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Study of the Relationship between the Drape and Characteristics of Fabric Using Graphic Methodology and the AHP Method

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Abstract
This research aimed to increase knowledge of the various responses of drape parameters to different selected fabric properties. The principal goal is to optimise the fabric properties and obtain the desired draping effect for garment textiles by the graphic method and AHP method. The goal is to establish a model that reflects the impact of fabric properties, such as the bending rigidity in the warp, weft and skew directions, shear stiffness, weight, and thickness on drape parameters such as the drape coefficient (CD), number of folds (NF), folding depth index (FDI) and draped distance ratio (DDR).

Key words: *drape parameters, response surface methodology, fabric properties, AHP.*

Introduction

Drape is a parameter that plays a significant role in selecting and developing textiles for clothing. The drape is a phenomenon that depends on and is influenced by the construction parameters and the fabric's material [1, 2]. This parameter is determined by mechanical characteristics: bending rigidity, shear properties, and others. All these mechanical properties have an immediate relation to fundamental fibre properties and fabric construction. Several attempts have been made to study this relationship. The exploitation and application of artificial intelligence methods are increasingly important in engineering problems [3], for example, multiple researchers have examined the artificial neural network to resolve this problem [4, 5]. In his study, Bahera attempted to predict the woven drape profile f using finite element analysis [6]. In another study, Niwa and Seto explained the correlation between the drape coefficient and the mechanical characteristics of fabric using the multiple regression method [7]. Then, they discovered the mechanical properties of the fabric using the KES system. In another study, Viswanaath et al. presented a new method of assessment of fabric drape [8].

In their research, Thouraya et al. displayed a method that helps divine and identify the drape parameters and designate the drape phenomenon by applying the fuzzy logic method [9], as well as attempting in another work to indicate the correlation between seelcted fabric parameters and the drape using principal component analysis [10]. In the work of Basu et al., various computational tools for the prediction of fabric behaviour were proposed [11]. Based on new engineering trends, Hu et al. used computer models to predict fabric properties and performances [12].

In industrial requirements, textile fabrics have great importance in the textile process as their properties must conform precisely to the needs of the users. Thus, the prediction of their properties and their final behaviour is significant.

In this study, we tried to obtain the most likely fabric to meet garment requirements with a low, high, or average drape value, for which we adopted the graphical method. First, we used the the response surface technique, which enabled us to determine the approximate relationship between the input variables and output responses. Using this method allows, through different colours or grayscale, to obtain an overview of each property's results and trends based on the parameters in question. Each colour or grey level represents the areas where we have the same values of the measured property [13].

Secondly, we used the method of diagram contours, which aims to seek compromise areas, visualise the influences of different parameters on the drape, facilitate end-user buying decisions, and simplify the manufacturer's choice concerning the properties related to drape necessary for the textile products in question. Each property's lower and upper limits on this chart represent each response's acceptance range [14]. Thus, this diagram gives an overview by merging different parameters and showing the compromise or areas that can meet the demands of other characteristics simultaneously through the acceptance of each property limit. Finally, knowing the optimal properties, we can find the fabric parameters that can ensure the level of drape required.

Using diagram contours allows us to visualise the influence of the properties of fabric on drape characteristics: the drape coefficient (CD), number of folds (NF), drape distance ratio (DDR), and the index of fold depth (FDI) [15]. This technique allows to make decisions about the choice of fabrics used and their applications.

To verify the results and optimise the solutions, we used the AHP method (Analytic Hierarchy Process), which is a procedure for organiaing and analysing complex decisions. This system, made by Thomas L. Saaty, is based on mathematics and psychology. It describes an objective strategy to quantify the importance of decision criteria, and it is practiced in many kinds of judgment situations [16, 17].

Materials and methods

To prepare study samples, we used sixty-three woven fabrics, both twill and plain. Standard atmospheric conditions were used to condition the fabric samples. The fabrics were 80% cotton and 20% cotton/polyester.

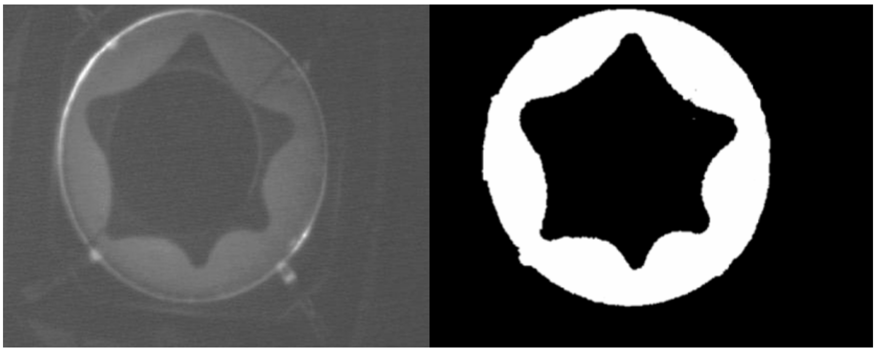

Figure 1. Result of drape image analysis.

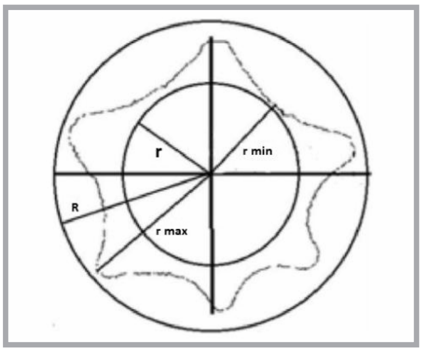

Figure 2. Dimensions used in drape calculation.

Determination of fabric characteristics

Selected standards and tools were used to identify and characterise the samples employed in this study. For example, we used the French Standard NFG07-104 to measure the fabric weight [18], and we applied the Cantilever Test to identify the bending rigidity in the weft, warp, and skew directions. Determination of the shear rigidity was undertaken within the FAST system. These instruments were used to measure the mechanical and dimensional properties so as to quantify the aesthetic fabric properties objectively. In this study, the FAST-3 system was used to determine the fabric's extension.

Calculation of drape parameters

Some research was made to determine the drape using image processing [19]. In our work, we developed a MATLAB application, and used a Cusick drapemeter to apply the image analysis (***Figure 1***) and to determine the drape coefficient *DC* (%) [20].

The extraction of the drape shape presented in the previous image was carried out following a series of image processing steps: reading and coding the original image, conversion to a gray level image, noise reduction using the adopted filters, and finally the thresholding step.

In ***Figure 2*** various dimensions were used in the drape calculation.

Where,
r – Radius of the supported disc,
R – Radius of disc global,
r_{max} – Maximum radius of the draped sample,
r_{min} – Minimum radius of the draped sample.

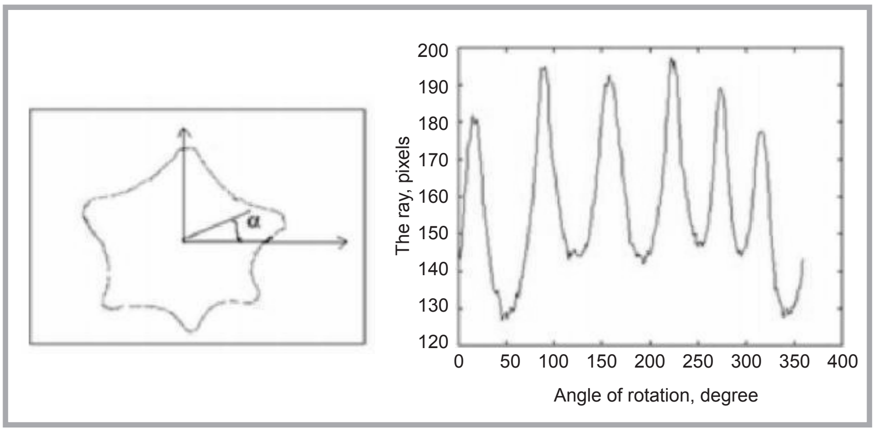

Figure 3. Distribution of the ray throughout the drape.

$$DC = \frac{drape\ surface\ (pixel) - \pi \times (supported\ disc\ radius\ (cm) \times c)^2}{\pi \times (global\ disc\ radius\ (cm) \times c)^2 - \pi \times (supported\ disc\ radius\ (cm) \times c)^2} \quad (1)$$

$$DC = \frac{drape\ surface\ (pixel) - \pi \times (r\ (cm) \times c)^2}{\pi \times (R\ (cm) \times c)^2 - \pi \times (r\ (cm) \times c)^2} \quad (2)$$

***Equations (1)** and **(2)**.*

This representation was obtained following the step of tracing the shape of the drape by showing the outline.

We can calculate the drape parameters from this figure containing the different functional dimensions: the drape coefficient, drape distance ratio, and fold depth index.

a. Calculation of the drape coefficient (DC)

In this work, we calculated the drape coefficient (*DC*) using the following ***Equations (1)*** and ***(2)***, where,
DC – Drape coefficient,
c – Correlation between the centimetre and pixel.

b. Calculation of the drape distance ratio and fold depth index

The drape distance ratio (*DDR*) and fold depth index (*FDI*) were computed by applying the equation formula suggested by Jeong and Philips [21].

$$DDR = \frac{R - r_{ad}}{R - r} \quad (3)$$

and $$FDI = \frac{r_{max} - r_{min}}{R - r} \quad (4)$$

Where,
r_{ad} – Radius means value of the fabric drape.

c. Determination of the fold number (NF)

The fold number is an essential parameter associated with the virtual appearance of clothing. The distribution of the various distances of all the outer contour points confirms the minimums and maximums' presence, as shown in ***Figure 3***.

The representation of the diagram of the maximums and minimums was carried out following the calculation of the distance between the center of the form of the drape and all the adjacent points of the contour.

Graphical method: the response surface and graphic contours

Response surface methodology (RSM) explores the relationships between several analytical variables and one or more response variables. The method was established by George E. P. Box and K. B. Wilson in 1951 [22]. The principal concept of RSM is to practice a set of measures to achieve an optimal response.

On the other hand, graphic contour' methodology combines mathematical optimisation techniques to improve processes and product performance [23]. In our application, the problem arises in k variables (x 1, ..., x k) and m responses (y 1, ..., y m).

We adopted the response surface method with overlapping contour diagrams obtained by superimposing graphic contours to find the most likely fabric and entirely meet the garment requirements with low, moderate or high drape.

Analytic Hierarchy Process AHP

The main steps of the Analytic Hierarchy Process algorithm are as mentioned below:

- Establish the construction of the decision problem and criteria selection.
- Generate a pairwise matching matrix for all the criteria.
- Develop a pairwise comparison matrix for each alternative for each criterion.
- Create a normalised pairwise matrix.
- Determine the vector weight of the normalised pairwise matrix.
- Measure the consistency value.

To confirm the results of the AHP, the consistency ratio (CR) was computed employing the following ***Equation (5)***:

$$CR = \frac{CI}{RI} \quad (5)$$

Where,
RI – the random index, presented in ***Table 1.***

The values found in this table are unchangeable values related to the number "n" of the variables used.

CI – the consistency index, calculated by the following equation

Table 1. Random Index (RI).

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Table 2. Parameters of the different classes by the Fuzzy C-means method.

Classes	Statistical parameters	DC	NF	DDR	FDI
Class 1	Minimum	0.28	8	0.4	0.34
	Maximum	0.55	10	0.89	0.42
	Average	0.415	9	0.64	0.38
Class 2	Minimum	0.53	6	0.26	0.4
	Maximum	0.78	7	0.48	0.47
	Average	0.65	6.5	0.37	0.43
Class 3	Minimum	0.74	2	0.10	0.45
	Maximum	0.95	5	0.28	0.56
	Average	0.84	3.5	0.19	0.50

Table 3. Performance modeling CD, NF, DDR, and FDI regression of the response surface.

Characteristics	Standard deviation	Performance variables			
		RMSE	*MARE*	R^2	R^2_{Adj}
CD	0.181	0.069	0.096	0.889	0.879
NF	2.190	0.676	0.116	0.903	0.894
DDR	0.174	0.121	0.260	0.801	0.783
FDI	0.058	0.021	0.038	0.877	0.866

$$CI = \frac{\gamma_{max} - n}{n - 1} \quad (6)$$

Where,
n – order of the matrix,
γ_{max} – The average of all the consistency values.
– Obtain an overall relative score for each alternative

Results and discussions

Classification of Fabric Samples by the FCM Method

Generally, there are three classes in the evaluation of drape: low, medium, and high. This classification is concluded from real and industrial applications and cases. In this study, we used the Fuzzy C-means method to classify fabric characteristics, and the drape parameters allow to identify the fabric that varies depending on the application [24]. Indeed, a fabric that belongs to class 1 (low drape) must minimise the drape coefficient, maximise the number of folds, minimise the index of the depth of folds, and maximise the distance draped ratio. However, to belong to the second class (medium drape), we seek to position the drape parameters' values in the corresponding intervals' centre. While in the third case class (high drape), it is necessary to maximise the drape coefficient, minimise the number of folds, maximise the index of the depth of folds, and minimise the draped distance ratio.

To explain the drape classification, in ***Table 2*** we present some statistical data (minimum, maximum, and average).

This table provides a good explanation of the statistical distribution of the drape's characteristics. The Fuzzy C-means method classified the digital drape parameters of the samples tested into three classes.

Use of the response surface methodology

We determined the relationship between the input variables and responses to estimate the response surface for each parameter. Then, we calculated the performance variables: the root-mean-square error (RMSE), mean absolute relative error (MARE), coefficient of determination (R^2), and adjusted R-squared ($R2_{adj}$).

a. Effect of bending rigidity through B_{skew} and B_{warp} on drape parameters

The graphic contour diagram in ***Figure 4*** shows the evolution of draped parameters in dependence on the bending rigidity in the skew direction and warp direction.

According to the diagrams in ***Figure 4***, the drape coefficient's highest values and the depth fold index are obtained for high

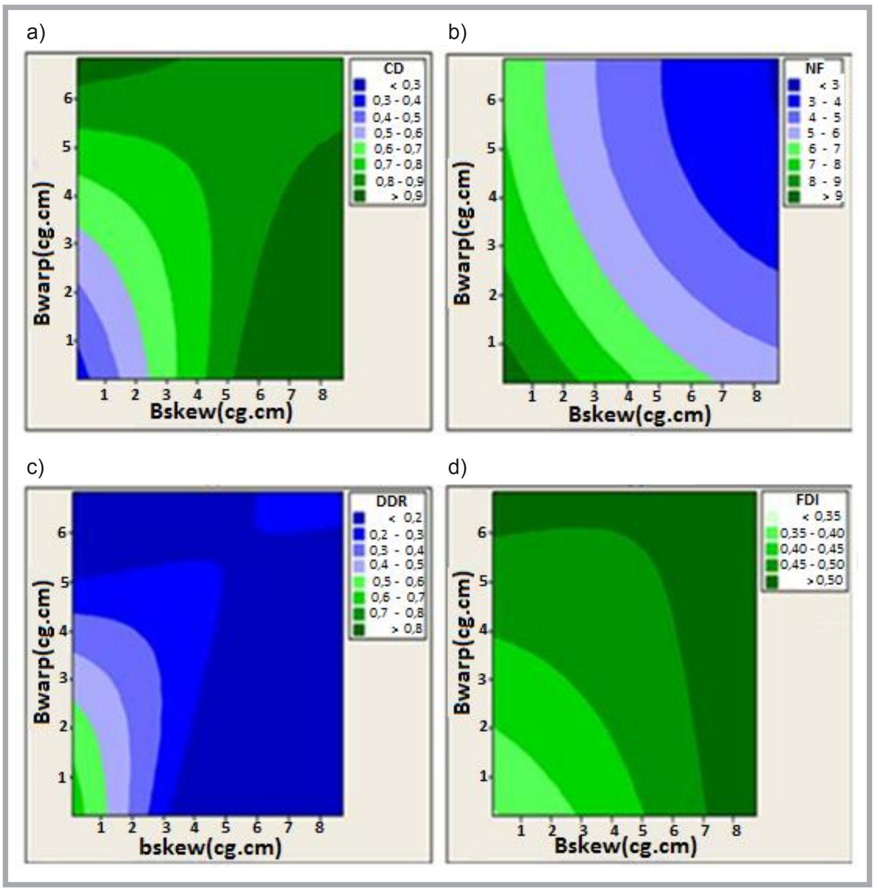

Figure 4. *Effect of rigidities bending through B_{skew} and B_{warp} on parameters of the drape.*

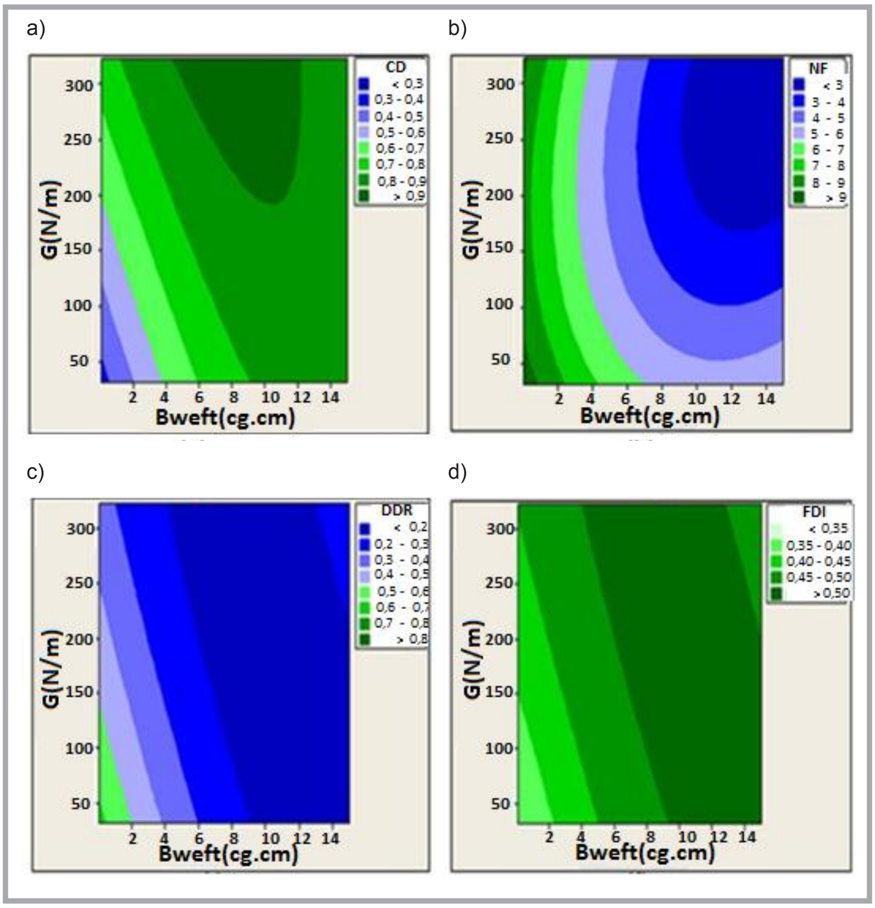

Figure 5. *Effect of bending rigidity B_{weft} and shear stiffness on drape parameters.*

values of the bending rigidity in the skew and warp directions. Similarly, we note that most values of the bending rigidity in the warp and skew increase at the folds' lowest values and ratio drape distance.

To better understand the phenomenon, in ***Table 3*** we present the performance modeling regression of the response surface.

CD = 0.333 + 0.106 $\mathbf{B_{skew}}$ + 0.062 $\mathbf{B_{warp}}$
NF = 9.909 – 0.787 $\mathbf{B_{skew}}$ – 0.879 $\mathbf{B_{warp}}$
DDR = 0.667 – 0.142 $\mathbf{B_{skew}}$ + 0.032 ($\mathbf{B_{skew}}$* $\mathbf{B_{warp}}$)
FDI = 0.338 + 0.018 $\mathbf{B_{skew}}$ + 0.031 $\mathbf{B_{warp}}$

From ***Table 3***, we can conclude that there is an excellent correlation between fabric characteristics (B_{skew} and B_{warp}) and drape parameters (CD, NF, FDI). The correlation coefficients are very close to 1 (R^2 relating to CD = 0.889, R^2 relating to NF = 0.903, and R^2 relating to FDI = 0.877). Also, we can judge that there is a good correlation between the parameters of the fabric with DDR (R^2 = 0.801).

b. Effect of bending rigidity B_{weft} and shear stiffness G on drape parameters

The diagram below shows drape parameters' evolution depending on the bending rigidity in the weft direction and shear stiffness.

The diagram in ***Figure 5*** shows that the weft rigidity directly affects the drape coefficient and folding depth index. Indeed, the more the rigidity, the higher B_{weft} is ; and the parameters (CD and FDI) are high. On the other hand, high values of shear stiffness correspond to the drape coefficient and folding depth index.

In the same chart, we see that the shear stiffness has no significant effect on the variation in the number of folds. At the same time, the bending rigidity in the weft direction is closely related to this parameter. Indeed, the more the bending rigidity, the higher B_{weft} is , with the number of folds being small. Similarly, the shear stiffness and bending rigidity in the weft direction are closely linked to the drape distance ratio. The more the shear stiffness G and B_{weft} , the lower the DDR .

In ***Table 4*** we present the performance modeling regression of the response surface.

CD = 0.306 + 0.077 $\mathbf{B_{weft}}$ + 0.001 **G** – 0.002 $(\mathbf{B_{weft}})^2$
NF = 10.142 – 0.725 $\mathbf{B_{weft}}$ – 0.018 **G** + 0.034 $(\mathbf{B_{weft}})^2$
DDR = 0.670 – 0.074 $\mathbf{B_{weft}}$ + 0.002 $(\mathbf{B_{weft}})^2$
FDI = 0.332 + 0.026 $\mathbf{B_{weft}}$ + -9.40 10-4$(\mathbf{B_{weft}})^2$

The results that we can derive from ***Table 4*** are very similar to those found previously in ***Table 3*** (R^2 relating to CD = 0.916, R^2 relating to NF = 0.932, R^2 relating to DDR = 0.79, and R^2 relating to FDI = 0.87).

There is a perfect correlation between the fabric's parameters with the bending rigidity B_{weft} and shear stiffness G.

c. Effect of the thickness and surface mass on drape parameters

The diagram in ***Figure 6*** shows the evolution of drape settings according to the surface mass and thickness.

This diagram shows that the thickness slightly affects the drape coefficient, number of folds, index of deep folds, and drape distance ratio.

On the one hand, the surface mass (W) is related to these parameters with different proportions. The drape coefficient and index of deep folds increase with the increasing mass surface. On the other , the more the surface mass (W) decreases, the more the number of folds and drape distance ratio increase. In ***Table 5*** we present the performance modeling regression of the response surface.

CD = 0.414381 + 0.00156898 **W**
NF = 9.35684 – 0.0141329 **W**
DDR = 0.46743 – 7.47 10^{-04} **W**
FDI = 0.356321 + 0.00040816 **W**

From the correlation coefficients in ***Table 5*** (R^2 under 0.5), we can conclude a weak correlation between the drape parameters, surface mass (W), and thickness.

Using the contour diagram method

The principle of looking for compromise areas is giving each property an acceptance area. If we choose to put ourselves in the white zone, we find a solution that perfectly meets the study's objectives. Each property's lower and upper limits in the diagram represent the range of acceptance of each response [25].

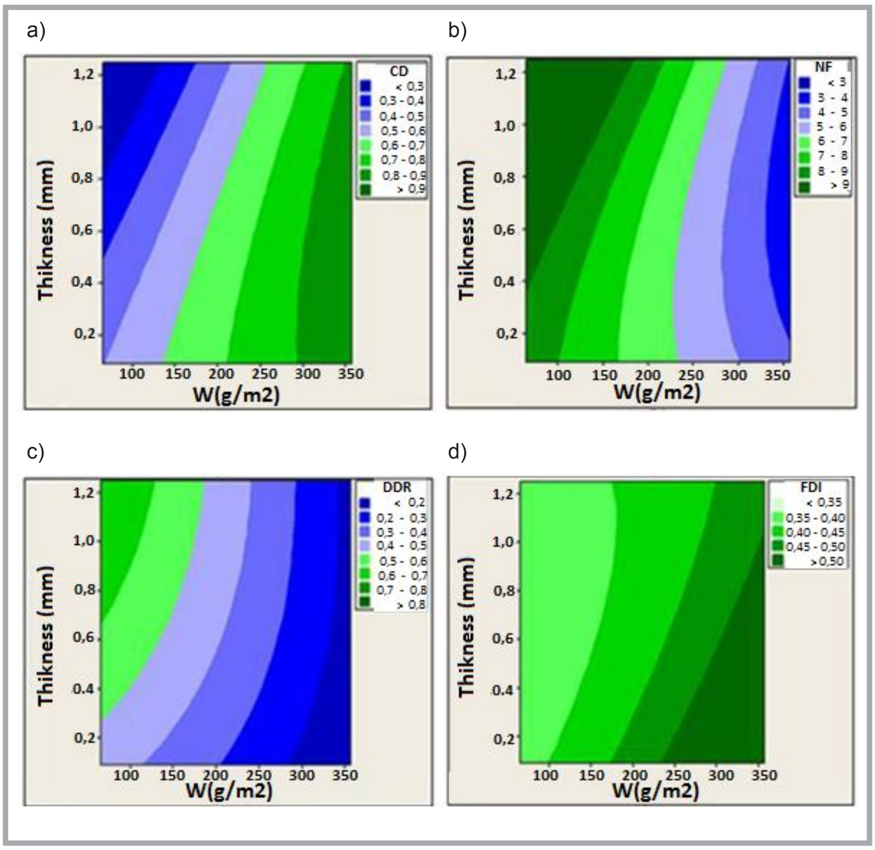

Figure 6. *Effect of the thickness and surface mass on drape parameters.*

Table 4. *Performance modeling DC, NF, DDR, and FDI regression of the response surface.*

Characteristics	Standard deviation	Performance variables			
		RMSE	*MARE*	R^2	R^2_{Adj}
CD	0.181	0.052	0.070	0.916	0.909
NF	2.190	0.564	0.090	0.932	0.926
DDR	0.174	0.079	0.155	0.790	0.771
FDI	0.058	0.021	0.037	0.870	0.858

Table 5. *Performance modeling DC, NF, DDR, and FDI regression of the response surface.*

Drape characteristics	Standard deviation	Performance variables			
		RMSE	*MARE*	R^2	R^2_{Adj}
CD	0.1811	0.136	0.194	0.430	0.380
NF	2.190	1.607	0.257	0.460	0.408
DDR	0.174	0.142	0.355	0.337	0.270
FDI	0.058	0.001	0.077	0.500	0.447

Table 6. *Characteristic results from the contour diagram method.*

Class	Interval limit	B_{skew}, cg.cm	B_{warp}, cg.cm	B_{weft}, cg.cm	G, N/m	W, g/m²	Thickness, mm
Class 1	Min	0.081	0.186	0.072	30.91	65	0.09
	Max	2	2.6	2.4	150	219	1.25
Class 2	Min	0.3	1.3	1.7	30.91	170	0.09
	Max	3.75	4.8	6.5	270	282	1.25
Class 3	Min	3	2.8	4.5	60	280	0.09
	Max	8.761	6.85	15.01	322.9	357	1.25

Table 7. *Study case: fabric characteristics.*

B_{skew}, cg.cm	B_{warp}, cg.cm	B_{weft}, cg.cm	G, N/m	W, g/m²	Thickness, mm
0.089	0.650	0.072	52.3	68	0.48

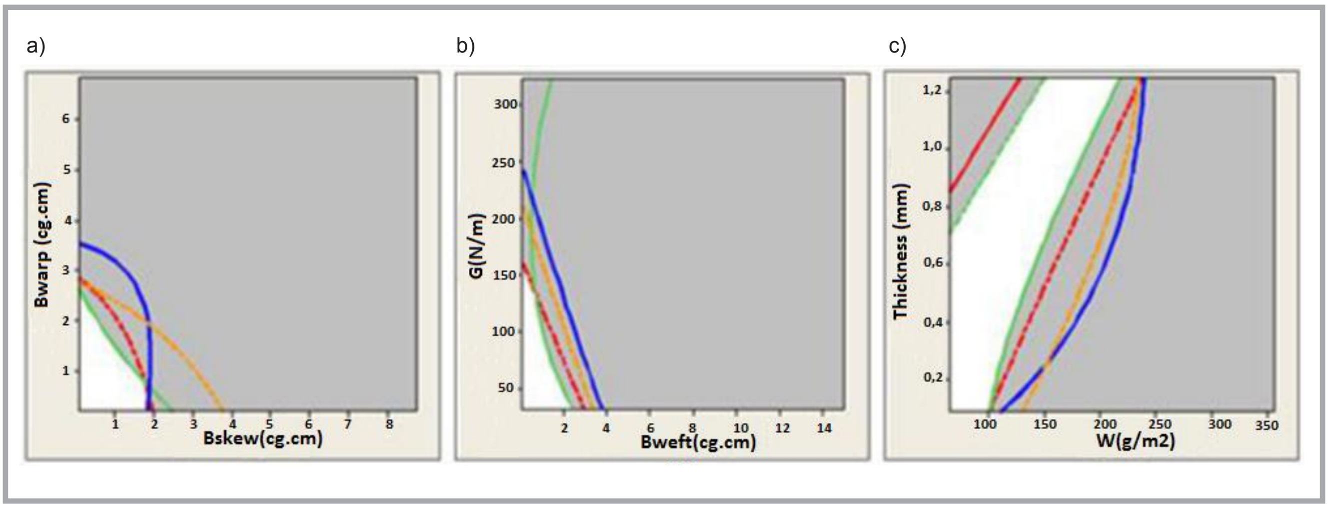

***Figure 7.** Contour diagrams for Class 1: a) flexural rigidity B_{warp} and B_{skew}, b) flexural rigidity B_{weft} and shear rigidity, and c) thickness and mass surface.*

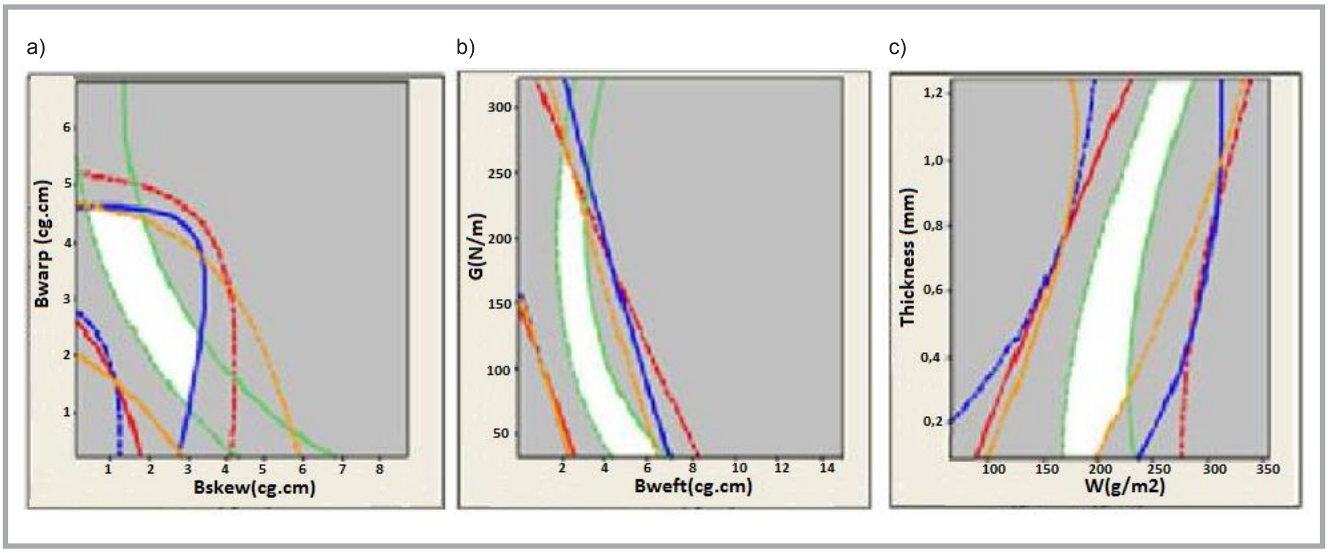

***Figure 8.** Contour diagrams for Class 2: a) B_{warp} and B_{skew} flexural rigidity, b) B_{weft} flexural rigidity and shear rigidity, and c) thickness and surface mass.*

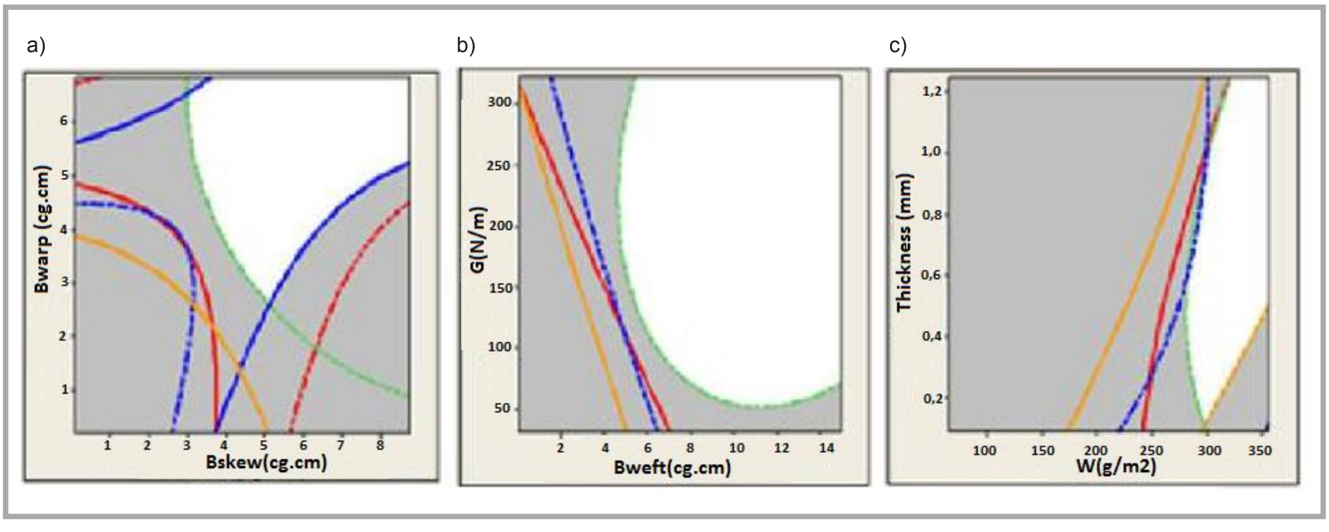

***Figure 9.** Contour diagrams for Class 3: a) flexural rigidity B_{warp} and B_{skew}, b) flexural rigidity B_{weft} and shear rigidity, and c) thickness and surface mass.*

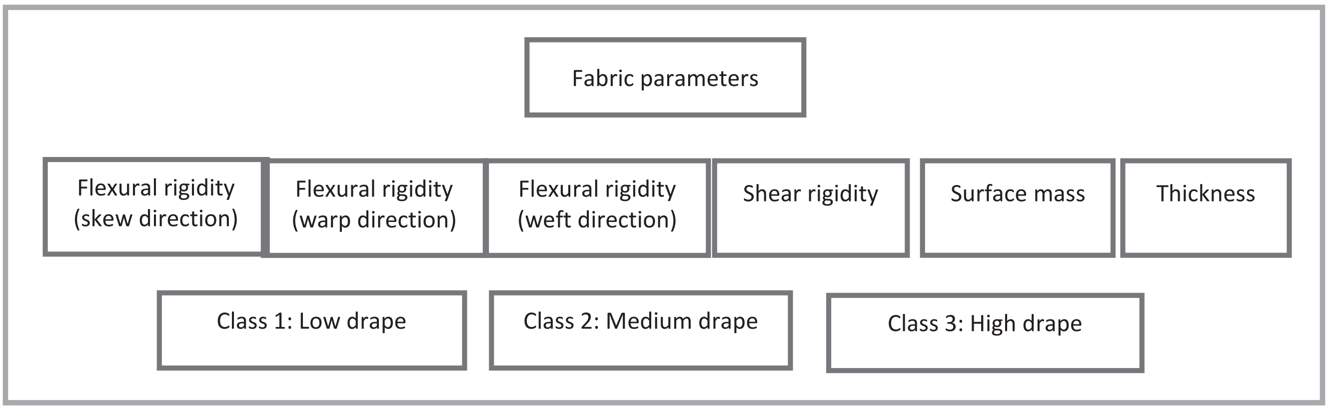

Figure 10. *AHP process for drape classification.*

Thus, this diagram makes it possible to have a global view by grouping the different properties. Also, by showing the compromised area, it is possible to satisfy the distinct parameters' requirements through each property's acceptable limits. Finally, knowing the optimal characteristics, we can look for the fabric parameters to ensure the obtainment of the drape in question.

We note that we can optimise the different fabric properties by this method and achieve the drape effect sought for clothing textiles. In ***Figures 7***, ***8*** & ***9***, we present the results of this research.

By examining these charts, we see the white areas of compromise that achieve a fabric drape with the defined effect and acceptable selected drape parameters. We note that these results confirm the conclusions proved by Hu [26]. As a result, in ***Table 6*** we present the intervals of membership of the various parameters making it possible to obtain a definite drape class.

Using the Analytic Hierarchy Process AHP

To determine the suitable drape for fabric, we use the AHP method in our research. For this, we first start to specify the AHP process for drape classification.

As shown in ***Figure 10***, we have six inputs representing the fabric's characteristics (flexural rigidity in skew, warp and weft directions, shear rigidity, surface mass, and thickness) and three outputs representing the drape classification (low, medium, and high drape).

To explain the calculation process and determination of the correct class of drape by the AHP method, we present below a case study of a fabric with well-defined characteristics, shown in ***Table 7***, and we attempt through this calculation to determine the corresponding drape class.

In ***Table 8***, we present the pairwise comparison matrix of the criteria. Then, in ***Table 9*** we display the normalisation matrix. After that, we calculate the consistency ratio as shown in ***Table 10***.

In the rest of the calculation, we determine the pairwise comparison matrix for each drape class for the following criteria: flexural rigidity in the skew, warp and weft directions, shear rigidity, m surface mass, and thickness.

Then, we calculate the normalisation matrix for each pairwise comparison matrix for each drape class for the criteria mentioned above.

Table 8. *Pairwise comparison matrix of critera.*

	Flexural rigidity (skew)	Flexural rigidity (warp)	Flexural rigidity (weft)	Shear rigidity	Mass surface	Thickness
Flexural rigidity (skew)	1	1/7	1/9	1/9	1/9	1/3
Flexural rigidity (warp)	7	1	3	1/3	1/3	3
Flexural rigidity (weft)	9	1/3	1	1/3	1/9	3
Shear rigidity	9	3	3	1	1/3	9
Surface mass	9	3	9	3	1	9
Thickness	3	1/3	1/3	1/9	1/9	1
Sum	37.00	7.81	16.44	4.89	2.00	25.33

Table 9. *Normalisation matrix.*

	Flexural rigidity (skew)	Flexural rigidity (warp)	Flexural rigidity (weft)	Shear rigidity	Surface mass	Thickness	Weight, %	Consistency
Flexural rigidity (skew)	0.03	0.02	0.01	0.02	0.06	0.01	0.02	6.15
Flexural rigidity (warp)	0.18	0.13	0.18	0.07	0.17	0.12	0.14	6.80
Flexural rigidity (weft)	0.24	0.04	0.06	0.07	0.06	0.12	0.10	6.41
Shear rigidity	0.24	0.38	0.18	0.20	0.17	0.36	0.25	6.75
Surface mass	0.24	0.38	0.55	0.61	0.50	0.36	0.44	7.07
Thickness	0.08	0.04	0.02	0.02	0.06	0.04	0.04	6.27

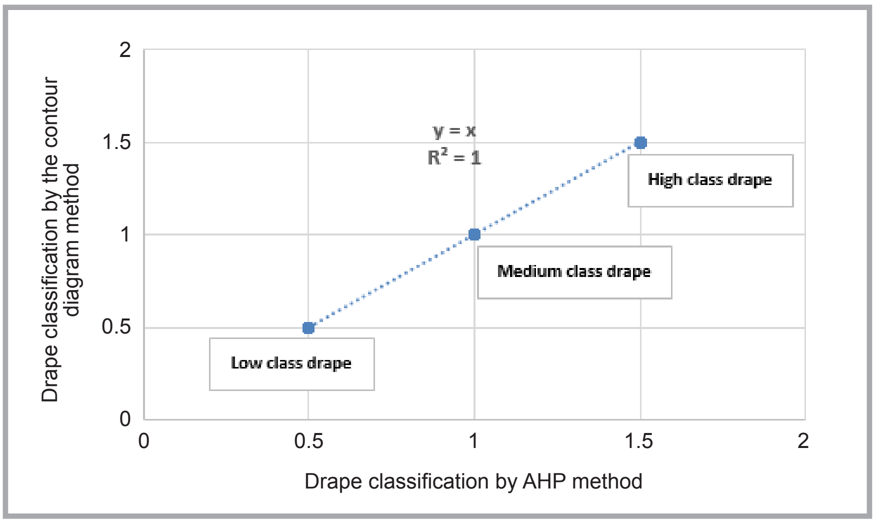

Figure 11. *Correlation between the AHP method and contour diagram method.*

To validate the calculation, we calculate each pairwise comparison matrix's consistency ratio.

To explain the procedure adopted, we present above the pairwise comparison matrix for each class of drape for the following criteria: flexural rigidity in the skew direction (***Table 11***), the normalization matrix (***Table 12***), and consistency ratio calculation (***Table 13***).

We continue to determine the pairwise comparison matrix for each drape class for the other criteria (flexural rigidity in the warp and weft directions, shear rigidity, surface mass, and thickness. Finally, we obtain the optimal result (draping class) through the solution matrix presented in ***Table 14***.

From ***Table 14*** it is clear that a higher weight (69%) corresponds to a lower class of drape. Therefore, we can conclude that low drape characterises our sample. This AHP calculation approach was applied to all the samples.

As a result, by comparing the results found by the AHP method and those found jointly by the Fuzzy C-means classification and the contour diagram method, as shown in ***Figure 11***, we see a perfect correlation between the two processes.

In the diagram below, we symbolise the drape class by these values: (low class of drape: 0.5; medium class of drape: 1; high class of drape: 1.5).

From these results, we can deduce that the two methods (Graphic method and AHP method) proved their efficiency in determining the exact correlation between the drape parameters and the fabric's characteristics.

Table 10. *Consistency ratio.*

RI	1.24
n	6
γ_{max}	6.57
CI	0.11
Ratio	0.09

Table 13. *Consistency ratio.*

RI	0.58
n	3
γ_{max}	3.04
CI	0.02
Ratio	0.03

Table 11. *Pairwise comparison matrix for each class of drape for the following criterion: flexural rigidity in the skew direction.*

	Class 1: Low drape	Class 2: Medium drape	Class 3: High drape
Class 1: Low drape	1	3	5
Class 2: Medium drape	1/3	1	3
Class 3: High drape	1/5	1/3	1
Sum	1.53	4.33	9.00

Table 12. *Normalisation matrix.*

	Class 1: Low drape	Class 2: Medium drape	Class 3: High drape	Weight, %	Consistency
Class 1: Low drape	0.65	0.69	0.56	0.63	3.07
Class 2: Medium drape	0.22	0.23	0.33	0.26	3.03
Class 3: High drape	0.13	0.08	0.11	0.11	3.01

Table 14. *Matrix of solution.*

	Flexural rigidity (skew)	Flexural rigidity (warp)	Flexural rigidity (weft)	Shear rigidity	Surface mass	Thickness	Weight, %
Class 1: Low drape	0.63	0.64	0.75	0.59	0.80	0.33	**0.69**
Class 2: Medium drape	0.26	0.28	0.19	0.33	0.12	0.33	**0.22**
Class 3: High drape	0.11	0.07	0.06	0.08	0.08	0.33	**0.09**

Conclusions

The choice of a method based on a graphical grid to look for areas of compromise allows us to visualise the influences of the various parameters that affect the drape. This method also facilitates the user's purchase and simplifies the manufacturer's choices regarding the drapery properties required for the textile products in question. This method helps determine fabric characteristics from the selected drape parameters. It also allows us to give a range of solutions from which we can obtain the desired drape effect.

These diagrams allow us to provide different drape properties according to the fabric's selected properties. To optimise these properties and obtain a better drape, we must seek the value of bending rigidity in the warp, weft, and skew directions, as well as the shear stiffness, and surface mass to maximise drape properties.

In this work, we also used the AHP. It is necessary to produce a judgment and decision or judge and evaluate various options in situations where no possibility is complete and perfect.

In our case study, we note the agreement between the solutions obtained using both the AHP and graphical method.

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Declaration of conflicting interests

The authors declare there is no conflict of interest.

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