

Selecting wool-type fabrics for sensorial comfort in women office clothing for the cold season, using the multi-criteria decision analysis

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Abstract. This article presents the strategy and the procedure used to achieve the declared goal: fabrics selection, pursuing sensorial comfort of a specific women-clothing item, by using the multi-criteria decision analysis. First, the objective evaluation of seven wool-type woven fabrics, suitable to the quality profile expected for the defined destination, was accomplished. Then, a survey was conducted on a sample of 187 consumers, women aged between 18 to 60 years old, with a background in the textile field, regarding both the preferences manifested in purchasing products, and the importance of various sensory perceptions through handling materials used in clothing products. Finally, the MCDM applied through the implementation of previous accomplished software STAT-ADM, allowed choosing the preferred wool-type fabric in order to get the expected sensorial comfort of women office trousers for the cold season, according to the previously established criteria. This overall approach showed good results in fabrics selection for assuring the sensorial comfort in women's clothing, by using the multi-criteria decision analysis based on a rating scale delivered by customers with knowledge in the textile field, but non-experts in the fabrics hand evaluation topic.

1. Introduction

The development of any supply chain for the textile apparel products primarily aims to fulfill the customer specified and unspecified requirements on every chain link level, but also to meet the needs and expectations of the final customer, represented by a consumer niche [1, 2].

In particular, women clothing constitute challenges for everyone involved in systematically adding value: designers, manufacturers, suppliers and retailers. One of these challenges is to create customer confidence in a potential sensory comfort (besides the need to achieve a good-looking silhouette), generated by the use of a particular material for a certain destination [3,4].

Concretely, bearing in mind women's criteria for purchasing clothes (other than fashion-related demands), we expect that this specific niche will select their items like shirt/skirt/dress/trousers/coat designed for hot/cold season, as well as home clothing/casual/casual office/sports activities, to match their sensorial comfort demands, generated by visualization and handling [1,4]. Therefore, for a specific market niche that is the ready-to-wear women office clothing intended for the cold season, more exactly trousers made of wool-type fabrics, consumers' perception about the sensorial comfort should be strongly related to the wearers' preferences regarding the selected fabrics.



In this paper, experiments were conducted in three successive stages, to achieve the declared goal – fabrics selection pursuing sensorial comfort of a specific women-clothing item, by using the multi-criteria decision analysis.

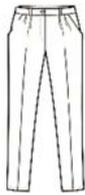
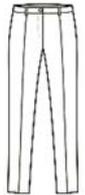
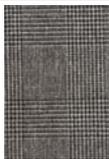
2. Methodology

2.1. Materials

In this paper, the entire work was carried out for seven wool type-woven fabrics with different fibre compositions, pattern and properties, considered suitable for the quality profile expected in comfortable women office trousers for the cold season.

The designed clothing item and the main description of the selected fabrics to produce the "ready-to-wear trousers collection", are presented in table 1.

Table 1. Ready-to-wear office trousers collection for women.

Trousers ^a							
Fabrics	F1	F2	F3	F4	F5	F6	F7
Pattern							
Weaves	plain	plain	plain	twill 2/2	plain	twill 2/2	twill 2/1
Raw material	PES64% /CV34% /EL 2%	Wool 45% /PES 55%	PES75% /CV23% /EL 2%	Wool 100%	Wool 44% /PES 54% /EL 2%	Wool 45% /PES 55%	Wool 44% /PES 54% /EL 2%

^a Source : <https://www.shutterstock.com>

2.2. Objective evaluation of fabrics for characteristics linked to the handle attributes

The first step in achieving the paper's goal was to perform the objective evaluation of seven wool-type woven fabrics with different fibres composition and pattern, suitable to the quality profile expected for comfortable women office trousers for the cold season.

Considering the six pair of physical bipolar attributes described by the well-known handle technique for subjective evaluation (by means of several actions for evaluation of the mechanical and surface properties), three groups of attributes for the sensorial comfort were established: flexible/stiff, thin/thick and light/heavy [4, 5].

Usual tests were carried out in the textile laboratory, assessing the three characteristics linked to the handle attributes from both the theoretical and practical point of view: flexibility (%), thickness (mm), and mass per surface unit (g/m^2).

For all selected fabrics, a sampling was carried out following the standards of specific testing methodology. According to SR EN 139:2005, fabrics samples were conditioned at $65 \pm 4\%$, relative humidity and $20 \pm 2^\circ\text{C}$ for 24 hours, before testing.

2.3. A survey of women's preferences about purchasing clothing

In parallel with the objective evaluation, a survey with nineteen questions on preferences manifested in purchasing clothes was conducted on a sample of consumers - women aged between 18 and 60 years (with the average age of the sample 36.6 years), with a background in the textile field.

Given the results of the survey (with a 7.2% survey error), the ranking made by the 187 respondents about the importance of various sensory perceptions through handling materials used in clothing products, can be considered almost conclusive. Hence, the presumption of an existing group of consumers with the ability to select a clothing product appeared group that could provide valuable assistance in reaching the best-desired final product characteristics according to their preferences.

2.4. Using the multi-criteria analysis based on a rating scale delivered by customers

The third stage of this study consisted in using the decision-making tool named Electre [6, 7] by means of a previous accomplished software STAT-ADM (written in Romanian). STAT-ADM software was designed to optimize processing of cotton throughout the technological flow of fibers in spinning mill.

Currently included as an interactive ICT-based learning tool, STAT-ADM allows the virtual simulation of the processing optimization in textiles companies for spinning, weaving, and clothing during several teaching and research activities within the Faculty of Textiles, Leather and Industrial Management of Iasi, Romania [8].

However, in this paper, the software was used for choosing the preferred wool-type fabric from a range of items, in order to get the expected sensorial comfort of women office trousers for the cold season, by comparing the seven fabrics according to previously established criteria.

3. Results and Discussion

According to the experimental part, the following results have been obtained:

3.1. On the objective evaluation of fabrics

The average values of the three properties linked to the sensorial comfort, for each fabric indented to manufacturing the trousers, are summarized in table 2.

We can observe that it is hard to make a distinction in order to get a hierarchy between variants of fabrics, having as reference all three features as an ensemble.

Table 2. Fabrics properties linked to the sensorial comfort.

Properties	Fabrics	F1	F2	F3	F4	F5	F6	F7
Flexibility (%)		64	51	67	53	63	58	61
Thickness (mm)		0.43	0.35	0.34	0.36	0.36	0.49	0.48
Mass per surface unit (g/m ²)		216	167	180	182	158	210	220

3.2. On the survey

187 women participated in the survey and among them, 17.1% were students, 74.3% employees and 7% entrepreneurs.

Given the basic training of respondents (88.8% with higher education, masters and doctoral graduates and 11.2% high school graduates), it is considered significant for this paper to highlight some opinions:

- Among the surveyed women's favorite clothing products, the options were: blouses 81.3%, trousers 72.7%, shirts 49.7%, dresses 34.2% and skirts 29.9%
- When asked about the importance of different influence factors on the decision to buy a clothing item, the following hierarchy was obtained: general appearance 94.7%, quality of materials 93.8%, price 83.9%, brand 20.9%, fashion 40.1%, advertisement 3.6%

As shown in the figures 1a, 1b, 1c, the respondents never buy clothing items without analyzing the materials by reading the label (about 88.2%, figure 1a) and through handling (about 91.4%, figure 1b), or if the materials generate a feeling of discomfort after handling (about 95.7%, figure 1c).

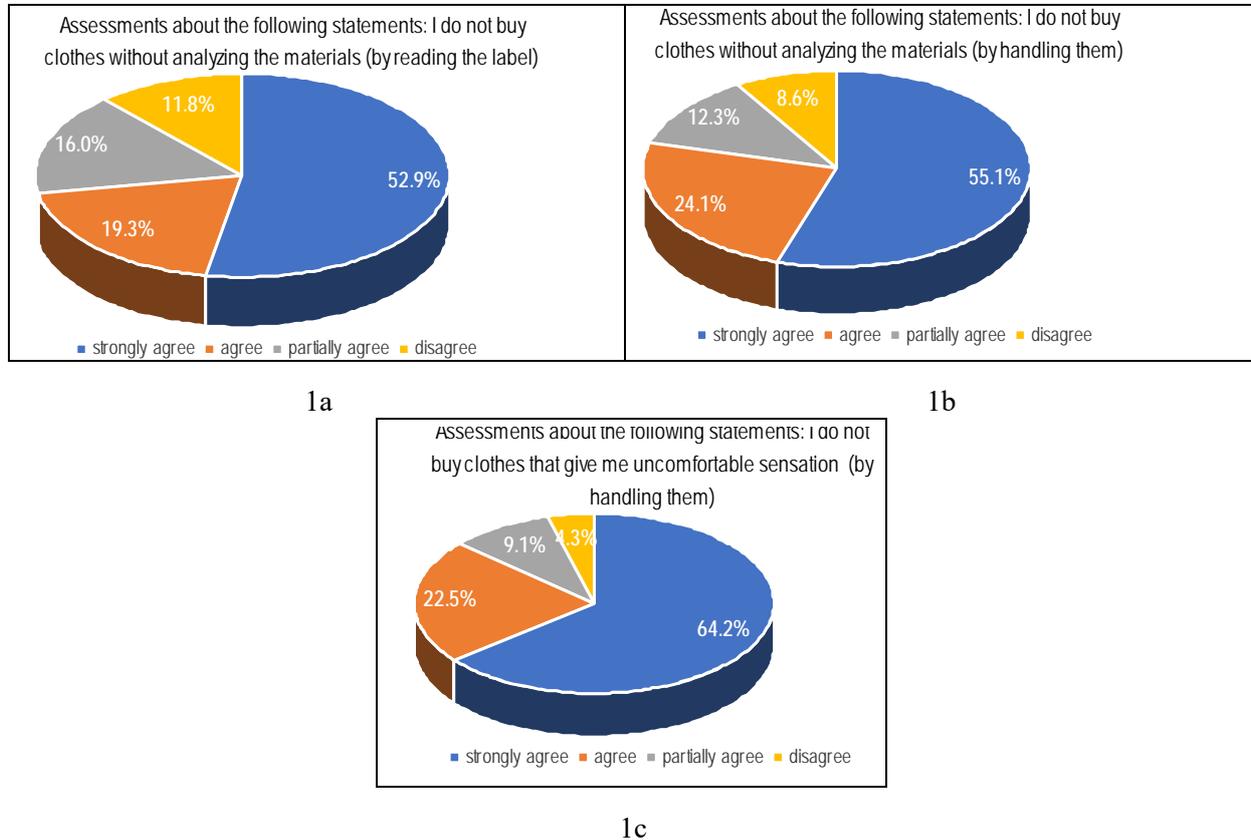


Figure 1. Answers regarding several criteria of purchasing clothing.

Regarding the answers about the importance of various perceptions caused by the fabrics' handling, the respondents had to rank the three bipolar attributes for the feeling of sensory comfort, when buying a certain clothing product.

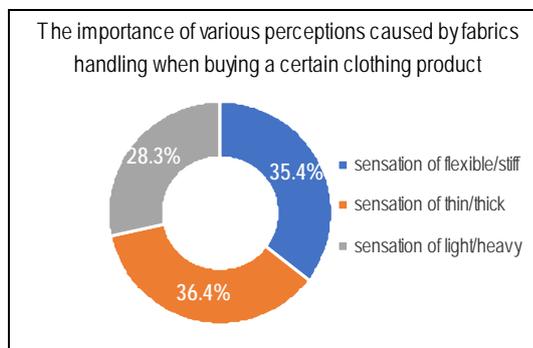


Figure 2. Answers regarding the ranking of feelings caused by the fabrics' handling.

The wording of the questions in the survey was in this case, as follows: *Please, evaluate the importance of various perceptions caused by handling of the materials, perceptions that will create sensory feeling of comfort when buying a certain clothing product. Product: office attire; for*

the cold season; for women (skirt, dress or/and trousers) Scoring: 1- most important feature; 3- least important feature. Attention! Each attribute pair category will be given a different note”

As shown in figure 2, the feeling of sensory comfort of the 187 women when buying office trousers for the cold season, can be called a "niche reaction to the market" characterized by bipolar attributes in the following order: thin/thick (36.4%), flexible/stiff (35.4%) and light/heavy (28.3%).

3.3. On the multi-criteria analysis based on a rating scale delivered by surveyed women

Figure 3 summarizes all the important data in screenshot, namely the STAT-ADM main window, and the results visualization after running the software.

The figure shows the active fields for data entry and follow-up; the subsequent stages according to the STAT-ADM software algorithm [8] are running through:

- nominating the current experiment and nominating the criteria (A and B), specifying also the number of experimental variants;
- nominating the measured values of the B group criterion and specify the number of the data for each combination (in our case, there are average values only, so the number is 1);
- nominating the criteria importance by filling the options *Criterion* and *Ranking*, hence completing the hierarchy of criteria for the multi-criteria analysis;
- filling headings *Index* and *Average values* after completing the above conversational fields with the average values of the three properties that are linked to the sensorial comfort for each fabric intended for manufacturing the trousers, as shown in table 2.

The screenshot displays the STAT-ADM software interface. On the left, there are several input fields: 'Experiment' (MCD for sensorial comfort), 'Criterion A' (Fabrics suitable for comfortable trousers, value 7), 'Criterion B' (Fabrics properties linked to sensorial comfort, value 3), 'Measured value - Criterion B' (Characteristics as Attributes, value 1), and 'Criteria importance' (a table with Criterion 1, Ranking 10; Criterion 2, Ranking 9; Criterion 3, Ranking 8). Below these are 'Intermediate steps' (Matrix of Consequences and Utilities, Matrix of Concordance and Discordance) and 'Results' (a list of numbers 2, 4, 5, 3, 6, 1, 7). On the right, a table shows 'Index' and 'Average values' for 17 items. At the bottom right, there are buttons for 'Calculated values', 'Exist', and 'Edit'.

Index	Average values
1	0,43
2	64
3	216
4	0,35
5	51
6	167
7	0,34
8	67
9	180
10	0,36
11	53
12	182
13	0,36
14	63
15	158
16	0,49
17	58

Figure 3. Screenshot: STAT-ADM main window and results visualization.

Figure 3 also contains inactive fields that become active only in a certain order, with quick launch buttons operated by a mouse click:

- intermediate steps with the following calculations: *Matrix of Consequences and Utility* and, *Matrix of Concordance and Discordance*; for any of the two options, a submenu is activated and *Calculated values*, otherwise *Exist* or *Edit*, become active;
- the *Results* data field becomes active and is filled in automatically at the end of the application, to visualize the results of the experimental variants hierarchy, for selecting the optimal fabric article.

According to the algorithm, each criterion has an assessment scale depending on the assigned technological relevance. The original approach in this paper was that the analysis criteria were actually the three groups of attributes for the sensorial comfort linked with three fabrics properties and in addition, the criteria grading was carried out according to the above ranked options achieved from the survey: thickness (36.4%), flexibility (35.4%) and heaviness (28.3%). Therefore, the criteria B listing grading according to the ranked option and importance coefficients calculation for STAT-ADM, were as follow: Criterion 1: Thickness (mm), grade 10, importance coefficient 0.370; Criterion 2: Flexibility (%), grade 9, importance coefficient 0.333; Criterion 3: Mass per surface unit (g/m^2), grade 8, importance coefficient 0.297.

The best fabric for pursuing the aim of this study corresponds to the maximal positive value of the difference sum column, after calculating the matrix of differences. In figure 3, the hierarchy in the *Results* field shows the fabric F7 as being the most adequate for manufacturing comfortable women office trousers for the cold season. The following fabric within the hierarchy is F1. According to the multi-criteria decision analysis, the worst choice to produce the "ready-to-wear trousers collection" would be the fabric F2.

4. Conclusion

The outcome of this paper was that the sensorial comfort of the selected fabrics is strongly related to the consumers' perception; therefore, some of the important groups of attributes for the sensorial comfort can be added as an assessment scale in the multi-criteria decision analysis, to be consistent with the reality.

By using the STAT-ADM decision-making tool in this paper, it was possible to select, simply and quickly, the proper fabric out of the ranked options, by comparing them according to the assessment scale with previously established criteria given not by experts, but by a large group of consumer as decision makers.

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