MULTIVARIATE ANALYSIS IN QUALITY DESIGN OF COTTON BLENDS

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Abstract

In the world's textiles, economics and technology demand high quality in instruments to select fibers for quality design products.

Quality assurance and quality design begin with the purchase and selection of raw cotton. Testing of samples from every bale of cotton assures the mill of uniform blending for consistently yarn quality.

HVI systems give reliable raw cotton properties that are essential for product quality design and processing requirements.

Selection of fiber properties is important for uniform mixes and yarn quality design. Fiber and yarn properties involve a great number of variables and data.

When multiple variables are involved, the multivariate analysis is one statistical technique used to reduce the number of responses to a smaller set of variables.

We defend that is interesting to use multivariate analysis of the fiber's blends and the yarn's properties to design the yarn's quality.

In this work multivariate analysis is applied to design the cotton blends and the yarn quality.

Introduction

Improved products constantly raise the level of expectation for next-generation products. In many cases, technology and innovation are moving more rapidly than our ability to do good design engineering and manufacturing by old methods. Quality products that perform as advertised and does so without variation are now part of the informed customer's expectation. Often, only testing can give us the information necessary to decide the quality of a product.

Our job as researcher is to find the most efficient schemes of testing and to apply such schemes to as broad a gamut of applications as possible to obtain the information required to make a successful product.

The data resulting from HVI systems is a collection of measurements of the cotton fiber's properties of different dimensions. The conclusions to be drawn from the experiment cannot be reliably found out by simple direct inspection of the data. Classification, summary description, and rules of evidence for the drawing of valid inference are required. Statistics provide the methodology by which this can be done.

Implicit in any experiment is the presumption that arguing it from the particular to the general is possible and that new knowledge can be obtained by the process of inductive inference.
Multivariate statistical analysis is concerned with data collected on several dimensions of the same individual. As in invariate statistics, it shall assume that a random sample of multicomponents observations have been collected from different individuals or other independent sampling units.

However, the common source of each individual observation will generally lead to dependence or correlation among the dimensions, and it is this feature that distinguishes multivariate data and techniques from their univariate prototypes.

In our experience, the modeling of cotton mix properties, the principal-component analysis is exceedingly useful for data reduction, analysis of the latent structure of multivariate systems.

The principal-component analysis consists of an orthogonal transformation of the coordinate axes of a multivariate system to new orientations through the natural shape of the scatter swarm of the observation points.

By partitioning the total variance of all responses into successfully smaller portions we arrived at an objective means of determining the new coordinates.

Under the factor model each response variate will be represented as a linear function of a smaller number of unobservable *common-factor* variates and a single latent specific variate.

For those reasons our treatment of factor analysis will be directed to its modern explication as a problem in statistical estimation.

Factor analysis is used frequently to reduce a large number of responses to a smaller set of uncorrelated scores. By definition each component is a linear compound of the original responses.

For the factor model evaluation of such scores is neither so simple nor so uniquely defined, and it will consider two intuitively appealing methods for computing the values of the latent factors of a subject.

The object of this work, is to develop in textile research the

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applications of multivariate statistical methods. Emphasis is placed on the analysis and interpretation of data obtained from the conduct of experiments results in HVI systems to design the cotton blends of carded and combed yarns.

Materials and Methods

Four different types of the 100% cotton fibers blends are made: two carded cottons' blends and two combed cottons' blends.

These mixes are analysed in the HVI systems where are characterized yours properties (Table 1).

To study the most important fibers blends we are used the multivariate analysis. The variables' data involved in this analysis are the cotton's blends.

Analysis in principal components was used and computes component lines that summarize associations among variables.

To limit the number of factors was retained the eigenvalue greater unit.

We use the correlations that give equal influence to each variable in the matrix.

It is desirable to have a simple structure among component loading. To achieve this, the set of component axes is rotated for the varimax method that maximize the variance of loading down through columns of the component loading matrix.

Results and Discussion

In carded fiber blends the analysis in principal components show that four factors are sufficient to represent the data: almost 88%. These factors justify nearly the total variation of the samples (Tables 2, 4, 6 and 8).

For the combed fibers blended, the analysis of the model result that almost 81% of the total variance is attributed to the first three factors (Tables 10, 12, 14 and 16).

Thus, four models are studied. To the carded cotton fibers blends one model with four factors and all variables seem adequate to represent the data and one other with four factors and without the first three variables.

To the combed cotton fibers blend the models studied are: three factors and all variables' properties and three factors and the three first variables excluded.

Analysis of the rotated factor matrix suggests modeling of the carded cotton mixes involve all variables (Tables 3 and 7) the fourth factor is associated to yellow content property, the third factor to elongation and reflectance degree, the second factor to the micronaire and length properties and the first factor is related with the area, color grades, count, final grade, leaf, strength and trash weight properties.

In the carded cotton blends without the first three properties (Tables 5 and 9) the fourth factor is related to yellow content property, the third factor to the elongation property, the second factor to the final grade, leaf, reflectance degree, strength, and trash weight properties and the first factor represents to micronaire and length properties.

After rotation the analysis the models to the combed mixes with all properties (Tables 11and 15) reliable that the factor three is always associate to yellow content property, the second factor concerns area, color grades, count, final grade, leaf, micronaire, reflectance degree, strength and trash weight properties and the first factor is more closely identified with elongation and length properties.

The model concerning the combed mixes without the first three properties (Tables 13 and 17) shows that the third factor is always associated to yellow content property, the second factor is related to final grade, leaf, reflectance degree and trash weight properties and the first factor appears to be a dimension measuring to micronaire and mechanicals and length properties.

This study reliable that to design of the carded blends is important to consider area, color grades, count and the mechanics properties. In the yarns combed blends the most important properties are always the micronaire and the mechanical and length properties

So, multivariate analysis appears to be a good statistical technique to design the quality yarns and the fibers cotton blends.

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Table 1: Fiber properties

Property	Abbreviation
AREA	AREA
COLOR GRADES	CGRD
COUNT	COUNT
ELONGATION	EL
FINAL GRAD	FGRAD
LEAF (USDA Code)	LF
YELLOW CONTENT	+B
MICRONAIRE	MIC
REFLECTANCE DEGREE	RD
SPAN LENGTH 2,5 %	SL 2.5
SPAN LENGTH 50 %	SL 50
STRENGTH	STR
UPPER HALF MEAN LENGTH	UHM
UNIFORMITY INDEX	UI
UNIFORMITY RATIO	UR
TRASH WEIGHT	Wt %

CARDED COTTON BLENDS

Table 2: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
AREA	1	5.98626	37.4	37.4
CGRD	2	5.31239	33.2	70.6
COUNT	3	1.37877	8.6	79.2
EL	4	1.20273	7.5	86.8
FGRAD	5	0.74290	4.6	91.4
LF				
+B				
MIC				
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table 3: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4
AREA	0.67034			
CGRD	0.88182			
COUNT	0.93673			
EL			-0.94837	
FGRAD	0.93210			
LF	0.88065			
+B				-0.87083
MIC		0.72983		
RD			-0.93675	
SL 2.5		0.94955		
SL 50		0.98741		
STR	-0.66403			
UHM		0.95870		
UI		0.96255		
UR		0.93097		
Wt %	0.78154			

Table 4: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
EL	1	5.36202	41.2	41.2
FGRAD	2	3.78430	29.1	70.4
LF	3	1.30479	10.0	80.4
+B	4	1.10842	8.5	88.9
MIC	5	0.44123	3.4	92.3
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table5: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4
EL			-0.95702	
FGRAD		0.94119		
LF		0.89985		
+B				-0.96647
MIC	0.73070			
RD		-0.90317		
SL 2.5	0.94809			
SL 50	0.98783			
STR		-0.65600		
UHM	0.95900			
UI	0.96423			
UR	0.93265			
Wt %		0.82270		

Table 6: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
AREA	1	6.23612	39.0	39.0
CGRD	2	4.15523	26.0	64.9
COUNT	3	1.79977	11.2	76.2
EL	4	1.44244	9.0	85.2
FGRAD	5	0.94837	5.9	91.1
LF				
+B				
MIC				
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table 7: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4
AREA	0.76958			
CGRD	0.97082			
COUNT	0.89826			
EL			-0.90249	
FGRAD	0.69239			
LF	0.92241			
+B				-0.86614
MIC		0.88589		
RD			-0.92459	
SL 2.5		0.94861		
SL 50		0.97645		
STR	-0.82325			
UHM		0.95995		
UI		0.94726		
UR		0.89661		
Wt %	0.94675			

Table 8: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
EL	1	4.66377	35.9	35.9
FGRAD	2	3.59895	27.7	63.6
LF	3	1.85066	14.2	77.8
+B	4	1.65217	12.7	90.5
MIC	5	0.51842	4.0	94.5
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table 9: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4
EL			0.91736	
FGRAD		0.91695		
LF		0.78382		
+B				-0.58245
MIC	0.87649			
RD		-0.77276		
SL 2.5	0.95681			
SL 50	0.98135			
STR		-0.77460		
UHM	0.96472			
UI	0.94795			
UR	0.90204			
Wt %		0.83757		

COMBED COTTON BLENDS

Table 10: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
AREA	1	5.79143	44.5	44.5
CGRD	2	3.06734	23.6	68.1
COUNT	3	1.52752	11.8	79.9
EL	4	0.88159	6.8	86.7
FGRAD				
LF				
+B				
MIC				
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table11: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3
AREA		-0.66049	
CGRD		-0.89305	
COUNT		0.96445	
EL	-0.51955		
FGRAD		0.82424	
LF		0.87989	
+B			0.64335
MIC		0.72983	
RD		0.96422	
SL 2.5	0.83915		
SL 50	0.97269		
STR		-0.92126	
UHM	0.87593		
UI	0.94326		
UR	0.85035		
Wt %		0.92939	

Table 12: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
EL	1	5.92810	45.6	45.6
FGRAD	2	2.56324	19.7	65.3
LF	3	2.01775	15.5	80.8
+B	4	0.92175	7.1	87.9
MIC				
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table13: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3
EL	-0.91614		
FGRAD		0.95865	
LF		0.82604	
+B			0.89821
MIC	0.88598		
RD		0.89446	
SL 2.5	0.80295		
SL 50	0.93427		
STR	-0.86270		
UHM	0.85234		
UI	0.90699		
UR	0.76027		
Wt %		0.97653	

Table 14: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
AREA	1	6.55138	40.9	40.9
CGRD	2	4.62746	28.9	69.9
COUNT	3	1.88674	11.8	81.7
EL	4	0.90685	5.7	87.3
FGRAD				
LF				
+B				
MIC				
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table 15: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3
AREA		0.95663	
CGRD			0.86120
COUNT		0.88249	
EL	-0.68765		
FGRAD		0.87530	
LF		0.87530	
+B			0.75198
MIC		0.88589	
RD		0.75546	
SL 2.5	0.76976		
SL 50	0.98705		
STR		0.63178	
UHM	0.80056		
UI	0.93075		
UR	0.80690		
Wt %		0.93363	

Table 16: Factor Extraction

Variable	Factor	Eigenvalue	% of Var	Cum Pct
EL	1	5.63785	43.4	43.4
FGRAD	2	3.19459	24.6	67.9
LF	3	1.58378	12.2	80.1
+B	4	0.80338	6.2	86.3
MIC				
RD				
SL 2.5				
SL 50				
STR				
UHM				
UI				
UR				
Wt %				

Table17: Rotated Factor Matrix

Variable	Factor 1	Factor 2	Factor 3
EL	-0.70455		
FGRAD		0.86441	
LF		0.94722	
+B			0.67595
MIC	0.73750		
RD		-0.72173	
SL 2.5	0.78090		
SL 50	0.98912		
STR	0.63851		
UHM	0.81390		
UI	0.93701		
UR	0.79697		
Wt %		0.91412	