üzerinde ölçüm yapılarak teknik föyler oluşturulmuştur. Teknik detaylara göre giysinin orijinal kalıbı elde edilmiştir. Bu ölçüler ve kalıp formları birebir uygulanarak 3D giydirme yazılımında kalıplar hazırlanmıştır. Orijinal ve eski tarihli bir üçeteğin kumaş ve diğer malzemeleri örnek alınarak 3D giydirme yazılımında avatara giydirilmiştir. Üçetek ve göynekte üst bedene özgü kol ve bel hareketleri, şalvarda da ağ formundan etkilenen hareketler uygulanmıştır. Araştırma sonucunda kalıp oyuntularının; giysilerde hareket rahatlığı sağladığı gözlenmiştir. Günlük hayatta yapılan hareketlerin kolaylıkla yapılabildiği ve giysilerin bu anlamda ergonomik olduğu söylenebilir.Çalışma geleneksel giysilerin teknik detay ve ölçülendirmesini sağlamıştır. Giysilerin beden üzerindeki gerginlik ve basınç değerleri ile giyen kişiler üzerindeki ergonomik etkileri de tespit edilmiştir.

Anahtar Kelimeler: 3D Moda Tasarım, Kalıp Oyuntu Formları, Bilgisayar Destekli Kalıp Hazırlama, Geleneksel Giysiler, Dijial İkiz

INTRODUCTION

Clothing, which initially emerged as a necessity of life, gradually integrates the accumulated knowledge of the society in which it exists and transforms into a cultural phenomenon (Ural, 2023)In Turkish culture, the characteristics and origins of clothing trace back to Central Asia. It has a long historical background and has interacted with a vast geographical area over time. Changing belief systems and cultural exchanges have enriched the diversity of garments (Koç & Çelik, 2015). Türkiye possesses a remarkably rich variety of traditional clothing. While regional differences exist, garments such as entari, şalvar, and kuşak continue to be prevalent across all regions (Özus, Erden, & Tufan, 2014).

The essential qualities expected from a garment include suitability for its intended use, freedom of movement, material quality, adaptability to climate conditions, ergonomic comfort, durability, and ease of maintenance. Traditional clothing embodies many of these attributes. Given the climatic conditions of the time, limited material resources, and the need to support physically demanding labor, these garments are considered highly functional. Their ability to maintain a standardized pattern form for many years further reinforces this idea.

Traditional Turkish Clothing Pattern Forms

In traditional Turkish clothing, layered dressing was preferred according to lifestyle. Additionally, geometric pattern forms were used ((Şahin, 2016), (Aktaş & Adanır, 2024)). Due to the narrow width of the fabric, garment forms were observed to be created by adding strips and side inserts to maximize fit to the body. Considering that the patterns consist of square, rectangular, circular, and triangular pieces, it can be said that a technique called "geometric cutting" was employed (Şahin, 2016).

The most important factor in garment pattern design was the narrow width of the fabrics woven on the looms of the time. As a result of narrow weaving, narrow sleeves and bodices widened with side inserts stand out. Nonetheless, they utilized pattern forms that ensured the highest efficiency from the narrow fabric (Aktaş & Adanır, 2024). In daily life, narrow sleeves and bodices pose challenges for bodily movement. These additions not only provided freedom of movement but also helped create aesthetically harmonious garments that fit the body. During the pattern-making stage, it was crucial to create suitable forms for movement freedom in joint areas such as arms and legs. Garment form is important in adapting to the differences in the body during movement and static postures. Anthropometric measurements and ergonomic features are prioritized in garment patterns (Vural, Koç, Koca, & Pamuk, 2006).

The üçetek was referred to as henteri in colloquial language. It is also the name given to the dress of the üçetek outfit. The üçetek consists of three separate pieces below the waist to allow freedom of movement. It is worn over the şalvar and göynek. It can have U-shaped or V-shaped necklines (Koçu & Koçu, 1967), (Sözen & Geyik Değerli, 2022).

The şalvar, which holds a significant place in Turkish clothing culture, has been seen in various styles throughout Anatolia (Koca, Koç, & Vural, 2007), (Enes & Doğan Sözüer, 2024). Today, it continues to be worn in many villages across Anatolia. Developed under the influence of horseback riding culture, the şalvar is now used in modern cuts (Enes & Doğan Sözüer, 2024). The şalvar is worn with a drawstring or elastic at the waist and cuffs. Square pieces are added to the crotch area of the şalvar to facilitate movements such as stretching, bending, and leg mobility (Baran & Koca, 2018). According to Baran and Koca (2018), rectangular or triangular gusset pieces added to the crotch of the şalvar were used to provide ease of movement, such as bending and stretching. They noted that şalvars without pieces tended to have wider cuts.

The göynek is worn over the şalvar and under the üçetek. It can be considered an undergarment. It is traditionally included in bridal trousseaus without an opened neckline. On the wedding night, the bride creates the neckline cutout (Koca & Kırkıncıoğlu, 2016).

3D Fashion Design Software

3D fashion design software is widely used in the industry for the sample preparation process. Instead of producing physical samples, digital samples are created as they achieve the same results, offering a sustainable alternative in the decision-making process for the final prototype of the model to be produced. In such software, the measurements, and features of the avatar (virtual mannequin) can be modified and adjusted to match size charts (Aydoğdu, Yeşilpınar, & Erdem, 2017), (Tatman, 2021), (Tatman, Soydan & Gümüş, 2022), (Ural & Tatman, 2025).

Research and industries usage have also supported that digital samples are identical to physical products ((Porterfield & Lamar, 2017), (Power, 2013), (Zangue, Pirch, Klepser, & Morlock)). Therefore, older, culturally significant products can also be studied in a 3D environment to test patterns, ergonomics, and various other aspects.

While simulating garments in 3D dressing software, the software can detect the effects of gravity on the fabric, the pressure it creates on the body, and its tightness or looseness values. These values offer the opportunity to identify and correct potential issues before physical production.

Upon reviewing the literature, Koçu (1967) prepared a dictionary providing detailed information on traditional Turkish clothing. Şahin (2016) conducted research on pattern analysis in traditional Turkish clothing and highlighted the characteristic of geometric cutting patterns. Enes and Sözüer (2024) addressed şalvar patterns and zero-waste pattern placement. Vural et al. (2006) conducted a detailed study on sleeve forms in traditional women's garment patterns. Aktaş and Özkavruk Adanır (2023) focused on the zero-waste principle in pattern placement for traditional Turkish women's clothing production. They emphasized achieving garments with maximum efficiency from fabrics without waste. Regarding the traditional women's clothing of Denizli's Tavas district, Erden, Tufan, and Özus (2014) investigated the traditional women's clothing of the Tavas district. Koca and Kırkıncıoğlu (2016) examined traditional bridal attire in Denizli. Esirgenler and Başaran (2008) designed creations inspired by three-piece dresses (üçetek) from Hırka village, Tavas.

METHODOLOGY

In the present day, the üçetek is still worn at henna night ceremonies in Denizli's Tavas district. From a pattern form perspective, the use of original patterns from the earliest examples of the üçetek to today provides an opportunity for detailed analysis. When the üçetek attire is viewed holistically, it consists of various pieces such as head accessories, şalvar, göynek, üçetek, kuşak, and socks. As the research focuses on round cutout forms in patterns of armhole, neck and crotch, the study is limited to garments featuring these characteristics (üçetek, göynek, şalvar).

The research population consists of the garment pieces of the üçetek (henteri) from Denizli's Tavas district. In this context, field research was conducted to access as many garments as possible and create accurate digital copies with proper pattern measurements and materials. Measurements were taken from the garments, pattern forms identified, and garment owners' registration information collected. The study received ethical approval from Pamukkale University's Social and Humanities Research Ethics Committee on January 13, 2025, under protocol number 68282350-2025-01.

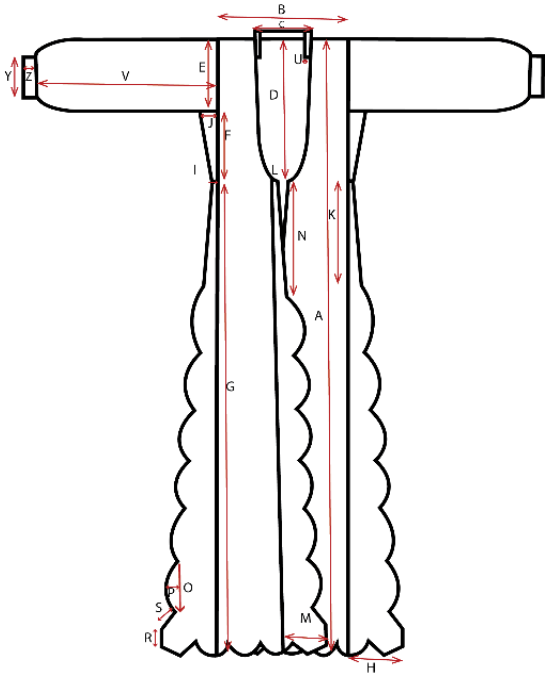
The study analyzed 64 üçetek, 22 göynek, and 28 şalvar garments, all created between 1900 and 1997. It was observed that the measurements of the analyzed garments were similar. Certain measurements were found to be standardized, recurring across multiple garments. Technical information forms for the garments were created based on the most frequently recurring measurements.

Using the obtained technical drawings and measurements, patterns were prepared in 3D fashion design software, and dressing and fitting processes were performed on avatars. To ensure accurate results from garment testing, original fabrics and embellishments were utilized in the 3D garments. For each model, tension maps and pressure maps were analyzed during various poses. These values indicate the tension and pressure exerted on the body when the garment is worn.

Üçetek (Henteri)

The term Üçetek (Henteri) is used to refer to both the complete set of garments and the individual long dress (entari) worn over the ensemble.

Table 1. Technical form for üçetek

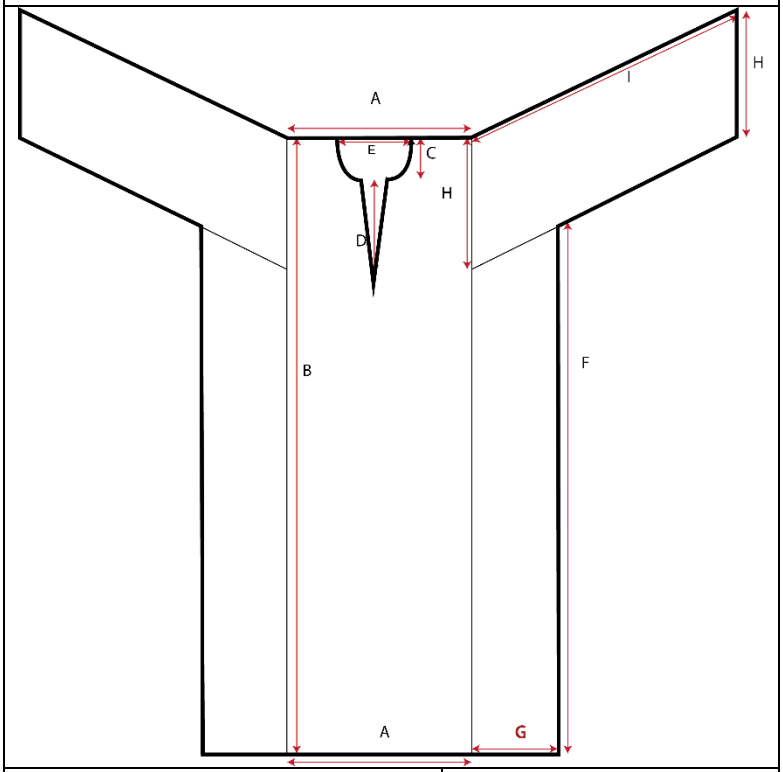
Üçetek technical drawing		Measurement Points	Measurements (cm)
	A	Model Lenght	120
	B	Shoulder Width	42
	C	Back Neck Width	12
	D	Front Neck Depth	28
	E	Armhole Depth	17
	F	Underarm Gusset Length	14
	G	Side Panel Length	103
	H	Side Panel Hem Width (Front-Back)	12
	I	Side Panel Upper Width	2
	J	Underarm Gusset Width	8
	K	Side Panel Wave Starting Point	16
	L	Front Panel Upper Width	2
	M	Front Panel Hem Width	13
	N	Front Panel Closure Depth	28
	O	Wave Width	10
	P	Wave Depth	3
	R	Corner Wave	3,5
	S	Corner Wave Depth	3,5
	T	Neckline Length	20
	U	Neckline Binding Width	1
	V	Sleeve Length	45
	Y	Cuff Length	20
	Z	Cuff Width	4
		Sleeve Cuff Vent	8

In the garment, the shoulders are formed by bringing a single-width fabric from the back to the front without any seams. The neckline and front center are later cut out to shape. Rectangular-cut sleeves are attached, and gusset pieces and side panels (peş) are added to the sides. Üçetek share similar features in terms of sewing and pattern making. Although there are slight variations in length measurements, patterns are placed and cut according to the width of the fabric to achieve zero waste (Aktaş & Adanır, 2024). At the junction of the bodice and sleeves, gusset pieces tapering towards the waist can be found under the arms (Koca & Kırkıncıoğlu, 2016).

Göynek

In the Tavas region, göyneks are widened by adding pieces to the sides. The fabrics are typically woven from materials such as cotton or silk, often crinkled or plain cloth. When making a göynek, as much fabric width as available is used. The fabric is cut to the total length of the front and back. There are no seams at the shoulders. The neckline is opened later by cutting the center. Due to insufficient bodice width, pieces are added to the sides. The part of this additional piece that comes under the arm forms a triangular shape resembling a pencil tip. Similarly, to ensure width at the hem, triangular pieces are added where the back and side panels meet.

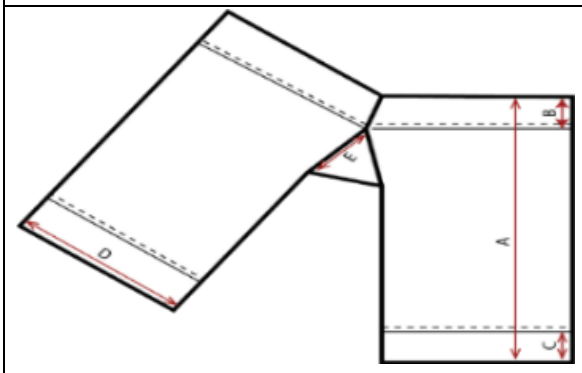
Table 3. Technical form for göynek

Göynek technical drawing		
		
Measurement Points		**Measurements (cm)**
A	Shoulder Width-Weaving Width	30
B	Model Length	85
C	Front Neck Drop	6
D	Front Neck Vent	22
E	Front Neck Width	16
F	Side Panel Length	66
G	Side Panel Width 1/2	15
H	Armhole Depth-Sleeve Width (1/2)	19
I	Sleeve Length	45
İ	Skirt Triangle Piece Length	35
J	Skirt Triangle Piece Width	10

Şalvar

In the Tavas region, şalvar is used with a high crotch and reaches knee length. A square-shaped gusset piece is located in the crotch area. While the drawstring and cuffs are made of American cloth, the gusset piece in the crotch area is made of printed cotton fabric (basma). The lining fabric inside the şalvar is the same as that of the üçetek. The main parts are also made from the same fabric as the üçetek.

Table 2. Technical form for şalvar

Şalvar technical drawing		
		
	Measurement Points	**Measurements (cm)**
A	Model Length	85
B	Waist Elastic Groove	10
C	Hem Elastic Groove	10
D	Hem Width	80
E	Crotch Gusset Piece Length	20

Production of Garments in 3D Software Programme

The materials of a 1900-dated üçetek from the Teffekkül Ömürlü archive in Garipköy, Tavas district, formed the basis for the fabric and technical characteristics of the 3D garment (Figure 1). In original garment striped wowen fabric was used. Line based weaving has enabled the people of Anatolia to encode their observations of nature, accumulated knowledge, and belief systems into textiles, by harnessing the line's full expressive potential and memory function (Uğurlu, 2021;257). In the Tavas region, şalvar and üçetek are made from the same fabric. Both garments are lined with plain cloth (kaput). The crotch and drawstring sections of the şalvar are completed with materials such as muslin and printed cotton fabric (basma).

Figure 1. Üçetek

The garments were dressed on a standard size 38 avatar. Measurements identified during field research were generally close to each other. Therefore, it was observed that the üçetek garment has standardized size characteristics, even if custom-made. Thus, an avatar with standard size 38 measurements and

average height was created using references from the literature (Aldrich, 2008); (Cihangir, 2002); (Shoben & Ward, 1987).

As shown in Figure 2, renderings of the front, back, and side views of the üçetek, şalvar, and göynek were added to the human-shaped avatar.

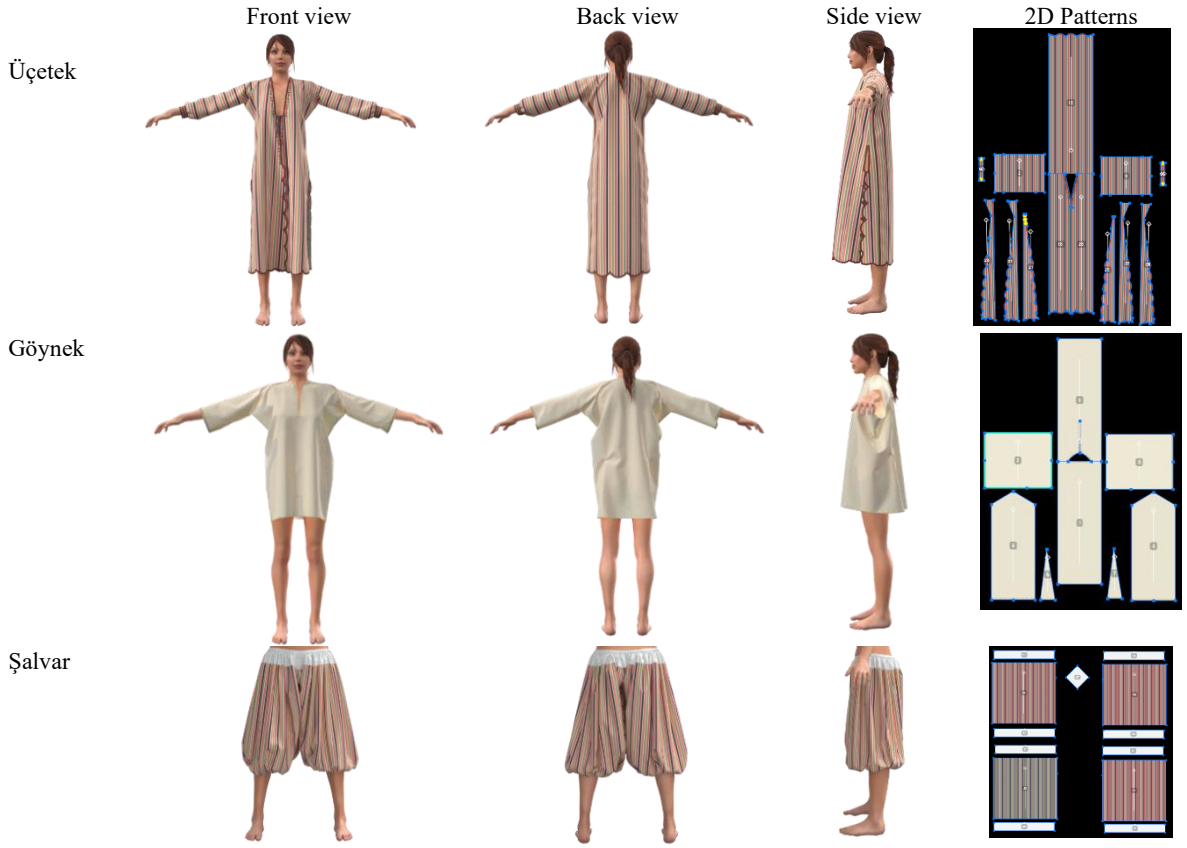


Figure 2. 2D patterns and front, back, and side views of the üçetek, şalvar, and göynek

FINDINGS

The tension and pressure values from the study conducted using Browzwear V-Stitcher software are presented in Figure 3 and Figure 4. It can be noted that colors ranging from green to orange indicate garments suitable for the body. Light blue and white colors show that the garment is loose, while red indicates tightness and tension.

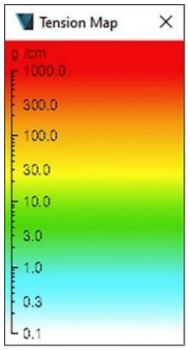


Figure 3. Tension maps

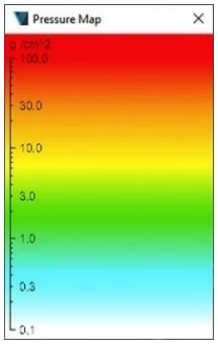


Figure 4. Pressure maps

Fitting studies were conducted on the avatar in different poses to identify the tension and pressure maps of the üçetek garment. To clearly observe the tension maps and pressure maps values, the garment was dressed on a black mannequin-style avatar, and screenshots were taken (Figure 4, Figure 5).

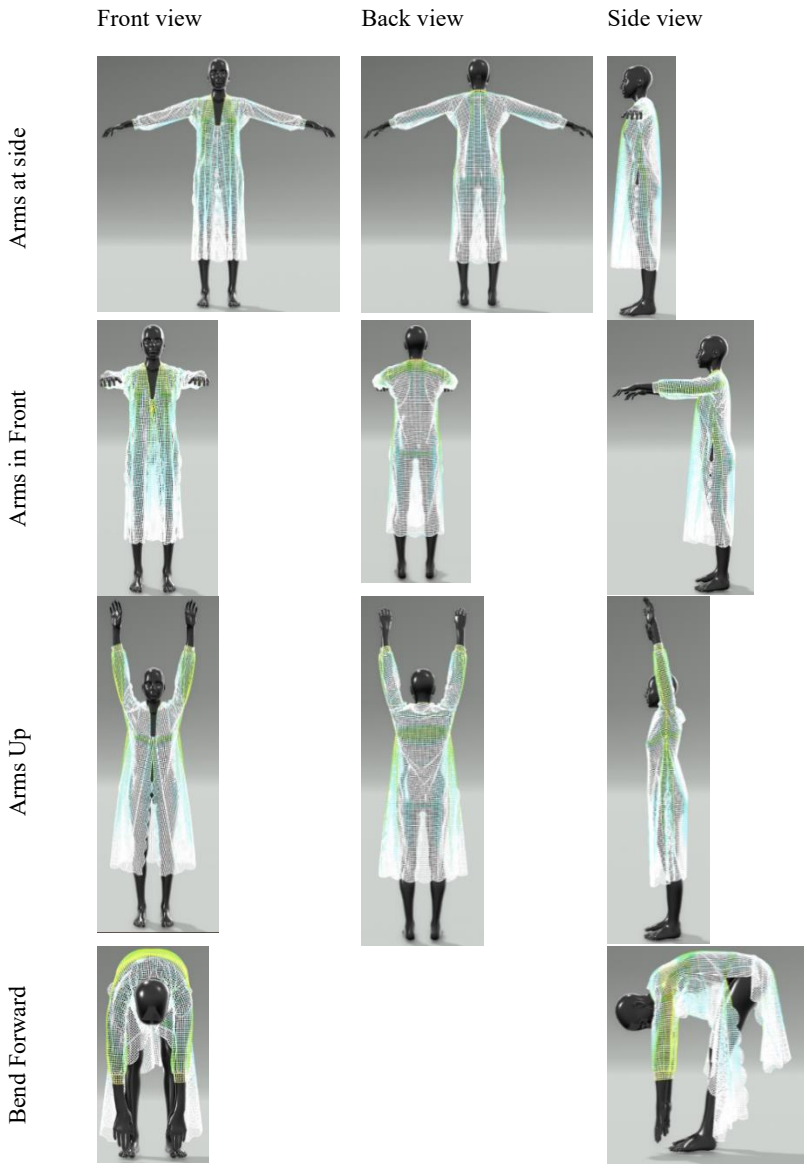


Figure 5. Tension maps of üçetek visuals

The tension map values of the üçetek were analyzed in different poses (Figure 5). It can generally be stated that the garment is loose overall. When the arms are extended sideways, slight tension was observed in the fabric at the front neckline and nape. When the arms are stretched forward, normal tension values were recorded on the back, sleeves, and neckline. In a forward bending position, normal tension was observed on the back and sleeve areas. However, the area where the sleeve is attached to the body exhibited slightly higher tension.

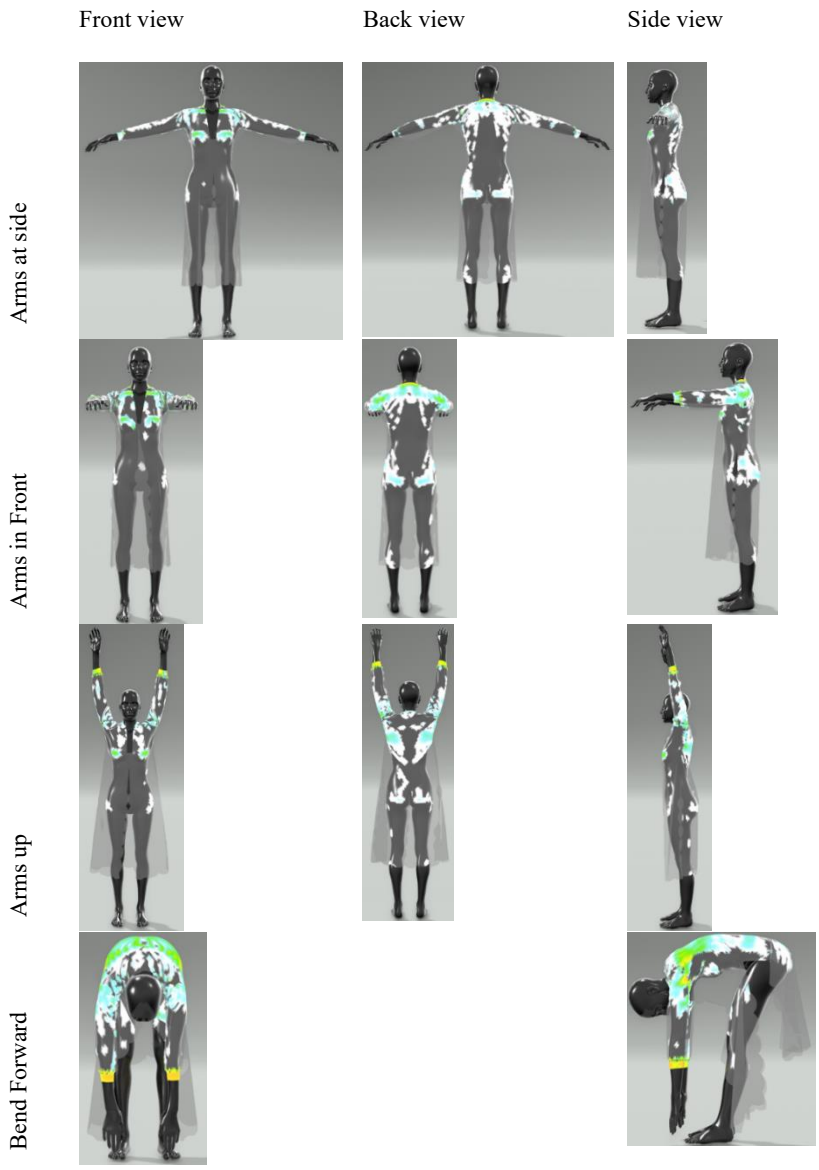


Figure 6. Pressure maps of üçetek visuals

The pressure map values of the üçetek were examined in various postures. In postures where the arms were raised, positioned to the side, or extended forward, the pressure exerted by the fabric on the body was observed to be quite low. In a forward bending posture, normal pressure values were recorded.

The pattern for the göynek worn underneath the üçetek was prepared according to the measurements provided in the technical form. Cotton cricle was used as the main fabric, while raw cloth was employed for the sleeves.

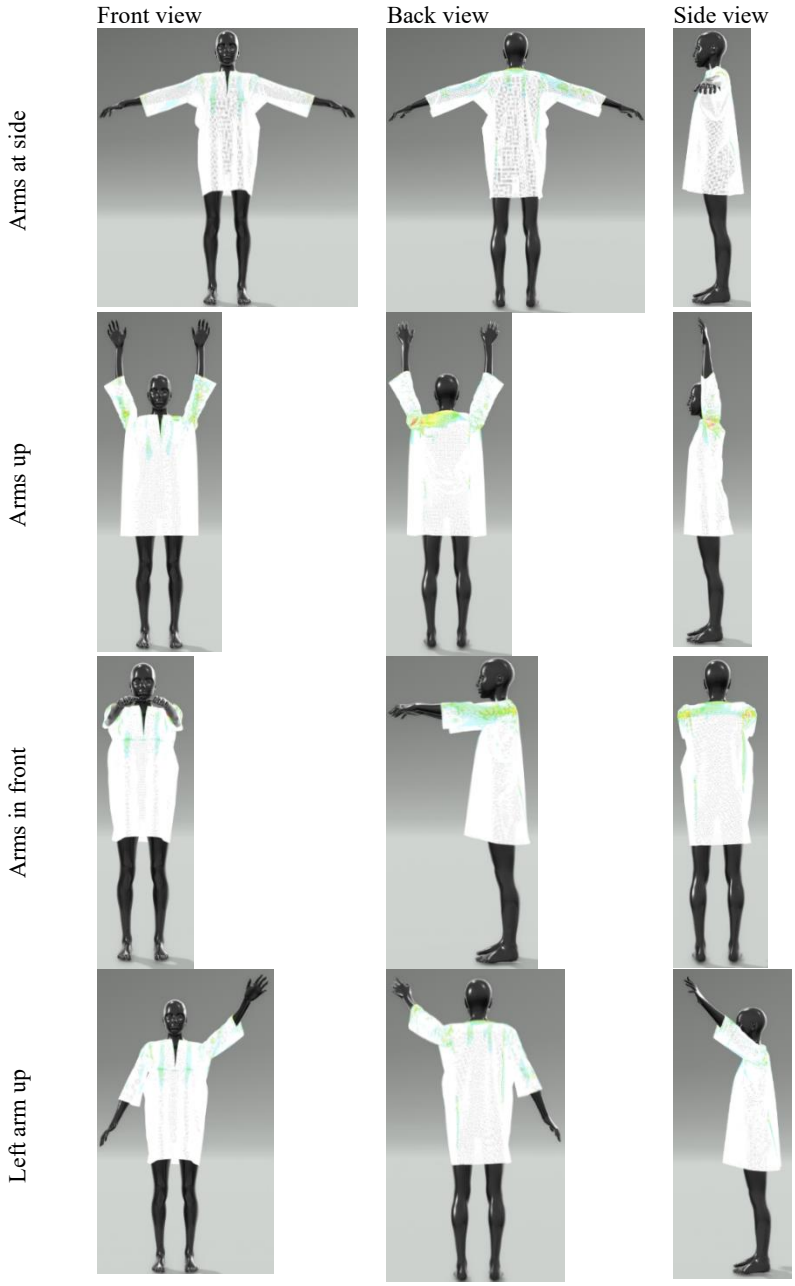


Figure 7. Tension maps of göynek visuals

The tension map values of the göynek are presented in Figure 7. When the arms are in a side position or with one arm raised, the göynek appears completely loose and comfortable. In the arms-raised position, normal tension values are observed under the arms and on the back. When the arms are stretched forward, very slight tension occurs on the back and upper sleeves.

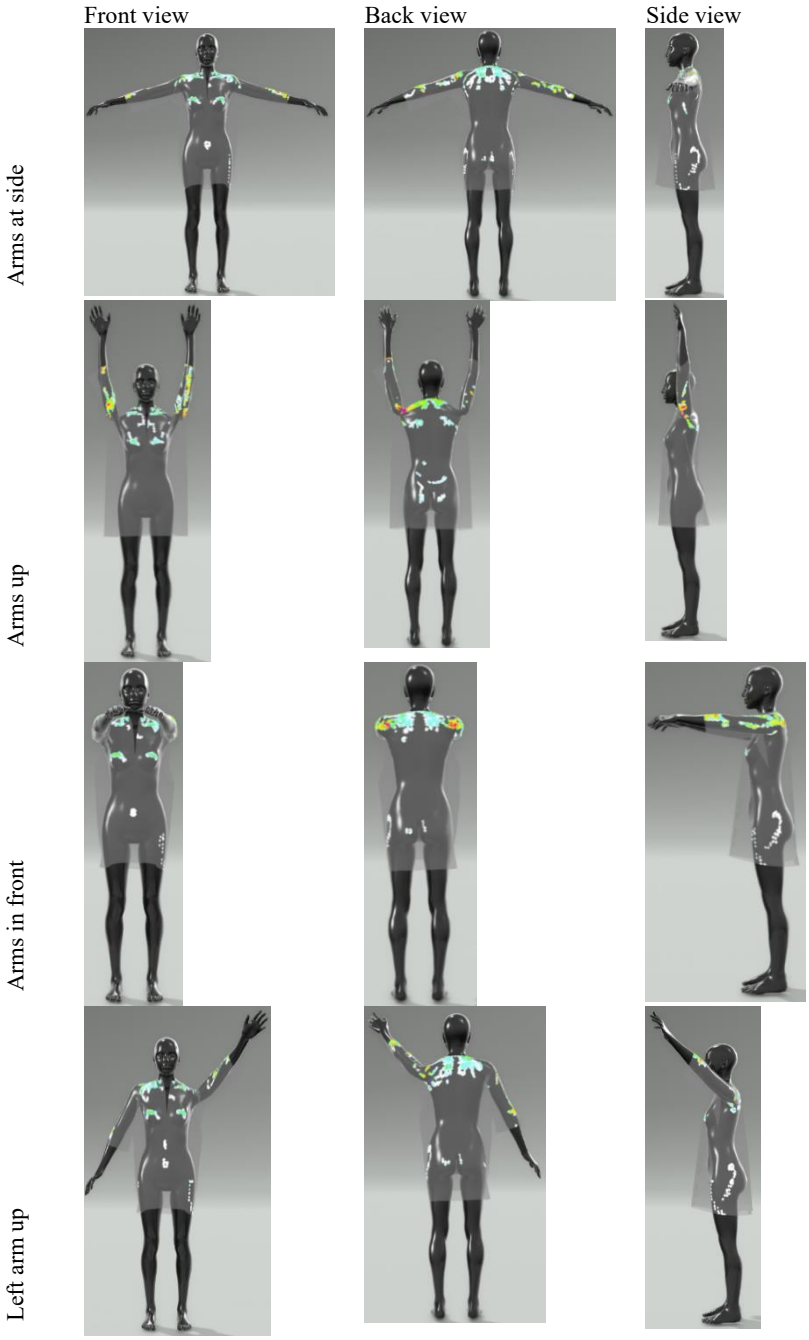


Figure 8. Pressure maps of göynek visuals

The pressure map values of the göynek are presented in Figure 8. In the arms-raised position, normal pressure values are observed under the arms, on the back neckline, and on the sleeves. When the arms are extended forward, pressure is observed only on the shoulders. In other postures, the pressure values are below normal levels.

For the şalvar, the primary fabric used is the same as the üçetek, while the lining is made from plain cloth (kaput bezi). The drawstring sections are also made from plain cloth, and the square gusset piece added to the crotch is made from printed cotton fabric (basma). The şalvar is gathered at the waist and cuffs with elastic. Due to its wide dimensions, it creates a voluminous appearance. In the Tavas region, the şalvar is gathered above the knee with elastic attached to the drawstring, and its length ends below the knee.

The tension maps and pressure maps values of the şalvar in various postures are presented in Figure 9 and Figure 10.

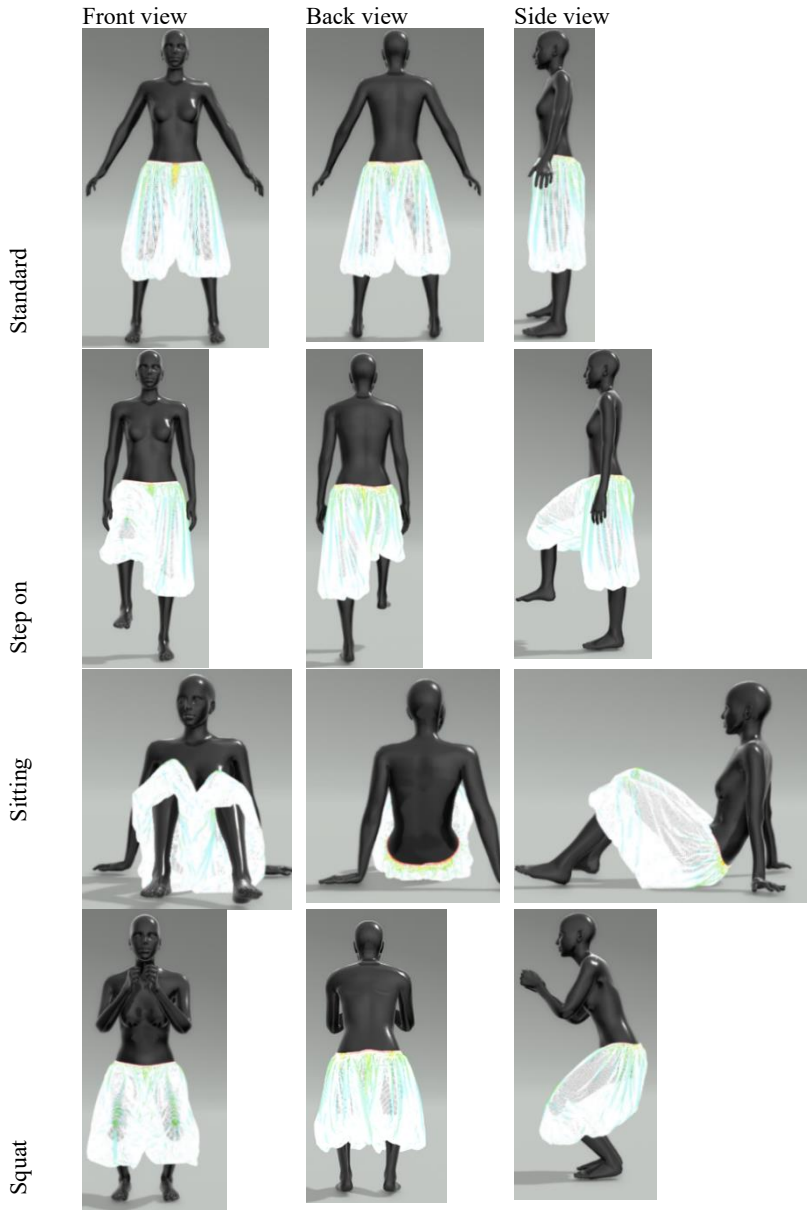


Figure 9. Tension maps of şalvar visuals

When analyzing the tension map values of the şalvar, it was observed that the garment is quite loose, with no tension detected in the fabric anywhere. When worn, the şalvar allows for ease of movement during daily activities such as sitting, climbing stairs, squatting, and walking. The tension map image related to the crotch form is particularly noticeable when the garment is stationary. Slight tension was detected in the crotch area, indicating that the added gusset piece functionally influences the garment's performance.

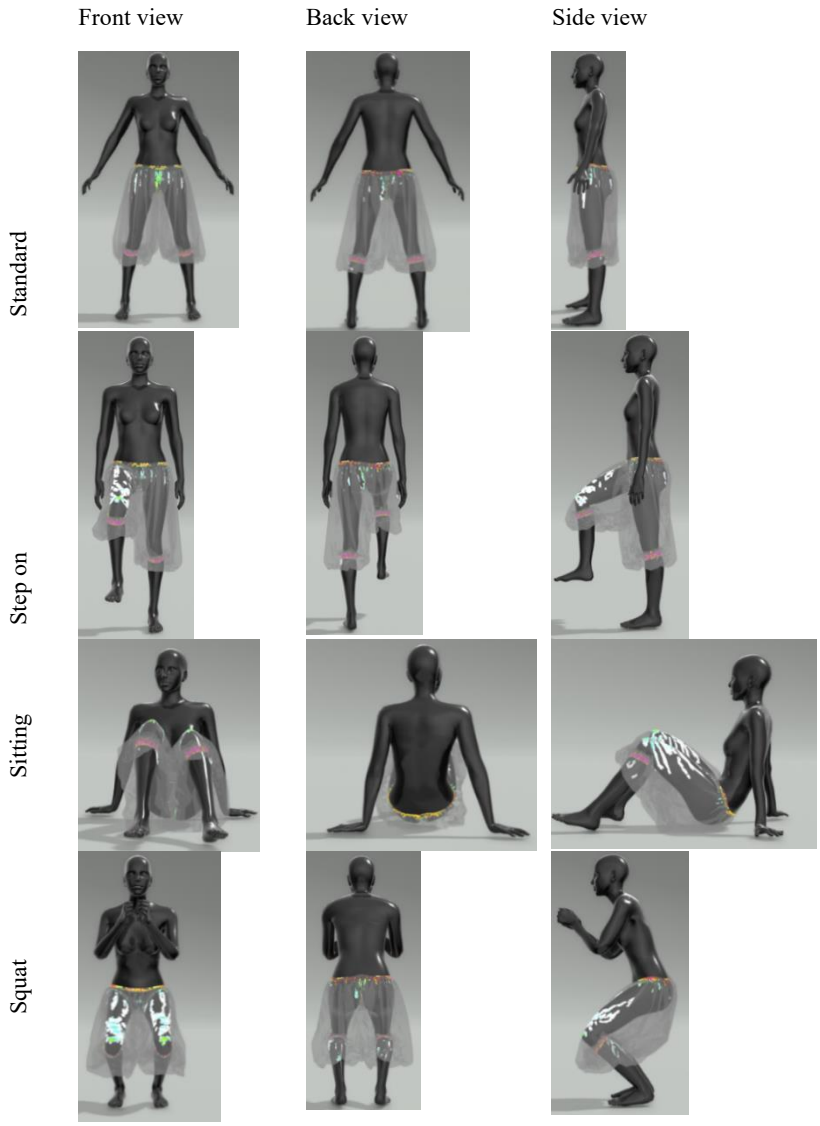


Figure 10. Pressure maps of şalvar visuals

When analyzing the pressure map values of the şalvar, it was observed that the elastic parts exert pressure on the body in all postures. While stationary, tension was detected in the added gusset piece in the crotch area.

CONCLUSION

Traditional garments that have survived to the present day were mostly produced for special occasions such as weddings. Due to limited resources these clothes were dressed many times. While the üçetek was preferred during more specific events, the şalvar and göynek were used as daily wear. Therefore, it was important that these garments did not restrict the wearer's freedom of movement. In this regard, the study is significant in identifying the functional and ergonomic features of historical garments.

The research is limited to components of the üçetek garment from Denizli's Tavas district, specifically the women's şalvar, üçetek, and göynek. To ensure the accuracy of the postures on the avatar, original fabric physics were utilized.

The original pattern measurements and forms were preserved in the study. The garments have a very loose cut, resembling what is now termed "oversized" designs. In this respect, traditional üçetek garment can also be regarded as a form of timeless and sustainable clothing.

Based on the analyses conducted, it was observed that the added allowances aimed to enhance mobility and ensure ergonomic usage. It is believed that the modifications made in the sleeve, side, and crotch

contours contributed to ease of movement. Even during maximum physical activity, the body's limbs were able to move freely. Similar findings have also been supported in related studies (Vural, Koç, Koca, & Pamuk, 2006).

When analyzing the tension maps and pressure maps values, it was determined that areas such as the underarm, neckline, and crotch maintained normal values. This demonstrates that these forms added functionality to the garment.

Through this study, the technical drawing, patterns, and fabric details of the üçetek garment from the Tavas region were digitally recorded. Considering the challenges of implementing and testing the positions used in the 3D dressing software in real life, it can be said that this study presents a sustainable working method.

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