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Possibility of designing the smart decorative bridal dress

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***Abstract*---**The study initially addressed the smartification of wedding dress from aesthetics, the facilities required for the bride, and the ease of use. Then and using surveys, the possibility of producing smart wedding dresses was analyzed to investigate the economic feasibility. To this end, the study was divided into three sections: investigating the possibility of designing smart decorative bridal dresses, reviewing the technologies needed, and a survey on the acceptance of the potential market to justify the economic feasibility of the proposed product. The statistical population included customers and experts in the bridal clothing industry. The data was collected using a researcher-made questionnaire with confirmed validity and reliability. The sample size was obtained as 100 participants for each group (a total of 200 participants); 100 responded to one part of the questionnaire, and 100 responded to the other part. According to the results, designing a smart decorative bridal dress seems possible, might be welcomed by the commercial market, and comes with economic feasibility. Moreover, intelligent facilities like color- and model-changing and heating and cooling can be designed for smart bridal dresses.

***Keywords*---**smart bridal dress, economic feasibility, market potential, smart technology.

Introduction and statement of the problem

Despite the wide range of applications of smart clothes, there is little coherent information about the principles and factors influencing the process of designing. The products have not yet been systematically defined or categorized, though it is difficult to classify them due to their variety (Cho, 2010). This is because smart clothes overlap and can be examined in several aspects. Due to the widespread use of functional clothing, it seems difficult to extract principles for covering all aspects. The different functions of each smart clothe require its standards, materials, and design and development processes. However, due to the evolving

nature of such garments, the available information is fragmented and generally protected (Pourmohammadi & Nemati, 2006).

The study mainly focuses on the aesthetics of clothing and attempts to examine the possibility of designing a smart bridal dress. Due to financial issues, high costs of design, parts, and the interdisciplinary nature of smart clothing, the main issue in the area deals with mass production capability. The present study initially addressed the smartification of bridal dress from aesthetics, the facilities required for the bride, and the ease of use. Then and using surveys, the possibility of producing smart wedding dresses was analyzed to investigate the economic feasibility. To this end, the study was divided into three sections: an investigation of the possibility of designing a smart decorative bridal dress, a review of the technologies needed, and a survey on the acceptance of the potential market to justify the economic feasibility of the proposed product (3-5). The ideal objective is to evaluate the feasibility of designing and producing a smart bridal dress in terms of market acceptance and economic efficiency. Therefore, practical objectives were introduced as the following:

- Investigation of the possibility of designing a smart decorative bridal dress.
- Review and analysis of the market acceptance of smart bridal dresses.
- Evaluation of the economic considerations of mass production of smart bridal dresses
- Assessment of the features of smart bridal dress.

Method

The main purpose was to investigate the possibility of designing a smart wedding dress; this is applied research in terms of purpose and a descriptive survey in nature and method. Designing a smart wedding dress played the role of a mediating variable. An independent variable was defined by examining the technologies helpful for producing such a dress. The effects were checked on economic efficiency (first dependent variable) and market acceptance (second dependent variable). The statistical population included customers and experts in the wedding dress industry. According to the studies, since there is no source to know the number of individuals, the statistical population is unlimited in size. Hence, the following formula was used to estimate the sample size.

$$\boldsymbol{n = \frac{Z^2 P(1-P)}{d^2} = \frac{1.96^2(0.5 \times 0.5)}{0.1^2} = 99.16 \approx 100}$$

Thus, the sample size was equal to 100 participants for each group (a total of 200 participants); 100 individuals responded to one part of the questionnaire, and 100 responded to the other part. The data was collected from library resources, the Internet, interviews and questionnaires. The questionnaire was prepared using interviews with experts on the composition and general outline of the questionnaire and using the relevant articles. It was developed in accordance with the research hypotheses and questions. The questionnaire assessed the customers' and experts' opinions through a Likert scale. The experts' opinions were also used to check the validity of the questionnaire. Face, content, and

construct validity were confirmed through confirmatory factor analysis. The reliability of the questionnaire was tested by Cronbach's alpha (Table 1).

Table 1
Reliability results

	Item	Number of the items	Alpha coefficient
Problems with the existing bridal dresses	1-5	5	0.799
Customers' preferences	6-11	6	0.725
Accepting the smartification of bridal dress	12-17	6	0.732
Preference of costs over facilities	18-21	4	0.778
Prioritization of the existing problems	22-25	4	0.702
Economic efficiency	26-30	5	0.811
Feasibility study of producing smart bridal dress	31-40	10	0.723
Overall reliability	1-40	40	0.878

Findings
Problems with the existing bridal dresses

In this section, the respondents' problems are presented to test the hypotheses and conclude whether they are satisfied with the solutions proposed by the researcher or not.

Bridal dress problems

Some questions were asked to investigate the customers' problems with the wedding dresses available in the market. The results show that the issue of weight was stated as the main problem for 10%, a relative problem for 23%, a negligible problem for 41%, no problem for 20%, and ineffective for 6% of the respondents. In addition, the lack of thermal and refrigeration ventilation of the existing wedding dresses were considered the main problem for 7%, a relative problem for 25%, a negligible problem for 37%, no problem for 24%, and ineffective for 7% of the respondents. Immobility was deemed the main problem for 1%, a relative problem for 21%, a negligible problem for 44%, no problem for 23%, and ineffective for 11% of the respondents. Disruption of doing personal and daily affairs was stated as the main problem for 4%, a relative problem for 21%, a negligible problem for 47%, no problem for 21%, and ineffective for 7% of the respondents. Difficulties with sitting and getting up were stated as the main problem for 7%, a relative problem for 28%, a negligible problem for 39%, no problem for 19%, and ineffective for 7% of the respondents. Table 2 presents the results in detail.

Table 2
Frequency and ranking of the problems with the available bridal dresses from customers' point of view

Choice	A lot of weight	Lack of ventilation	Lack of mobility	Difficulty with doing affairs	Difficulty with sitting and getting up
The main problem	10	7	1	4	7
Problem	23	25	21	21	28
Negligible problem	41	37	44	47	39
No problem	20	24	23	21	19
Ineffective	6	7	11	7	7
Total point	33	32	22	25	35

According to the table, the respondents ranked the problems with available bridal dresses as the following: difficulty with sitting and getting up (35%), a lot of weight (33%), lack of ventilation (32%), difficulty with doing affairs (25%) and immobility (22%), respectively.

Customers' preferences

Once the customers' problems with the available bridal dresses were identified, the priority of solving the problems is addressed in this section. As the results indicate, solving the problem of wedding dress volume was reported as absolutely important by 2%, important by 33%, moderately important by 38%, slightly important by 24%, and absolutely unimportant by 3% of the subjects. Solving the height problem was absolutely important for 1%, important for 4%, moderately important for 45%, slightly important for 27%, and absolutely unimportant for 23% of the subjects. Solving the ventilation problem was absolutely important for 19%, important for 49%, moderately important for 23%, slightly important for 23%, and absolutely unimportant for 5% of the respondents. Regarding the dress weight, it was absolutely important for 2%, important for 6%, moderately important for 36%, slightly important for 28%, and absolutely unimportant for 28% of the participants. Elimination of immobility was absolutely important for 4%, important for 23%, moderately important for 36%, slightly important for 31%, and absolutely unimportant for 6% of the participants. Finally, the assembly capability was absolutely important for 5%, important for 24%, moderately important for 40%, slightly important for 21%, and absolutely unimportant for 10% of the respondents. Table 3 presents the results.

Table 3
Frequency and ranking of the problems with the available bridal dresses from customers' point of view

Choice	Volume	Height	Ventilation	Weight	Mobility	Assembly
Absolutely important	2	1	4	2	4	5
important	33	4	19	6	23	24

moderately important	38	45	49	36	36	40
slightly important	24	27	22	28	31	21
Absolutely unimportant	3	23	5	28	6	10
Preference rate	35	5	23	8	27	29

Final ranking

According to whatever presented, mobility holds the first place with 35% of complaints, and ventilation ranks the last with 6% of complaints. Difficulty with doing personal affairs (29% of complaints), dress volume (23% of complaints), and weight (7% of complaints) come between mobility and ventilation (Table 4).

Table 4
Problems ranking by the number of complaints

Choice	Complaints (%)
Weight	7
Volume	23
Movability	35
Difficulty with doing personal affairs	29
Ventilation	6

According to customers, coverage is the most important factor with 42%, and coolness holds the next place with 23%. High mobility (21%), lightness (8%), and low volume (6%) were reported as the next priorities (Table 5).

Table 5
The importance of choices by customers' opinion

Choice	Importance (%)
Lightness	8
Coolness	23
Coverage	42
High movability	21
Low volume	6

And at the end of this section, and according to the analysis of the data obtained from the questionnaires, customers' preferences were checked. According to the results, beauty was ranked first with 45% preference, then comfort with 29% and freshness with 12% came next. The cost and coolness, both with 7%, were the last items (Table 6).

Table 6
Preference of choices by customers' opinion

Choice	Preference (%)
Cost	7
Comfort	29
Beauty	45
Freshness	12
Coolness	7

Hypotheses testing

Once the preliminary results were reviewed, the hypotheses were examined. The results for the conclusion are presented in detail.

Hypothesis 1: Designing a smart decorative bridal dress is possible.

To test the hypothesis, the possibility of producing smart wedding dresses was analyzed from technical and economic aspects. According to 7% of the respondents, it was absolutely possible to produce smart wedding dresses with the capability of changes in the volume. However, 16% cautiously thought of such a possibility. Moreover, 46% marked the choice *no comment*, 21% cautiously rejected the possibility of producing smart wedding dresses, and 10% believed in the impossibility of such a product. Further, the cost of producing a wedding dress with the capability of changing the volume was absolutely reasonable for 11% and partly reasonable for 13% of the respondents. In comparison, 45% of them didn't have any opinion. In addition, it was partly irrational for 26% and absolutely irrational for 5% of the respondents.

Regarding the possibility of producing smart wedding dresses with thermal and refrigeration capability, it was absolutely possible for 9% of the experts, partly possible for 12%, partly impossible for 32%, and absolutely impossible for 8% of the experts. However, 39% of them marked the choice *no comment*. The cost of producing a smart wedding dress with thermal and refrigeration capability was absolutely reasonable for 12% of respondents and partly acceptable for 21%. In comparison, 33% of them marked the choice *no comment*. However, 30% of the respondents partially opposed it, and 4% believed in the unrealisticness of expenses. Producing a smart bridal dress with color change capability was possible for 11% of the respondents and partly possible for 22% of them, while 39% of the participants had no opinion. However, it was cautiously impossible for 23% and absolutely impossible for 5% of them. The cost of designing a smart wedding dress with color change capability was reasonable for 7% and partly reasonable for 25% of the respondents, while 42% had no opinion. However, it was partly unreasonable for 19% and absolutely unreasonable for 7% of them. Designing a smart wedding dress with the capability of helping the bride's mobility is absolutely possible for 7% and partly possible for 23% of the respondents, while 40% of them marked the choice *no comment*. However, 25% partly opposed and 6% strongly opposed such a possibility. Producing smart wedding dresses with the capability of helping the bride's mobility is not

economical for 5% of the participants, and 27% cautiously did not justify the costs of such products, while 35% did have no opinion. However, it was partly reasonable for 26% and absolutely reasonable for 7% of the respondents. Producing a smart wedding dress with full assembly capability was absolutely possible for 7% of the experts, and 30% cautiously accepted such a possibility, while 36% didn't have any opinion. However, it was partly impossible for 21% and absolutely impossible for 6% of them. The cost of producing a smart wedding dress with assembly capability was absolutely reasonable for 6% of the respondents and partly reasonable for 26%, while 36% of them didn't have any opinion. However, it was partly unreasonable for 24% and absolutely unreasonable for 8% of the respondents. The results of testing Hypothesis 1 are presented in two tables. Table (7) provides the results of technical feasibility.

Table 7
Frequency of smart bridal dress production from a technical perspective

Choice	Volume change	Thermal and refrigeration ventilation	Color change	Mobility	Assembly capability
Absolutely possible	7	9	11	6	7
Possible	16	12	22	23	30
No comment	46	39	39	40	36
Impossible	21	32	23	25	21
Absolutely impossible	10	8	5	6	6

Table (8) provides the results of producing smart wedding dresses from an economic perspective.

Table 8
Frequency of smart wedding dress production from an economic perspective

Choice	Volume change cost	Thermal and refrigeration ventilation cost	Color change cost	Mobility cost	Assembly capability cost
Absolutely economical	11	12	7	7	6
Economical	13	21	25	26	26
No comment	45	33	42	35	36
Uneconomical	26	30	19	27	24
Absolutely uneconomical	5	4	7	5	8

Finally, all the choices were averaged and turned into a construct to review and present the overall result (Table 9).

Table 9
Final result for the possibility of producing a smart bridal dress

Final possibility	%
Strong	4
Medium	91
Weak	5

Figure 1 displays the corresponding diagram

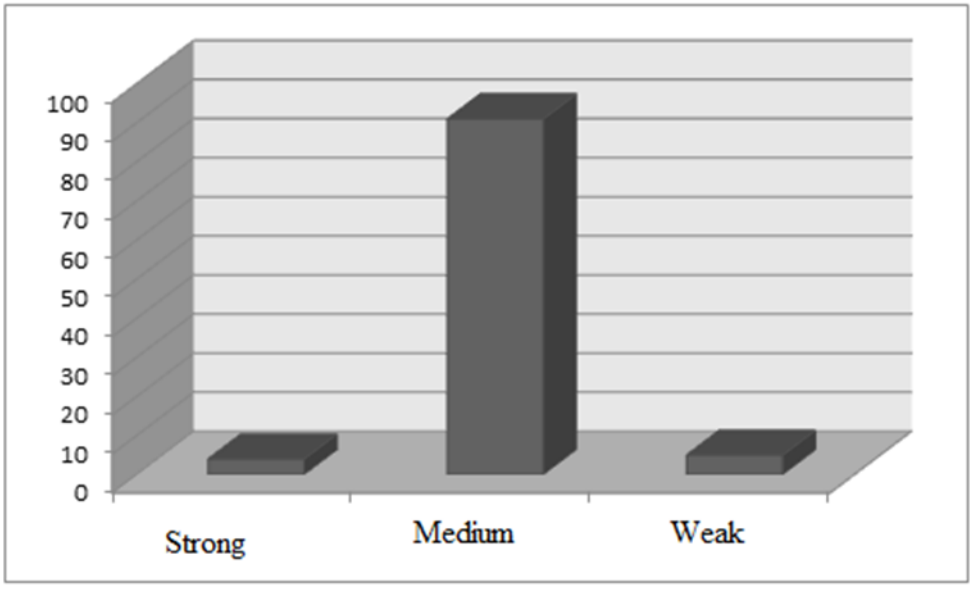

Figure 1. Column diagram of the final result for the possibility of producing smart wedding dresses

According to the results, a smart wedding dress can be produced with a medium to strong probability; thus, the first hypothesis is confirmed.

3-2-2 Hypothesis 2: Smart decorative bridal dress is welcomed by the commercial market

Production of smart wedding dresses imposes extra costs on the buyer and the previous costs. This might affect the market potential. According to 9% of the experts, the market has the potential for the cost increase. However, 26% cautiously endorsed market potential, and 36% had no opinion. Further, 6% of the respondents believed that renting a smart bridal dress- as a wedding tradition- is a difficult issue with plenty of problems. Accordingly, it is partly difficult for 22% of the respondents, while 31% didn't have any idea. Furthermore, for 30% of the participants, there is a slight price difference between an ordinary wedding dress and a smart one, though 11% do not realize any difference between the two categories. Some experts believed in the problematic nature of wedding dress rental and raised the issue of buying a wedding dress. The purchase of a

smart bridal dress was absolutely uneconomical for 8% and partly uneconomical for 13% of the respondents; 41% did not have a specific opinion. But, it was partly absolutely economical for 31% despite the problems and absolutely economical for 7% of the respondents.

Further, 5% stated that the wedding dresses available in the market are often made by hand. Hence, smartification will increase handcrafting costs sharply. This was agreed by 20%, partly disagreed by 18%, and absolutely disagreed with 6% of the respondents; 51% had no opinion. In the following, 6% of the respondents thought of the mass production of smart wedding dresses as unsafe with numerous financial risks, while 23% partly agreed with such a risk, 36% had no specific opinion, 24% partly disagreed, and 11% disagreed. Table 10 presents the results of the comparison.

Table 10
Frequency of market potential

Choice	Market potential	Rent	Purchase	Handcrafting cost	Mass production
Absolutely welcomed	9	6	8	5	6
welcomed	26	22	13	20	23
No comment	36	31	41	51	36
Low welcomed	22	30	31	18	24
Rejected	7	11	7	6	11

All the choices were averaged and converted into a general review construct (Table 11).

Table 11
Final result for market acceptance of producing smart bridal dress

Final possibility	%
Strong	9
Medium	75
weak	16

Figure 2 displays the corresponding diagram.

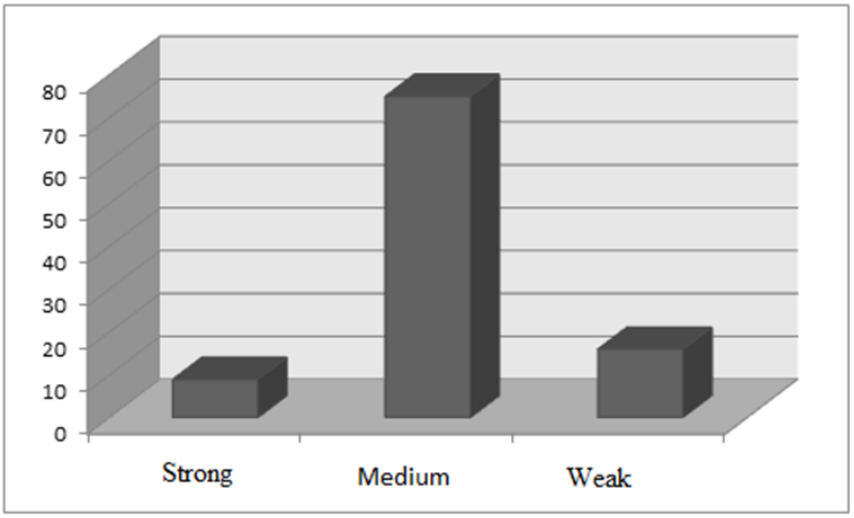

Figure 2. Column diagram of the final result for market acceptance of producing smart bridal dress

According to the results, market acceptance of producing smart bridal dresses varies frommedium to strong level; thus, the second hypothesis is confirmed.

3-2-3 Hypothesis 3: Designing a smart decorative bridal dress ensures economic justification

On the other hand, 5% of the respondents absolutely accepted the costs added as the result of smartification, 20% partly accepted, 37% did not express any opinion, and 33% partly opposed to the balance between the costs added and the smart facilities, and 5% absolutely opposed to this balance. Moreover, 7% strongly stated their willingness to pay extra in exchange for more mobility, 19% partly agreed, 39% had no opinion, 30% partly opposed and 5% strongly opposed to pay extra. Out of the subjects, 6% absolutely agreed with the increase in the cost of wedding dresses for more comfort in terms of heat and cold, 28% cautiously agreed,36% did not express any specific opinion, 20% partly opposed, and 10% absolutely opposed. Regarding the additional cost imposed on the buyer in exchange for more efficiency in sitting and getting up, 5% expressed their absolute preference, 25% stated relative preference, 38% did not express any opinion, 26% disagreed, and 6% absolutely disagreed. Table 12 presents the results.

Table 12
Frequency of economic justification for producing smart bridal dresses

Choice	General additional costs	Additional costs for more mobility	Additional costs for ventilation	Additional costs for sitting and getting up
Absolute preference	5	7	6	5
Relative	20	19	28	25

preference				
No comment	37	39	36	38
Low preference	33	30	20	26
No preference	5	5	10	6

All the choices were averaged and turned into a construct for a general review (Table 13).

Table 13
Final result for economic justification of producing smart bridal dress

Final possibility	%
Strong	7
Medium	64
Weak	29

Figure 3 displays the corresponding diagram.

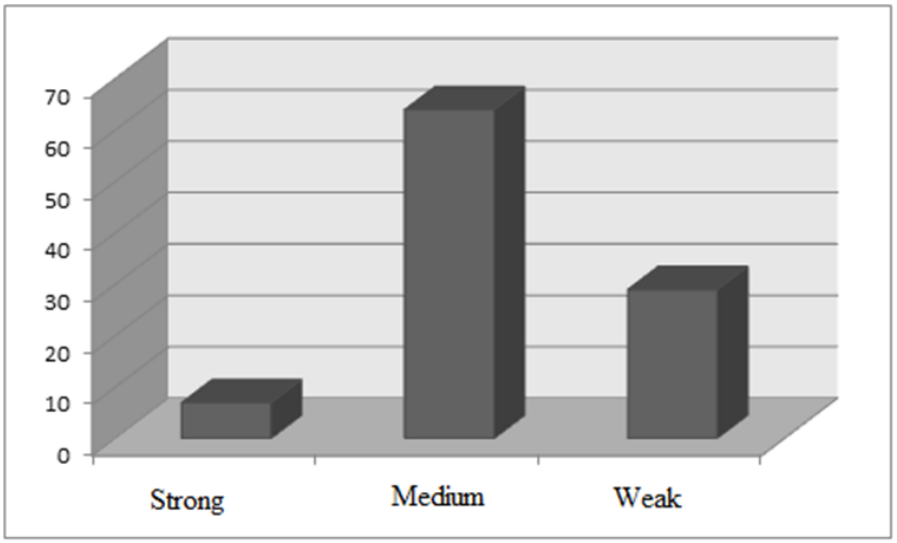

Figure 3. Column diagram of the final result for economic justification of producing smart bridal dress

According to the results, producing smart bridal dresses ensures an economic justification of medium to strong level; thus, the third hypothesis is confirmed.

3-2-4 Hypothesis 4: Intelligent facilities like changing the color and model and heating and cooling can be designed for a smart bridal dress

Out of all the respondents, 8% welcomed the installation of smart and electronic decorative elements on the wedding dress, 24% cautiously welcomed it, 40% did not have a clear opinion, 21% partly opposed, and 7% absolutely opposed to such

a product. Further, 6% seriously asked for assembled electronic decorative elements, 27% preferred assembling smart decorative elements, 34% had no specific opinion, 25% partly opposed, and 8% absolutely opposed such elements. On the other hand, 5% were interested in installing smart elements on smart wedding dresses, 20% welcomed it, 39% had no opinion, 31% partly opposed, and 5% absolutely opposed installing such an element over the bridal dress.

Regarding the connection of electronic components of smartphone applications, 9% strongly agreed, 22% partly agreed, 37% had no opinion, 19% disagreed, and 13% strongly disagreed. Furthermore, the use of smart elements to help the bride make-up that was raised for the feasibility study was strongly agreed by 9%, partly agreed by 27% of the respondents, while 33% of them did not have any opinion. In addition, it was partly disagreed by 27% and absolutely disagreed by 4% of the respondents who considered it ineffective. As the last design idea, the capability of changing color electronically and intelligently was absolutely agreed by 7%, agreed by 26%, disagreed by 21%, and absolutely disagreed by 9%, while 37% didn't express any opinion. Table 14 presents the results.

Table 14
Frequency of the possibility of bridal dress smartification

Choices	Electronic decoration	Assembled electronic decoration	Practical smart	Connection to cell phone	Smart make-up	Color changing
Absolutely possible	8	6	5	9	9	7
Possible	24	27	20	22	27	26
No comment	40	34	39	37	33	37
Relatively impossible	21	25	31	19	27	21
Absolutely impossible	7	8	5	13	4	9

All the choices were averaged and turned into a construct for a general review (Table 15).

Table 15
Final result for the possibility of bridal dress smartification

Final possibility	%
Strong	6
Medium	79
Weak	15

Figure 4 displays the corresponding diagram.

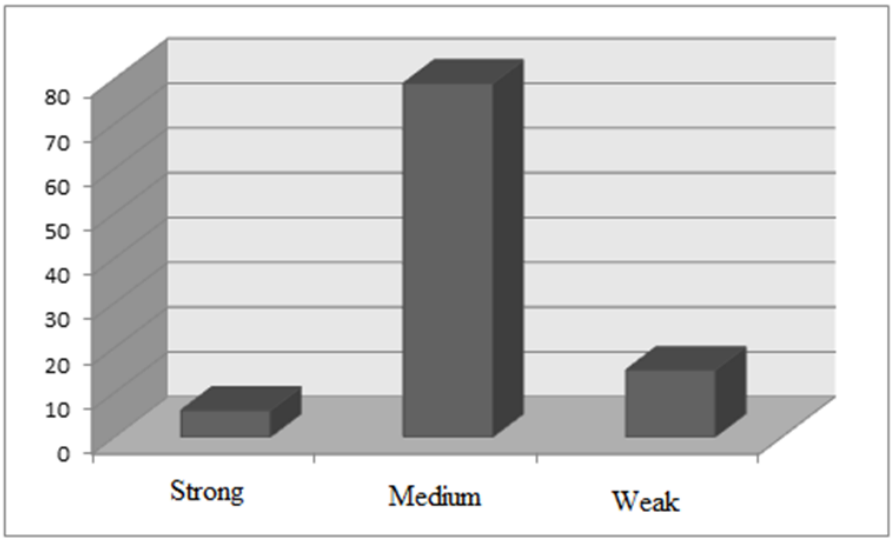

Figure 4. Column diagram of the final result for the possibility of bridal dress smartification dress

According to the results, the smartification of bridal dress is possible with a medium to strong probability; thus, the fourth hypothesis is confirmed.

Discussion and Conclusion

According to the customers, problems with the existing bridal dresses respectively include difficulty with sitting and getting up, high weight, lack of ventilation, difficulty with doing affairs, and immobility. A bridal dress is a flexible clothe as it is worn only once and for a particular party. Although there are corresponding complaints, it seems they are not serious and don't cause significant disruption to the market. Ariatom et al. (2015) reported that the current strategy is not good for embedding a wide range of electronic functions in a garment. This is primarily because it does not meet the needs of users, shopping criteria, and lifestyle. The results indicate the respondents' preference for personal health care and exercise programs that are aesthetically pleasing to their lifestyle and offer practical performance.

Regarding the customers' preferences for improving the efficiency of wedding dress, the results showed that elimination of size problems, the capability of assembling, better mobility, ventilation, weight, and height hold priorities, respectively. Most of the bridal dress problems appear due to the high volume, leading to high heat, lack of mobility, and the impossibility of sitting and getting up normally and thus, the inability of the person to do daily affairs. According to the final ranking, customers mentioned coverage as the most important factor; coolness, high mobility, lightness, and low volume, respectively, hold the next priorities. Hassanzadeh, Zolfaghari and Shariati Ayuri (2015) showed that using non-absorbent polyester fabric in the layer close to the skin reduces the wetness caused by the garment. Also, using polyester on the outer layer can help maintain the desired temperature.

Furthermore, the use of viscose fabric in the middle layer may reduce the accumulation of water in the center of the dress. Therefore, the polyester-viscose-polyester arrangement with the lowest value for the water accumulation index at the inner border (0.02), the highest values for the inner boundary temperature (33 ° C), and the average clothing temperature (16.1 ° C) may provide a good thermal/temperature condition and repel sweat from the skin to the environment. According to the results, mobility is the first complaint, and ventilation is the last; difficulty with doing personal affairs, the clothing volume, and weight hold the positions between the first and the last. As a solution, Ashrafi Azari et al. (2003) showed that NBC clothing without a mask (in group C) could affect cardiorespiratory endurance and speed, but not agility, abdominal muscle endurance and flexibility. NBC clothing with a mask in group B also affected cardiorespiratory endurance and speed but did not affect other elements. Nylon clothing could only affect the element of speed, not others. Experimental results from the study by Lou et al. (2020) revealed that a smart cloth monitoring system effectively measured skin temperature, relative humidity, and frequency, duration and intensity of data on different body areas. In this regard, Jung et al. (2018) proved that the prototype of interactive clothing had a good relationship with human emotional expression patterns. Their evaluation showed that the prototype could stimulate the participants' emotional response to achieve a higher score in the active sensor mode.

Further, technical performance must be aligned with the requirements of human emotional expression in designing interactive clothing. Beauty came first, followed by comfort and freshness in terms of customers' preference for wedding dresses. Cost and coolness were both at the bottom of the list. Our results also prove the possibility of producing smart bridal dresses significantly; thus, Hypothesis 1 is confirmed. In this regard, Pourmohammadi and Nemati (2016) reported that using design thinking while managing the design and development process is a new design approach. As systematic, creative, and human-centered thinking, design thinking can be considered a tool for research and the core management of design and development and a tool for knowledge production. With our findings, hypothesis 2 is confirmed: *smart decorative bridal dresses will be welcomed in the commercial market.*

Hypothesis 3 is established: *Designing a smart decorative bridal dress ensures economic justification*. Through research and development (R&D), Lee (2020) developed four convergence prototypes with four different functions: 1) Recognition of the rear space to track vehicles or people approaching and warn the user via vibration; 2) Bluetooth hands-free provides remote control functions like phone calls and voice play; 3) Vital signal monitoring to measure and display the user's heart rate and body temperature through an internal application and smartphone to take care of the user's health. The development was based on determining the initial usability of a garment and its practical digital functions, minimization of the size of system modules that can be easily assembled and disassembled to facilitate washing and maintenance of the system, and thus help the diversification of using fashion and mode.

Hypothesis 4 is also confirmed: *Intelligent facilities like changing the color and model and heating and cooling facilities can be designed for the smart bridal dress*.

Nemati (2016) presented four general categories of the design process, functional needs, user acceptance, and materials and manufacturing technology as the output that can be used as a checklist in the initial phases for appropriate design strategies and the development of other functional clothing.

Recommendations

Two recommendations are presented: practical suggestions and suggestions for future studies.

Practical suggestions

- The use of viscose fiber in the middle layer of clothing to regulate body temperature.
- The use of NBC technology in smart wedding dresses increases the wearer's agility.
- The use of Lee's technology to equip the bridal dress with applications connected to smartphones.
- Inclusion of design process, functional needs, user acceptance, materials and manufacturing technology in designing and producing wedding dresses.
- 5 - Using non-absorbent polyester fabric in the lining and close to the skin reduces the amount of wetness caused by the garment.

Suggestions for future studies

- Re-conduction the present study with a larger and wider statistical population.
- Investigation of the ethnic and cultural diversity of individuals
- Conduction of separate research on assembly capability.

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