

Sustainable Fashion Design of Al-Sadu Fabric by Using Zero Waste

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Abstract:

The aim of this research is to study the possibility of achieving the sustainability of the modern fashion using the traditional Sadu fabric with zero waste. in order to reduce the expected waste and to preserve the traditional Al Sadu craft in the Kingdom of Saudi Arabia. and with combination of the application of the aesthetic and functional aspect in the design process. to generate new ideas that combines both textile design and fashion design to serve the fashion design approach in general.

The research followed the descriptive and experimental approach by analyzing and describe some heritage models of Sadu weaving fabric in the Kingdom of Saudi Arabia, with some experimental designs for different patterns with zero waste of Al-Sadu weaving fabric using the specialized three-dimensional softwares to select the best designs that meet the requirements of clients. the research also pays attention to the traditional craft of Al -Sadu weaving fabric which is not much appreciated in fashion before.

The results showed that the craft of Al Sadu was used with functional and aesthetic without compromising its main value, the research approach used the sustainable design process for fashion and the ethical use of craftsmanship, the results indicate that zero waste fashion design approach achieves sustainability and ethical use of traditional crafts.

The research recommended to use zero waste approach in the fashion design curricula, and motivate the designers of fashion and the students to come up with new ideas for craftsmen that include integrating craft with design.

Keywords:

Sustainability, Zero-waste, Al-Sadu, Fashion

Paper received 24th January 2023, Accepted 5th March 2023, Published 1st of May 2023

1- Introduction:

Traditional industries are an interaction between cultural visions and values of societies, with their natural environment, and also among the societies. Al Sadu craft (weaving) is one of the ancient traditional crafts practiced by Bedouin women in the Arabian Gulf and in the Kingdom of Saudi Arabia (Canavan & Alnajadah: 2013) ⁽¹⁾.

The process of producing textiles and clothing before the industrial revolution consumes more time with long shelf time for the textile products that reduce the valuable resource of textile materials and wastes (Saeidi & Wimberley: 2015⁽²⁾, moreover, reducing the cycle of fast fashion, leads to the disappearance of ancient ancestral property craft. The zero waste is a complete system that aims to significantly change of the materials flow to prevent the wastes totally from the sources, the resulting, it eliminates the wastes permanently during production. (Al-Ansari: 2009) ⁽³⁾.

Many designers worldwide used zero-waste design, (Thenuwara 2012)⁽⁴⁾ in her book "Handwoven Heritage" to use a fashion design zero waste from the original fabric called "Dumbara" and make a new craft model to produce garments with aesthetic and functional aspect without change its essence. In order to maintain a distinctive creativity or craft, it is important to understand the available craft to be

commercially in modern markets (Senanayake & Gunasekara 2020)⁽⁵⁾. It is clear that, the importance of this research and its related to the design of sustainable fashion from Al Sadu traditional craft, its design depends on zero waste patterns in order to reduce the percentage of fabric waste, to achieve sustainability and to keep highlight the Al Sadu craft in the fashion as an economic product that can compete in the commercial markets.

2- The approach of the search

The current research follows the descriptive and experimental approach based on the qualitative data, that the researchers used in the theoretical and quantitative statistical study, the descriptive approach was used to analyze and describe the heritage models of Al Sadu weaving in the Kingdom of Saudi Arabia.

2-1- Search tools:

The following tool used to process the search:

2-1-1. Prototypes: Four weaving samples from the Al Sadu engravings, and analyzed the decorative design

2-1-2. Illustrations: used the software CLO 3D, V.6

2-1-3. Statistical Analysis: The suggested designs were evaluated by (14) experts from Saudi universities in the field of fashion to determine their level and suitability for aesthetically and

functionally using the questionnaire. The results of the questionnaires were evaluated using the SPSS software for statistical analysis.

3- Review of literature

3-1. Al Sadu Craft history:

The patterns Al Sadu found in Bedouin weaving reflect the desert environment in its simple, pure form, featuring geometric designs combined to flow in rhythmic repetition and symmetry. UNESCO explained that the primary bearers of Al Sadu are older Bedouin women who are master weavers. Master weavers play a crucial role in transmitting the related skills to others, most often within the household. Traditional weaving of Al Sadu in Saudi Arabia is inscribed in 2020 (15.COM) on the Representative List of the Intangible Cultural Heritage of Humanity Saudi Heritage Preservation Society 2019, (ksaforunesco) ⁽⁶⁾

Al-Sadu handicraft has long been renowned in Saudi society.

The first stage of the Al-Sadu process commences with shearing wool, cutting goats' hair and collecting fur from camels. The wool is then cleaned, prepared and sorted according to color and length, before being blown and shaken to rid it of any plants, thorns, dust or soil, it is then combed and cleaned with a special tool.

The second step, when it is cleaned three or more times with hot or cold water, with the addition of soap or special Al-Sadu powder, as well as other cleaning materials known in olden times

In the third stage, the women begin to spin the wool or hair, weaving it into threads.

In the fourth stage, the yarns are dyed with delightful colors using local plant extracts available in the desert environment, such as henna, turmeric, saffron, cactus and the indigo plant.

The fifth and final stage is where the weaving is carried out according to the chosen design and purpose. This process is usually performed by one or two women who exchange the yarn between them. One of them sits with a jack, while the other uses a warp-faced plain weave (Abudhabiculture) ⁽⁷⁾. The most important feature of traditional Al-Sadu weaving in the Saudi Arabia is the appealing and alluring value of the textiles, replete with decorations, symbols, shapes and inscriptions that reflect the nomadic Bedouin environment. The decorative units of Al-Sadu represent simple geometric shapes, the undulations of grasslands and sand. It may reflect many environmental elements, for instance palm trees and flowers; aspects of religious and social life, such as coffee utensils; and other household tools, Qur'anic verses, images of mosques and some animals that have special status, like camels, sheep, falcons and some desert reptiles (Abudhabiculture) ⁽⁷⁾.

The weaver creates these decorative patterns through intertwining, overlapping, symmetry and congruence. Although these decorative designs and patterns occasionally vary between tribes and regions. In addition, dates may be used to denote specific events. The most frequently-used designs of Al-Sadu are as follows: the masters' design, tree design, Al Owerayan pattern, spotted leather skin, ammunition passer, grains, Asnan Al Khail pattern (Abudhabiculture) ⁽⁷⁾

3-2 Zero Waste Fashion:

In the fashion industry, there are two types of waste produced in the garment production process. First, there is waste produced by the industry during the production process, such as chemical residue and material left-over. Second, there is waste produced by consumers from the consumption process. Zero waste fashion focuses on suppressing the remainder of textile waste or left-over fabric produced in the garment production during the cutting process or known as pre-consumption waste.

The criteria of a zero-waste garment ideally should include the above mentioned, however, it also depends on the context of the garment design itself. Rissanen and Mcquillan (2016) ⁽⁸⁾ mentioned that the weight and importance of each criterion should compliment each other and should not result in any more issues such as the high production cost due to complicated design.

Furthermore, Rissanen and Mcquillan (2016) ⁽⁸⁾ suggest that during the design process of a zero-waste garment, there are few considerations a designer should oversee, namely:

- Garment type. The garment type and its basic shape will influence how designers implement the zero-waste concept, thus altering the visual appearance of the basic garment.
- Fabric Width. The width and in most cases, the length of the fabric will influence how the designer or pattern- maker decide on how to implement the zero waste concept according to the garment type.
- Fabric type. Designer or pattern maker should understand the characteristic of the fabric and how it will influence the visual appearance of the garment.
- Silhouette. An appropriate block should be used according to the type of fabric or garment.
- Fixed areas. The number of fixed areas in the pattern plot should not complicate the process.
- Specific features. There should be a consideration on what and how to apply specific features or detail in a garment.
- Construction and finishing. Details on closure and other supporting details will need further consideration in order to comply with the zero-

waste concept.

- Pattern pieces. Develop a system on how to document pattern pieces to assure future sustainability in the design process (Rissanen 2013 T.)⁽⁹⁾.

Zero-Waste Fashion Design (ZWFD) emerged to challenge the sector's boundaries and the inefficiencies in the design/make process of garments. Zero-Waste Fashion Design Practices (ZWDP) are based on the idea that fabric and form is interconnected. The either primary constraint when designing zero waste is to utilize 100% of the fabric width through single or multiple garments (McQuillan, H. 2020)⁽¹⁰⁾ The term zero waste was first introduced in the fashion context by (Fletcher 2008)⁽¹¹⁾ to transform the whole fashion system and supply chain from farmers to consumers while considering the circular economy approach. Zero waste clothing could eliminate cuts in the fabric or wraps the fabric length around the body, such as the sari in India. Also, it could be based on minimal cuts such as the kimono in Japan, which utilized folding, draping and geometrical cuts in garment construction.

Textile waste, due to inefficiencies in the apparel manufacturing process, amasses over 60 billion square meters of fabric annually⁽¹²⁾. This waste is not limited to fabric, but includes fibers and yarns, dyes and chemicals used in coloration, and increasingly valuable time, labor, and money invested in processing⁽¹³⁾. As the global demand for apparel products grows, and because resources are commodity driven, the apparel industry continues to seek methods of sustainability to address this growing global issue. The exploration of zero-waste design methods has gained traction over the past decade^(14, 15). In the apparel production process, 15 percent of cut fabric is lost due to patterns and markers (how the various pattern pieces are laid out on fabric)^(16, 17). Most garment markers still generate significant fabric waste. Zero-waste patterns can eliminate all fabric waste, either through the use of patterns made from whole cloth, interlocking pattern pieces, or multiple size or garment pattern layout methods^(17, 18).

In addition to the increased time needed for the making of zero-waste patterns, generating the designs in a range of sizes creates challenges in the mass of products. Creating individual markers for each garment size within identified fabric width constraints is highly inefficient and costly (18, 19). Thus, zero-waste designers tend to create one-size-

fits-most options, customized one-off designs, or single-consumer use pattern options for home use, thus limiting mass-market applicability. Each of these approaches addresses the global carbon footprint challenge⁽²⁰⁾.

Despite the environmental benefits, zero-waste pattern design, as an apparel production approach, is not without its challenges.

An analysis of 64 publicly available zero-waste patterns revealed the following six key issues:

- 1- the patterns often only work for one garment size,
- 2- the patterns only work for the intended textile width,
- 3- edge finishes are not considered in the pattern,
- 4- the pattern pieces are off-grain,
- 5- the patterns are not engineered for mass production, and
- 6- the patterns have insufficient directions⁽²¹⁾.

Until an approach is created that streamlines zero-waste into a fully executable, integrative process in mainstream fashion, environmental and sustainability impacts will be limited⁽¹⁶⁾.

Rissanen (2016)⁽⁸⁾ classified the most common methods for designing patterns in the garment industry into two main methods:

- 1- Complete piece production.
- 2- Cutting and sewing.

He confirmed that the first two methods are the most common in the ready-made garment industry, and that the third method is rarely used for many technical reasons which will not be discussed the current research, so the focus will be on the first two methods with an explaining how to reach zero waste or reduce waste by using both of them.

The first method: Complete piece production

This method was developed from the traditional method to produce manual knitted products using knitting needles, where rows of stitches are set with the required width for the required size with a specific design by decreasing or increasing the number and size of stitches in each row according to the design and size of the required garment, so a complete sleeve is produced and ready for assembly in the back and chest, which are also produced complete and ready for assembly without using patterns or traditional cutting.

Fully-fashioned knitted products can be produced in the industry by specialized knitting machines with certain specifications that are programmed to produce two dimensional pieces of garments with specific designs and dimensions, so that the minimum number of knitting operations to reach the final three-dimensional design, or the

production of complete three-dimensional garment parts of the desired design and size without sewing, using advanced knitting machines, however, this method is also the most time consuming and most expensive in the ready-made garment, when used to produce a complete garment, not just small parts (Ho & Tsan: 2012) ⁽²²⁾.

Rissanen has classified welding as a method to produce complete garments as well. Welding is a process to assembly the parts of garment by using thermoplastic materials and melting them to produce complete garment. It is not necessary for all pieces of garment to be made from synthetic materials, but it is sufficient only for the external edges to be made from synthetic or thermoplastic yarns, that melt when heat is generated. However, this method has very limited applications in the production of complete garment, and it does not exceed some rare trials, the most famous of which is the trial of Japanese fashion designer Issey Miyake ⁽²³⁾ in 1980 to produce a corsage from thermoplastic materials by welding.

In the study carried out by Manel Torres (2000) ⁽²⁴⁾ for a doctoral dissertation in 2000, the human body was sprayed to produce fibers and yarn directly to form 3D shape of the garment, which represents using non-woven materials for producing a whole garment. It is one of the most important applications of green design and sustainable fashion for many reasons related to the product life cycle, starting from the first stages of the supply chain, and ended to the customer.

In addition, the technology of producing these garments depends on spraying that convert into textile fibers directly on the human body, to achieve with this technology to the level of zero waste in the apparel industry. (Moon.2013) ⁽²⁵⁾.

There are many other trials that include weaving garment parts on looms to produce ready-to-weave parts without wasting of weaving and without subjecting them to a shearing process. The Indian company August called this method "cutting directly on the loom", the company confirms that this method saves 15% to 22% of the waste of the fabric during cutting.

The second method: cutting and sewing:

This is the most common method, which is tailoring according to body measurements and the shape of the design, then drawing the pattern by one of the normal methods, then cutting the fabrics accordingly and sewing machines. Although this method is the most common and easy, it generates

more wastes of fabrics during production of the garment, according to (Rissanne) and (McQuillan's) ⁽²⁶⁾, the made to measure for individual garments production is more and more highly wastes of fabrics than the mass production of garment.

During high quantity of mass production, the waste of fabric must be reduced, due to efficiency of the marker with different sizes for one marker, although the marker efficiency in the fact need good experience and know-how, with the advanced computer software.

The zero-waste depends on the method of the patterns and design of apparel. Of course, the skill and experiences of the designer and pattern can reduce the wastes of fabric by increasing the efficiency of marker up to 90% or more according to the design and style, also the intelligent designer and creative design for sustainability may reduce the waste of fabric. An example of this is mentioned by researcher Mark Liu's master's thesis⁽²⁷⁾, which aimed to create new designs using the waste of fabrics in the ready-made garment factories, it takes advantage of the new techniques, as many fashion designers are invited to invent the methods in the style of pattern design.

4 - Experimental Designs

4-1. Design the samples with Al Sadu pattern

To study the possibility of benefiting from the decorations of Al-Sadu fabric in the Kingdom of Saudi Arabia in the field of fashion design, four textile pieces were quoted from the Al-Sadu inscriptions.

The following is a presentation of the technical aspects that the researchers relied on to reach the best modification according to the controls that achieve the objectives of the research directly.

The line: The lines should be refracted in general and regular with repetitions and similar to the right and the left.

The color: The distribution of colors must be considering and symmetry in the distribution and the approximate amount of relative weight for each color.

Shape: The general shape has varying and overlapping areas that have a focus in the middle, then symmetry and congruence on the right and left sides, suggesting continuity towards the top and bottom.

The decorative design should be characterized by balance, symmetry, and repetition in relation to the adjoining of colors distribution with a focus on one color in the middle of the decorative piece.

4-1-1 First textile unit design of Al Sadu:

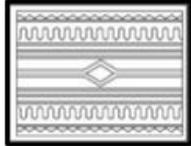
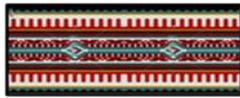
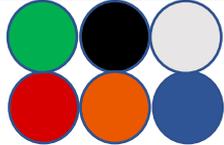
Decorative design	Textile Design	Textile unit	The colors used
			

Figure (1) tools of first design

4-1-2 Second Textile unit design of Al Sadu:

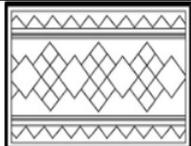
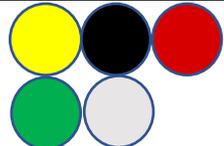
Decorative design	Textile Design	Textile unit	The colors used
			

Figure (2) tools of second design

4-1-3 Third Textile unit design of Al Sadu:

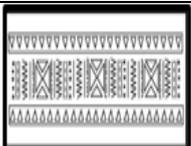
Decorative design	Textile Design	Textile unit	The colors used
			

Figure (3) tools of third design

4-1-4 Fourth Textile unit design of Al Sadu:

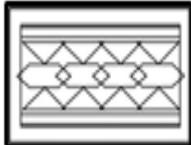
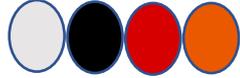
Decorative design	Textile Design	Textile unit	The colors used
			

Figure (4) tools of fourth design

4-2. The process of zero waste design using pattern of Al Sadu:

Five samples of Al Sadu apparel were designed as zero waste system by using 3D software CLO 3D, V.6..

4-2-1 The first design using Al Sadu pattern:

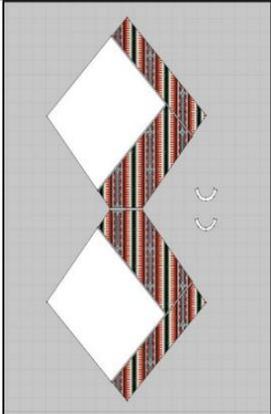
The Design	The Pattern	3 D Apparel	
			

Figure (5) processes, steps and implementation the first design

Analysis the first design:

The front side is in a rhomb shape, one of its tops in a straight line, to be joined by a tape and straps to the shoulders, either right or left, the top of rhomb

must be sewn on the right and left sides, it has top pointed shape that drapes during wearing from the right and left sides.

The back side is similar to the front side with the

same area and shape, but it is in the opposite direction, to complete the decorations on one side and the other side is in mono color.

Materials: The satin, but not shiny with small elasticity less than 2% is to give good drape on the

body.

Colors and distribution: The main color is white, and the decorative area is the same color of the Al-Sadu pattern as a reference, the design is placed at 45 angle to get the desired effect.

4-2-2 The second design using Al Sadu pattern:

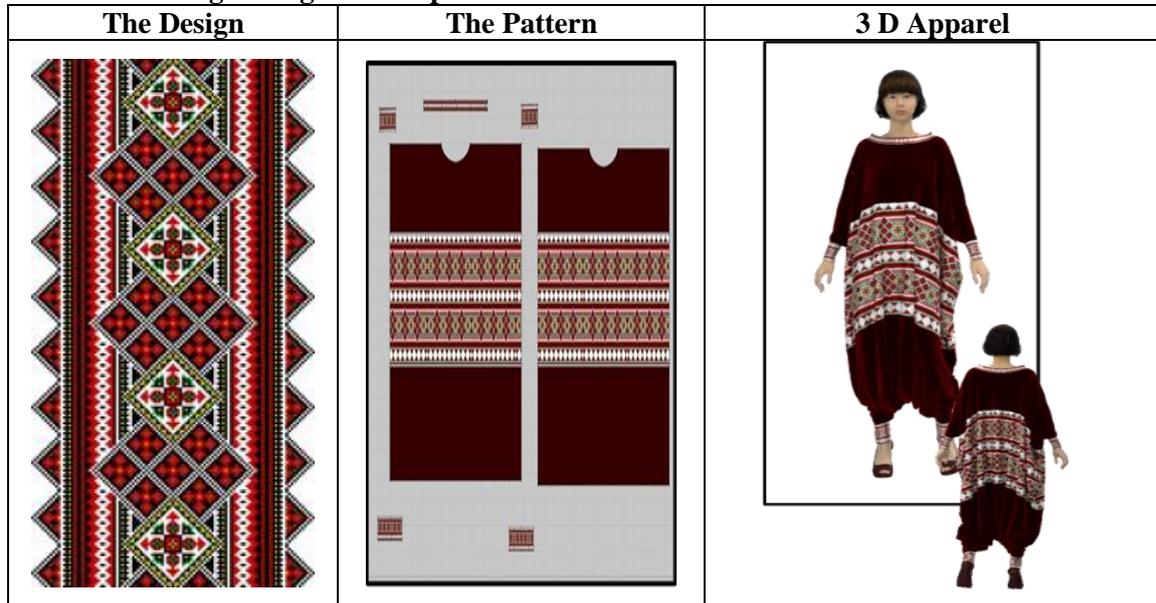


Figure (6) processes, steps and implementation the second design

Analysis the second design:

The front is a complete, separate rectangle with cross cuts to add the ornate material, and the width is suitable for the length of the sleeve, with a mini decorative cuff as the same pattern

The back side is a rectangle similar in size and shape to the front side, and the shoulder line to the right and left is straight up to the end of the sleeve length and has the same cross-cut, the design is sewn from the bottom, with allowance for the leg

opening from the bottom right and left, and an opening for the arm for both sides.

Materials: The suggested materials are from Viscose and the other material is woven cotton using Al Sadu weaving.

Colors and distribution: The basic color is dark red for both the front and back and for all design, except the middle part in the front and back, that will be from other material, with the same colors of the decorative unit of the Al Sadu fabric.

4-2-3 The third design using Al Sadu pattern:

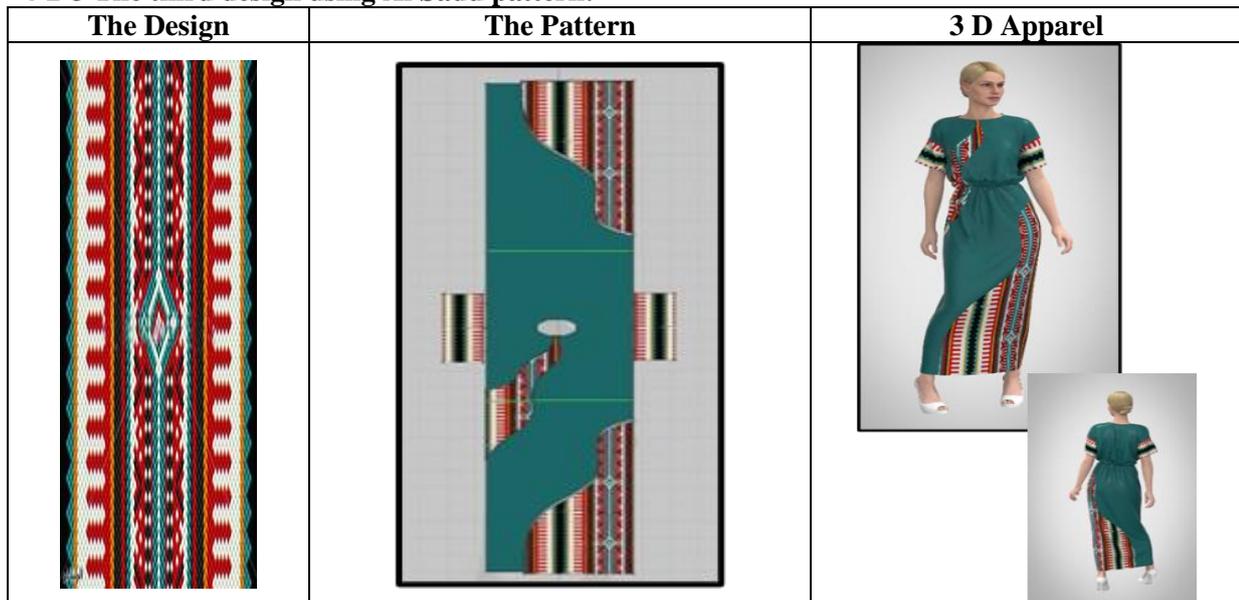


Figure (7) processes, steps and implementation the third design

Analysis the third design:

The front side is in a rectangle shape, some parts of design and sleeves are printed with the repeat of Al Sadu pattern.

The back side is similar to the front side as size and symmetry, the shoulder line in the left and right is straight, the sleeve length is supplemented with a separate part for each sleeve, the front and back are joined at the center line with an internal tape.

4-2-4 Fourth design using Al Sadu pattern:

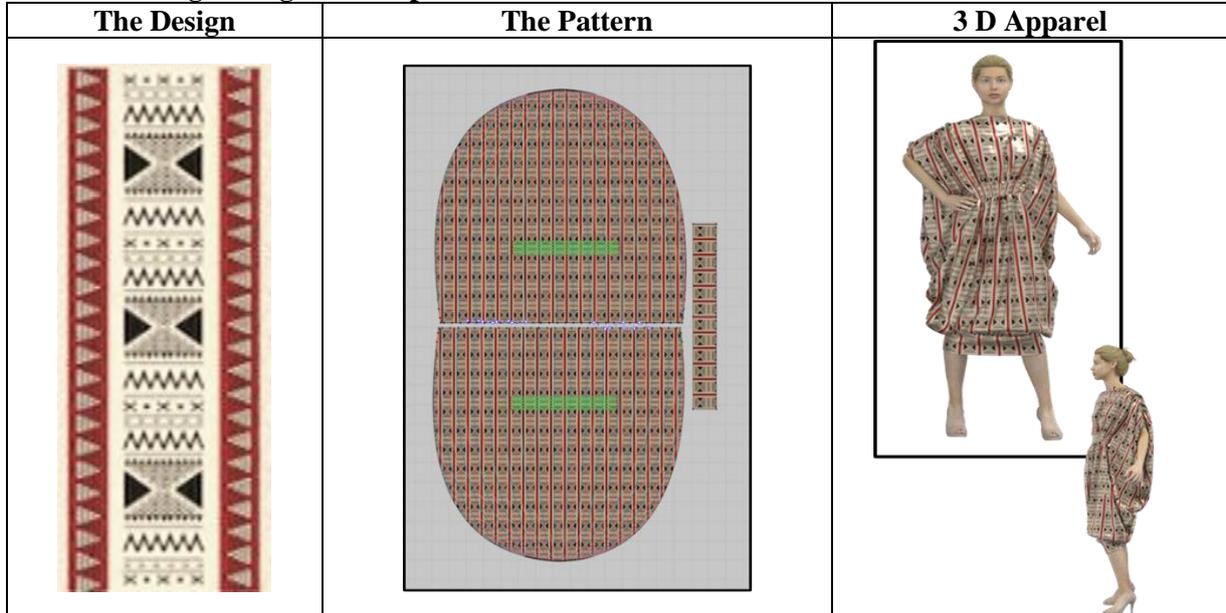


Figure (8) processes, steps and implementation the fourth design

Analysis the fourth design:

The front side is a bow that gathers the design from the bottom and middle, with a different color strip in the middle.

in the middle.

The back side is similar to the front side with seam allowance between the two bows for head opening, there is another allowance from the two sides above

4-2-5 Fifth design using Al Sadu pattern:

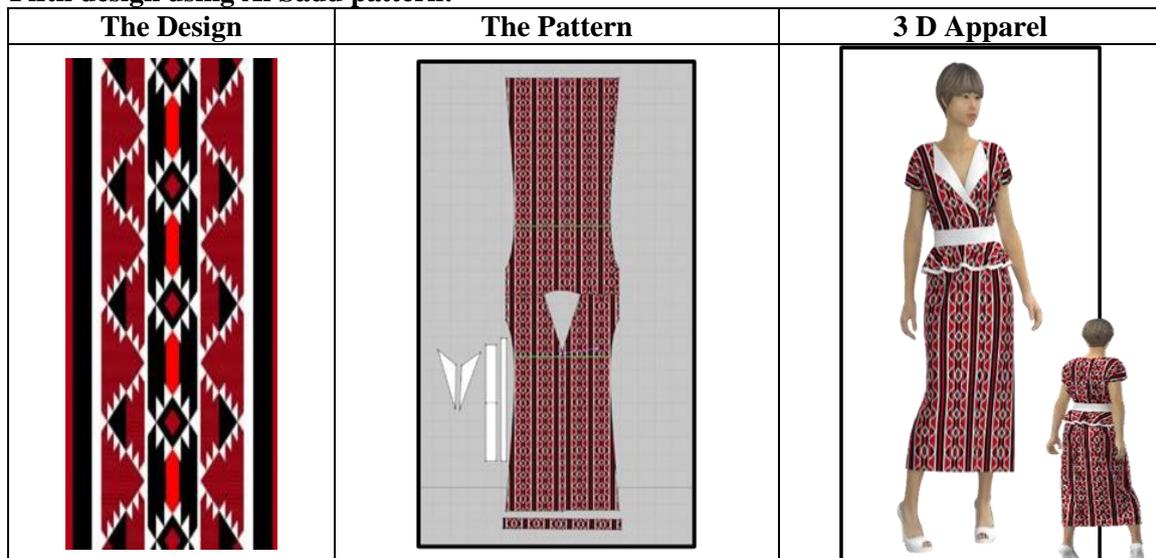


Figure (9) processes, steps and implementation the fifth design

Analysis the fifth design:

Materials: The suggested fabric for this design is satin without shiny, medium weight and the design is not asymmetrical, it means that the right part is different from the left part.

Colors and distribution: The basic color of the design is greenish-blue as a color that fits the color distribution of the decorative pattern of the reference Al Sadu fabric.

the bow without stitching for the arms, and it is symmetrical from the front and back with the same value.

Materials: the suggested fabric from linen printed, light weight good finished improve drape ability.

Colors and distribution: The traditional decorative patterns of Al Sadu are distributed adjacent in the length direction.

The front side is open from the center line, where

the design is opened and closed using white belt, a separate white cornice is attached to the belt to make a symmetrical collar from the right and left of the half front line.

The back side is a semi-closed line and fits the width of the front, the line of the shoulder is similar without slope for the right or left shoulder, the tail of the design is completely folded for both the front and back, the sleeves are folded and the belt is trimmed and folded twice the required width.

Materials: Cotton fabric (or viscose) printed with the selected pattern of Al Sadu decorations, similar to the reference source, with regular adjacent repeat in length direction.

Colors and distribution: the design depends on the adjacent repeat of the decorative pattern of Al Sadu unit, the white color of the collar and belt gives harmony for between all design from top to bottom.

5- Discussion and Evaluation

5-1 Evaluation Al Sadu designs by the experts in textile and fashion

The subjective method was used to evaluate the experimental of Al Sadu designs, by a questionnaire for 15 experts, the questionnaire has two aspects, the first focus on the aesthetic aspect, and the second focus on the functional aspect, with 10 questions.

So five-point Likert scale analysis is used because ANOVA Single Factor

Table (1) ANOVA single factor analysis for the aesthetical aspect

Design Nr.	Source of Variation	SS	d.f.	MS	F	P-value	F crit.
1	Between Groups	6.836	13.000	0.526	2.538	0.004	1.899
2	Between Groups	8.84	13.00	0.68	3.95	0.000	1.850
3	Between Groups	10.286	13.000	0.791	4.053	0.000	1.842
4	Between Groups	8.521	13.000	0.655	3.456	0.000	1.952
5	Between Groups	8.171	13.000	0.629	3.070	0.001	1.891

It is clear from the table (1) that the value F. critical is less than F. calculated and statistical significance between (0.000: 0.001) is less than 0.05, this indicates that the experts have different significance for the results of the questionnaire and they are impartial in evaluating the questionnaire.

The Reliability of the questionnaire of the aesthetical aspect of designs

The Reliability of the questionnaire is evaluated by

Table (2) Cronbach's alpha for the aesthetical aspect

Design Number	Research Tool	Items of evaluation	Cronbach's Alpha
1	Questionnaire	10	0.983
2	Questionnaire	10	0.952
3	Questionnaire	10	0.941
4	Questionnaire	10	0.938
5	Questionnaire	10	0.925

Table (2) shows the level of reliability of the

respondents can easily answer questions in this format, they just simply can choose from already given answers, and it is also easy to analyze.

What is the quality of the zero waste designs

Very poor (1) – Poor (2) – Fair (3) – Good (4) and excellent 5)

5-2 The aspect aesthetical for the five designs

The researchers used the well-known statistical package for social sciences (SPSS), and the following means were used:

- 1- Percentages, mean, standard deviation.
- 2- Alpha Cronbach.
- 3- Anova Single Factor test
- 4- Relative weight.

The results of the study can be classified into two sections as follows:

- 1- The aesthetical aspect of the five designs
- 2- The functional aspect of the five designs

Evaluation the impartiality of experts for the aesthetical aspect of designs by using ANOVA single factor at significant level 95%.

The variation of the results of the experts for the aesthetical aspect of questionnaire for all designs was evaluated by ANOVA single factor test

Table (1) shows the significant effect between the evaluation of experts for the aesthetical aspects of first, second, third, fourth and fifth design at the significance level 95%.

Cronbach's alpha, α coefficient alpha, which measures reliability, to check if multiple-question Likert scale questionnaires are reliable.

These questions measure hidden variables or unobservable variables, that are very difficult to measure in real life. Cronbach's alpha in table (2) measures how closely related a set of test items are as a group.

questionnaire for the five designs of aesthetical

aspect, and the value of Cronbach's alpha for all five designs is higher than 0.7, which indicates the reliability of the questionnaire.

Evaluation the score of experts for questionnaire of the aesthetical aspect of designs

Table (3) the main statistical analysis for the aesthetical aspect

Design Nr.	Mean	S.D	C.V%	Relative Weight %	Rank
1	4.38	4.88	5.5	89	3
2	4.32	4.9	6	91	4
3	4.48	4.7	5	95	1
4	4.42	4.9	4.9	93	2
5	4.25	5.1	6	87	5

It is noted from the table (3) that the means of the questions ranges between (4.25 and 4.48), and these values are very good, the standard deviation and the coefficient of variation between the results is small and these values are acceptable, and all these results show that the scores obtained by the questionnaire are relatively accepted.

Ranking the designs according to their relative weight.

The best design for aesthetical aspect as shown in

figure (10) is the design number three because :

- It expresses the aesthetic and artistic values of Al -Sadu weaving
- The design shows the characteristics of the heritage aspect of Al Sadu weaving
- The colors used for decoration of Al - Sadu fabric correspond to the basic colors of the design.

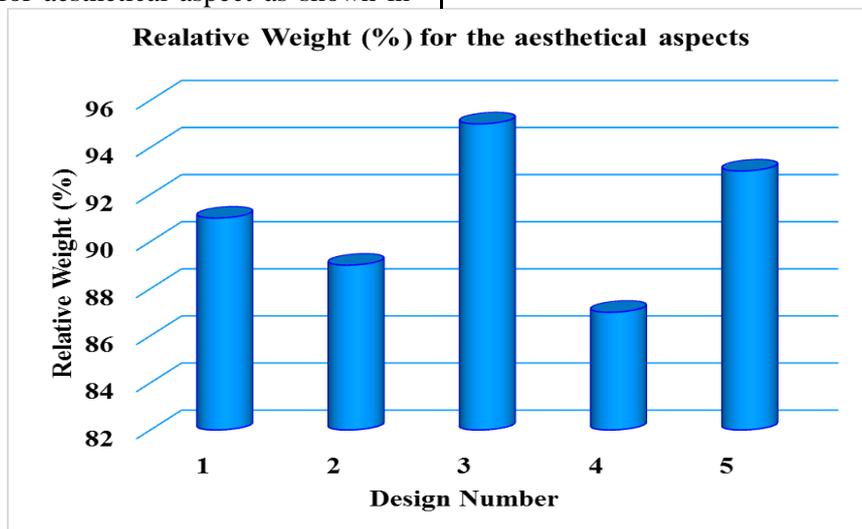


Fig. (10) Shows the ranking of the designs for aesthetical aspect

The next design in the ranking is number five because:

- It achieves the originality and modernity together.
- There is a relationship between the basic design elements (line, color, space and shape).
- The colours are matching with the modern fashion trends.

The rest of the designs are arranged as shown in the figure (10)

5-3 The aspect functional for the five designs

Table (4) ANOVA single factor analysis for functional aspect

Design Nr.	Source of Variation	SS	d.f.	MS	F	P-value	F crit.
1	Between Groups	11.771	13.000	0.905	5.331	0.000	1.799
2	Between Groups	11.436	13.000	0.880	5.155	0.000	1.877
3	Between Groups	8.543	13.000	0.657	3.508	0.000	2.046
4	Between Groups	10.771	13.000	0.829	4.500	0.000	1.988
5	Between Groups	14.343	13.000	1.103	6.882	0.000	2.546

Table (4) shows that the value F. critical is less than

Evaluation the impartiality of experts for the functional aspect of designs by using ANOVA single factor at significant level 95%.

The variation of the results of the experts for the functional aspect of questionnaire for all designs was evaluated by ANOVA single factor test Table (4) shows the significant effect between the expert's evaluation of for the functional aspects of all designs at the significance level 95%.

ANOVA Single Factor

F. calculated and p value is (0.000) and less than

0.05, this confirm that the results of experts are different definitely for the questionnaire and they are impartial in evaluating the questionnaire of function aspect.

The Reliability of the questionnaire of the

Table (5) Cronbach's alpha for functional aspect

Design Number	Research Tool	Items of evaluation	Cronbach's Alpha
1	Questionnaire	10	0.891
2	Questionnaire	10	0.924
3	Questionnaire	10	0.871
4	Questionnaire	10	0.908
5	Questionnaire	10	0.847

In is clear from table (5) that the Cronbach's Alpha of the questionnaire of functional aspects for the five designs is in the range between (0.847:0.924) and these values indicate that the reliability of the

functional aspect of designs

The Reliability of the questionnaire is evaluated by Cronbach's alpha, α coefficient alpha, to measures how closely related a set of test items are as a group.

questionnaire is accepted.

Evaluation the score of experts for questionnaire of the functional aspect of designs

Table (6) the main statistical analysis for functional aspect

Design Nr.	Mean	S.D	C.V%	Relative Weight %	Rank
1	4.46	4.6	5.5	94	3
2	4.08	5.98	6.9	87	4
3	4.22	5.4	6.2	90	1
4	4.16	5.8	6.7	89	2
5	4.32	5	5.8	92	5

It is noted from the table (6) that the means of the score of experts are in the ranges between (4.08 and 4.46), also the standard deviation and the coefficient of variation between the results is small and reduce the deviation between the results, and these results show that the scores obtained by the questionnaire are relatively accepted, also the relative weight each design is ranked in the table and will be illustrated in the following figure

Ranking the designs according to their relative weight.

The best design for aesthetical aspect as shown in figure (11) is the design number one because:

- Consume small fabric, and may help to reduce the consumption of textile materials
- It fulfills a zero waste for fashion design generally.
- It can be recycled to other products

The next design in the ranking is number five because:

- It reduces fabric wastes during apparel production
- It is suitable for various celebration.
- The design can be widely marketed

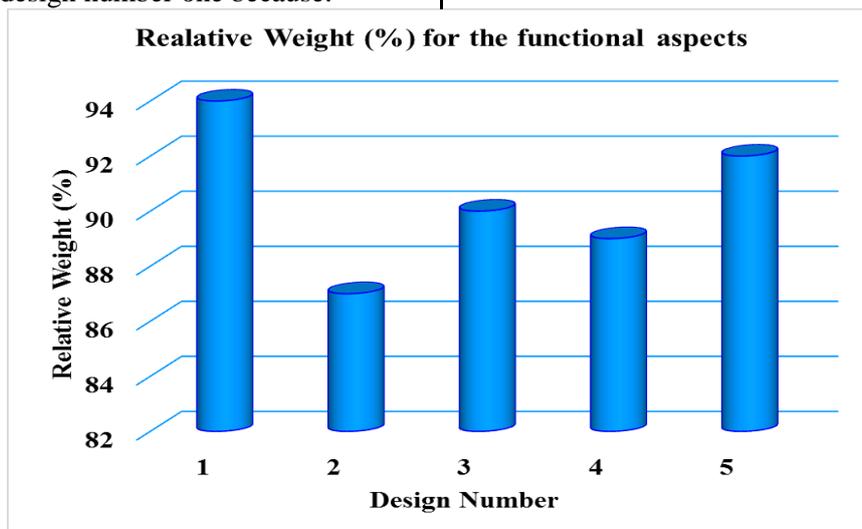


Fig. (11) Shows the ranking of the designs for functional aspect for the designs

The rest of the designs are arranged as shown in the figure (11).

From the results, we conclude the following:

The design number (3) has high coefficient of

quality with a percentage of (94.66%), followed by design number (4) with coefficient of quality of (85.72%), while the coefficient of quality the other designs ranged from (73.23%) to (46.43%), which

represents average coefficient of quality for designs (3) and (4) and (1).

These experimental results which were evaluated by the techniques mentioned above, showed that zero waste fashion design is a sustainable method to produce garment, it can also be a creative challenge for pattern making by assembling the importance role of the designer and pattern maker in a approach to creating garments with both aesthetics and function properties.

The zero waste method of production has improved the utilization of traditional sources of citation represented in the traditional craft of Al-Sadu weaving, thus, it was found that the design without waste has a positive effect on the quality of the clothing product to be economically, it has been shown that the traditional craft of Sadu can be utilized in fashion design and models using the zero waste method with a functional and aesthetic awareness without compromising their main value.

6 - Conclusion

The research focused the traditional craft of Al Sadu weaving and the zero waste design, the results showed that the craft of Al Sadu was used with functional and aesthetic without compromising its main value, the research approach used the sustainable design process for fashion and the ethical use of craftsmanship, the results indicate that zero waste fashion design approach achieves sustainability and ethical use of traditional crafts.

This idea is supported by previous studies where designers can support craftsmen by use the aesthetic and functional aspect in the design process without any changes the essence in order to preserve the craft as a distinctive creativity and commercially viable in the modern markets (Thenuwara: 2012), or zero waste design experiments that require from the designer to think not only as a fashion designer but also as a pattern maker and textile designer (2020: Senanayake & Gunasekara)

This study encourages fashion students to use traditional crafts in their design projects, and the researchers recommended promoting zero waste fashion in the fashion design curricula, urging designers and fashion design students to come up with new ideas for craftsmen that include integrating crafts with design.

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