A Statistical Analysis of Subjective and Objective Methods of Evaluating Fabric Handle

Part 3: Men's Summer Suiting Fabrics

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Abstract

A Factor Analysis is presented of assessments of the handle of a range of 156 men's summer fabrics by a panel of 56 judges drawn from the textile and clothing industries of Japan, Australia, New Zealand, India, the United States and China and a panel of eight Australian consumer judges with no experience in these industries. The analysis has been extended to include KES-F data on the mechanical and physical properties of these fabrics. Expert judges of men's summer fabrics may be classified into two groups, according to their pattern of fabric handle assessment. One group constitutes the Japanese and some Chinese judges, and the other group is associated with "Western" judges. The difference between these two patterns of fabric handle assessment has been related to the mechanical properties of the fabrics.

1. Introduction

In the first two parts of this series^[1,2], handle preferences and mechanical properties of men's winter suiting fabrics were discussed. These fabrics were assessed by experts drawn from the textile and clothing industries of different parts of the world. One factor in the analysis of the subjective assessments of fabric handle for men's winter suiting materials accounted for a substantial part of the judges' assessments. The judges appeared to assess the same fabric characteristics when rating the handle of men's winter suiting fabrics. However, for some specialized fabrics, the individual judge's taste and the judges' ratings of fabric handle to vary.

The summer fabrics pose an interesting problem. In a comparison of the expert assessments of Australian and Japanese judges, it was found that a slight negative correlation existed between the handle ratings of the countries 3). The existence of this lack of correlation implies that the experts are assessing different fabric properties which are not dependent on each other.

An analysis of the handle of men's summer suiting materials is presented in this paper for a wide range of international experts and some Australian consumers. The 156 men's summer suiting fabrics used in the study were chosen by the Hand Evaluation and Standardization Committee (HESC) from fabrics available on the Japanese market^[4].

2. Principal Component Analysis

2.1 Individual judges

From a total of 89 judges for which fabric handle data were available, a panel of 64 judges was selected using the

procedure outlined earlier^[1]. This iterative procedure sequentially eliminates the judge whose handle ratings are least explained in terms of the handle assessments of all the other judges in the panel. The final panel comprised six Japanese, 14 Indian, 13 Australian, five New Zealand,

Figure 1 The cumulative percentage variance is plotted with increasing numbers of principal component factors for fabric handle assessments of 64 judges from six countries for 156 men's summer suiting materials.

five United States and 13 Chinese expert judges and eight Australian consumer judges.

In spite of the selection of judges for consistency, the data required 15 factors to be extracted before the associated eigenvalue fell below unity. Figure 1 plots the cumulative variance of the handle assessments of the panel of judges explained by the first 16 factors. Twenty seven judges had a commonality over 0.5 on the first three factors and the matrix of correlation coefficients between these judges and factors, the structure matrix, is tabulated in Table 1.

The 15 sets of factor scores were rotated according to the varimax procedure such that the variance of the correlations within the rotated structure matrix is maximized. This procedure identifies judges whose commonality for the first three principal component factors was low but who still agreed significantly with the other judges. The structure matrix is tabulated in Table 2 for judges whose correlations with at least one of the first four rotated factors was greater than 0.5.

2.2 National panels of judges

Mean handle assessments were also calculated for

experts from the six National groupings and the Australian consumer judges. Results are presented in Table 3 for correlations between the three most significant principal component factors and both the mean handle assessments of these seven panels of judges and seven selected KES-F^[2] fabric parameters. These seven parameters were chosen from the full set of 17 KES-F parameters because they had a minimum correlation of 0.50 with at least one of the three principal component factors.

Correlations are presented in Table 4 of the rotated factors with the mean handle assessments of each of the seven panels of judges and eight KES-F parameters selected by same criteria as for Table 3.

Table 2 Rotated Structure Matrix

Variance*(%)	Rotated Factors			
	F1	F2	F3	F4
Judge	20.2	10.3	5.4	5.8
JJ1	—	.71	—	—
JJ2	—	.73	—	—
JJ5	—	.84	—	—
JJ6	—	.75	—	—
JJ7	—	.69	—	—
JJ8	—	.86	—	—
IJ1	.60	—	—	—
IJ2	.74	—	—	—
IJ3	.75	—	—	—
IJ5	.74	—	—	—
IJ6	.70	—	—	—
IJ8	.73	—	—	—
IJ9	—	—	—	— .56
IJ10	.56	—	—	—
IJ11	.72	—	—	—
IJ13	.72	—	—	—
AJ1	.60	—	—	—
AJ2	.63	—	—	—
AJ6	.80	—	—	—
AJ7	—	—	.58	—
AJ9	—	—	—	— .60
AJ16	.57	—	—	—
AJ17	.61	—	—	—
NZJ7	.52	—	—	—
NZJ8	.59	—	—	—
NZJ10	—	—	—	— .56
NZJ13	.65	—	—	—
USJ8	.70	—	—	—
CJ2	—	.54	—	—
CJ4	—	.50	—	—
CJ5	—	—	.75	—
CJ6	—	—	.53	—
CJ9	—	.58	—	—
CJ10	—	.52	—	—
CJ13	—	—	.61	—
CJ14	—	.68	—	—
CJ16	—	—	.68	—
AC1	.75	—	—	—
AC7	.67	—	—	—
AC8	.57	—	—	—

*Variance is the percentage of the total variance in the data accounted for by the nominated factor

Table 1

Judge		Principal Component Factors			Commonality
		F1	F2	F3	
Japan	J3	— .54	.61	.67	— .08
	J4	— .55	.71	.81	— .03
	J8	— .33	.73	.66	— .15
	J6	— .47	.56	.54	— .19
India	J2	.76	— .23	.63	.01
	J3	.69	— .08	.52	— .18
	J5	.56	— .11	.52	— .44
	J6	.79	— .18	.66	— .12
	J8	.67	— .10	.54	— .29
	J9	.63	.13	.50	.30
	J11	.82	— .05	.68	.01
Australia	J1	.74	.10	.55	.05
	J5	.81	— .19	.71	.14
	J6	.80	— .05	.69	— .20
	J16	.71	.10	.52	.05
	J17	.52	.26	.58	— .48
New Zealand	J7	.67	.02	.27	.52
	J8	.77	— .13	.06	.61
	J13	.76	.00	.09	.59
USA	J8	.80	.11	— .18	.69
China	J6	.35	.64	.12	.54
	J9	.32	.67	— .12	.57
	J10	.11	.72	— .14	.54
	J14	— .15	.76	— .03	.60
Australian Consumer	8	.70	.13	.10	.52
	9	.73	.11	.13	.57
	1	.78	— .14	— .16	.66

Structure matrix for the first three factors including only judges with commonality greater than 0.5.

3. Discussion

An intrinsic feature of the principal component technique is the significant degree of difficulty in defining precisely the level of significance for each factor isolated in the analysis. If all the observed variation in the data had been due to chance alone, the eigenvalues associated with the isolated factors would, on average, be unity. Consequently, eigenvalues greater than unity indicate some lack of randomness in the contribution made by the appropriate factor. However, the precise value of the eigenvalue below which one can consider the associated factor to be insignificant is arbitrary. In the current work, only those factors (when arranged in order of decreasing eigenvalue) which show a decrease of at least 0.5 from the eigenvalue of their predecessors have been considered.

3.1 Subjective assessments

A. Principal Component Factors
It can be seen from Figure 1 that there are two factors explaining about 40% of the variance in the handle assessments of the panel of 64 judges. In order to explain approximately 75% of the variance, another 15 factors have to be taken into account.

Table 3
Correlation of Variables with Principal Component Factors

Variable	Principal Components		
	F1	F2	F3
Tensile Resilience	-.15	.61	-.04
Bending Rigidity	-.74	.09	.19
Bending Hysteresis	-.24	-.65	.21
Deviation Surface Roughness	-.70	.09	.01
Hysteresis 0.5 deg. shear	.06	-.53	.14
Thickness	-.54	-.19	.13
Weight	-.66	.07	.19
THV Mean 8 Japanese judges	-.41	.82	-.08
THV Mean 8 Indian judges	.87	-.14	-.26
THV Mean 8 Australian judges	.94	.06	.07
THV Mean 8 Australian consumers	.86	.10	.13
THV Mean 13 New Zealand judges	.85	.14	.17
THV Mean 14 US judges	.89	.07	-.10
THV Mean 16 Chinese judges	.18	.89	-.12

Turning to Table 1, the fabric handle assessments of only 27 in the 64 judges were explained to better than 50% using the first three principal component factors. A large positive correlation with the second factor, links the Chinese and Japanese mechanism for assessing the fabrics, while a strong positive correlation with the first factor shows a similarity between the Australian, Indian, United States and New Zealand assessors. It is important to note that the Japanese judges correlate negatively with the 'Western' factor (factor 1), while this is not generally the case for the Chinese judges. To some extent we could hypothesize that the Japanese, besides having their own specific preference also dislike partially what Westerners prefer. The Chinese however seem to have some marginal preference for the pattern of Western assessment. The

Indian judges show a very strong preference for the pattern of Western assessment, perhaps influenced by the critical importance of the export market for men's suiting materials from India to western countries.

There appears to be no specific national preference associated with the third factor.

3.2 Rotated factors

After rotation of the first 15 factors, four factors explain a relatively high proportion of the handle assessment variance. These four factors explain 41.7% out of the total of 72.9% of the variance of fabric handle assessments extracted by the 15 Principal Component factors. Correlations are given in Table 2 of these four rotated factors with the assessments of 40 of the 64 judges who had a correlation of over 0.5 with any one of these factors.

Table 4
Correlations of Variables with Rotated Principal Component Factors

Variable	Rotated Factors			
	F1	F2	F3	F4
Tensile Resilience	-.12	.56	-.16	.14
Bending Rigidity	-.64	.25	-.15	.11
Bending Hysteresis	-.22	-.53	-.33	.18
Deviation Surface Roughness	-.53	.28	-.04	.32
Shear hysteresis @ .5 deg.	-.01	-.56	-.23	.16
Shear hysteresis @ 5.0 deg.	-.16	-.54	-.20	.14
Weight	-.53	.24	-.04	.23
THV Mean 8 Japanese judges	-.29	.93	.04	.03
THV Mean 8 Indian judges	.91	-.16	.12	-.10
THV Mean 8 Australian judges	.72	-.17	.31	-.38
THV Mean 8 Australian consumers	.63	-.15	.20	-.40
THV Mean 13 New Zealand judges	.66	-.06	.21	-.35
THV Mean 14 US judges	.72	-.14	.14	-.26
THV Mean 16 Chinese judges	.08	.60	.54	-.11

This table clarifies the information extracted from Table 1, improving the picture of the mechanism of fabric handle assessment. Once again there is one predominantly Western factor and one predominating Japanese factor. But, in this case a third factor yields an alternative Chinese pattern of assessment. Australian judge 7 favours this alternative mechanism as well.

Factor 4 expresses itself as another alternative to the Western assessment.

3.3 Subjective assessments and objective measurements

A. Principal component factors

Table 3 summarizes the correlations of objective and subjective data with the principal component factor scores. The Western factor, factor 1, indicates a preference for light-weight fabrics which have low thickness and low bending rigidity. A small deviation of surface roughness is preferred. The Japanese and Chinese judges appear to like materials with low bending and shear hysteresis and high tensile resilience. Fabric surface roughness, weight and thickness surprisingly seem to be unimportant

to the Japanese and Chinese judges.

B. Rotated factors

As seen in Table 4, there are again the two main groupings of National preference for fabric handle which are similarly linked to mechanical properties. Factor 3 is not strongly related to the mechanical properties shown in Table 4, but again highlights that unique pattern of handle preference shown by the Chinese judges.

3.4 Comparison with winter fabric handle

It is interesting to compare the results of analysis of the summer suiting materials reported in this paper with the analysis of the winter suiting materials reported previously in parts 1 and 2 of this series of paper^[1,2]. There are two important points that maybe drawn from this comparison. Firstly, it is clear that the objective mechanical and surface property data can be used readily to explain the subjective assessments of fabric handle made by expert judges from different countries in the case of winter suiting materials. For the summer suiting materials, a lower level of statistical precision is obtained when relating the objectively measured data to the subjective assessments of fabric handle. This result of the statistical analyses reported in this series of papers supports the comments made by many of the expert judges who remarked during the fabric handle survey that the summer suiting materials were much more difficult to assess for fabric handle than the winter suiting materials.

The second important result that may be drawn this series of papers is that the expert judges may be classified into groups according to their pattern of fabric handle assessment. This statement is true for both the summer and winter fabric analyses, but the grouping of judges is particularly striking in the case of the summer suiting materials. In this latter case, we have indentified two different patterns of fabric handle assessment—one that appears to be associated mainly with the Japanese judges and the other pattern of assessment associated with the “Western” judges. A third pattern of fabric handle assessment for the summer suiting materials, although statistically less clearly identifiable, is associated with the judges from the People’s Republic of China. These results have ramifications as far as the design and international marketing of particular styles of fabrics are concerned. There are strong cultural determinants of fabric handle preferences over and above differences in climate.

4. Conclusions

There are at least two modes of assessing fabric handle for men’s suiting materials—one used by the Japanese and, in part, by Chinese expert judges, and the other used by the Australian, Indian, New Zealand and the United States expert and Australian consumer judges. A significant proportion of the Chinese judges assess the handle of summer fabrics in a manner which, in part, is not related to the other expert of consumer judges and does not seem to be related to the fabric mechanical property data. This is shown by the correlation of 0.34 between the mean of the mean of the Chinese judges handle assessments and factor 3 in Table 4.

The differences between the two modes of assessment have been related to the mechanical properties of the fabrics. The mechanical properties which are related to these differences are the elasticity parameters for the tensile, shear and bending modes of deformation; fabric bending rigidity; fabric surface roughness; and fabric mass per unit area and thickness.

5. Further Work

Some information as to the sets of fabric properties which might have universal approval by consumers could be derived from the factors. Further work is required to pinpoint the fabric properties necessary to achieve universal approval. In this way fabric designers could optimise sales and profitability by producing fabrics which have the greatest international demand. This work may best be done by reporting the results of surveys together with the inclusion of the fabrics in question.

Although this paper represents the final one in the present series of three papers, interested readers are referred elsewhere^[5] for further development of the statistical analysis of the data of the fabric mechanical and surface properties. In reference^[5] the authors classified the suiting materials used in the present work into 20 different groupings according to their objectively measured data. The fabrics so grouped have been described by expert judges from the textile industry as homogeneous ranges of fabrics of a particular “style”.

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