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Subjective evaluation of hand knotted carpets

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Sixty-two different carpet samples have been evaluated for Carpet Aesthetic Value (CAV) and Carpet Hand Value (CHV) subjectively by ten different judges. Each carpet sample was considered individually and an estimated score was awarded on an arbitrary scale between 0 and 5. The rank correlations were worked out among different judges for CAV and CHV. The correlation coefficients for all the samples are found to be 0.37, 0.49 and 0.34 for CAV and 0.55, 0.53 and 0.52 for CHV for all the judges, manufacturers and users groups respectively, which are highly significant ($p<0.01$). This indicates that all the judges are in close agreement. The analysis to examine the influence of fibre mix, carpet constructional parameters and finishing treatment reveals that the CHV is influenced by fibre mix and it increases with the increase in knot density and pile height upto some level, whereas antique and herbal wash treatments reduce the CHV value.

Keywords: Aesthetic value, Antique finish, Hand knotted carpet, Knottage, Pile height, Wool

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1 Introduction

The carpet has a common basic function of covering base floor with a more attractive surface which is normally expected to be softer and warmer. The most significant factor affecting selection of carpet is the aesthetic one. Aesthetic features of carpet are solely dependant on individual customer preference; however the tradition, culture and climate significantly influence the choice of carpet, which cannot be evaluated objectively. Subjective evaluation is a tool, which could be used for the evaluation of aesthetic and comfort properties of carpet. Ince and Ryder[1] evaluated carpets subjectively using paired comparison technique. They found that the visual appearance had positive relation with mean fibre diameter, length and twist of yarn, whereas handle had good correlation with CV of fibre length, wool resilience, wool bulk and length set, and twist of yarn. Gupta *et al.*[2] studied the influence of medullated fibres on mechanical processing and product performance of hand knotted carpets adopting same technique. Patni *et al.*[3] adopted the ranking method for subjective evaluation while studying the influence of fibre and constructional parameters on functional properties of hand woven carpets. Arora *et al.*[4] studied the influence of tuft constitution on the performance of hand woven carpets using same method of subjective assessment. Kawabata *et al.*[5-8] applied technique of individual item assessment and estimated score was awarded on some arbitrary subjective scale under various studies for subjective evaluation of fabrics. They also applied same methodology for subjective assessment of blankets quality for establishing relationship with objectively measured properties.[9-10] Keeping these in view, the present study was undertaken to investigate subjective assessment method for quality evaluation of carpets.

2 Materials and Methods

2.1 Carpet Sample

Out of the 62 samples, 21 samples developed from fibre stage, 20 samples developed using commercial yarn and 21 samples procured from market were categorized as carpets A, B and C respectively. The details of fibre mix, constructional particulars, type of finish, etc. of carpets A, B and C are given in Tables 1- 3 respectively.

2.2 Subjective Assessment of Aesthetic Appeal and Handle

The aesthetic appeal and comfort of 62 samples were judged subjectively for evaluating the quality of carpets. The criterion for judgement was taken as visual appearance for aesthetic appeal and feel/touch/pressing by thumb through sensation for handle. Each carpet sample was evaluated for aesthetic appeal and handle by each of 10 judges (five engaged in carpet manufacturing and five purchasers/

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users). A ranking scale of 5 (excellent), 4 (very good), 3 (good), 2 (average) and 1 (poor) for both appeal and handle was adopted.[5] The average score of each person's rating is called the Carpet Aesthetic Value (CAV) and Carpet Hand Value (CHV).

2.3 Analysis and Presentation of Results

The method used in the analysis and presentation of subjective assessment of carpet handle is dependant, to some extent, on the aims of a particular study. In present study, the data presented are for correlation coefficients among the groups and between the groups for both the assessments.[11] The data are analyzed for rank correlations using bivariate correlations procedure which computes Spearman's rho correlation. It measures the association between rank orders. Correlations measure how variables or rank orders are related. Correlation coefficients range is from -1 (a perfect negative relationship) to +1 (a perfect positive relationship). A value of 0 indicates no linear relationship. The two-tailed probability test method was selected for test of significance.

3 Results and Discussion

3.1 Carpet Aesthetic Value

Carpet aesthetic value of the samples is calculated from subjective assessment made by ten judges and the mean value is denoted as CAV. The CAV of all sixty-two samples is reported in Tables 1-3. It is observed that carpets B and C have higher CAV (3.18) than that of carpet A (2.79). The range of CAV is found to be 1.08 –3.65 for carpet A, 1.75-4.60 for carpet B and 1.6-4.25 for carpet C. The preference of judges for carpets B and C may be due to colour and design effects in both commercial carpets and samples produced from commercial yarns, whereas the carpet A prepared from experimental yarns had no design and colour effects; these were made mainly by blending different fibres in spinning process.

3.1.1 Mean Correlation Coefficient and Standard Deviation

The mean values of correlation coefficient and standard deviation of subjectively assessed CAV for all carpets, carpets A, B, C categories and different groups of judges, i.e. all judges, only manufacturers and only users groups are shown in Table 4. The correlation coefficients for all carpet samples are 0.37, 0.49 and 0.34 for all judges, manufacturers and users groups respectively. These correlations are found to be significant at $p>0.01$ levels; however having lower value of coefficient. It shows that although all judges, irrespective of manufacturers or users, agree awarding the visual aesthetic value to the carpet samples; however, the individual preference of colour and design influences the CAV.

When these correlations are analyzed for different categories of carpets i.e. A, B and C, the correlation coefficients in carpets A, B and C are 0.25, 0.48 and

Table 1—Hand value of carpet A
[Carpet knottage – 2300 knots/dm^2 and Type of finish –normal]

Code	Fibre mix	Pile height mm	CAV	CHV
A1	Equine A + BM wool (10:90)	8	3.35	3.80
A2	Equine A + BM wool (20:80)	8	2.77	3.75
A3	Equine A + BM wool (30:70)	8	2.70	3.75
A4	Equine B + BM wool (10:90)	8	3.65	3.97
A5	Equine B + BM wool (20:80)	8	3.55	3.90
A6	Equine B + BM wool (30:70)	8	3.02	3.75
A7	Equine C + BM wool (10:90)	8	2.60	2.95
A8	Equine C + BM wool (20:80)	8	3.02	3.87
A9	Equine C + BM wool (30:70)	8	2.95	3.15
A10	Equine D + BM wool (10:90)	8	3.27	3.87
A11	Equine D + BM wool (20:80)	8	2.90	2.95
A12	Equine D + BM wool (30:70)	8	2.75	3.15
A13	Camel hair + BM wool (10:90)	8	3.15	3.10
A14	Camel hair + BM wool (20:80)	8	2.95	3.10
A15	Camel hair + BM wool (30:70)	8	2.70	3.40
A16	Camel hair + BM wool (40:60)	8	3.35	3.10
A17	RH + BM wool (10:90)	6	2.35	2.85
A18	RH + BM wool (20:80)	6	1.80	2.25
A19	RH + BM wool (30:70)	6	2.15	2.57
A20	Chokla wool dref spun yarn	8	1.08	1.20
A21	Mixed yarns of Equine blends	8	2.60	2.80
	Mean		2.79	3.20

CHV—Carpet hand value, CAV—Carpet aesthetic value, BM—Bharat merino, RH—Angora rabbit hair.

0.45 for all judges, 0.48, 0.66 and 0.47 for manufactures group and 0.22, 0.38 and 0.38 for users group respectively. The correlation coefficients for carpets B and C are found significant for all judges and manufacturers groups, however the opinion of users group does not agree among them, which is again due to the influence of individual opinion for appearance. Correlation coefficients for carpet A for all categories of judges are found to be lower as compared to that for carpets B and C. Among the

Table 2—Hand value of carpet B

Code	Fibre mix and colour	Knottage knots / dm^2	Yarn number Nm	Pile height mm	Type of finish	CAV	CHV
B1	NZ+CH (50:50) Orange	2300	2	8	Normal	3.05	3.40
B2	NZ+CH (50:50) Yellow	2300	2	10	Normal	3.55	3.86
B3	NZ+CH (50:50) Red	2300	2	12	Normal	4.60	4.57
B4	NZ+CH (50:50) Yellow	2300	2	14	Normal	3.27	3.30
B5	NZ+CH (50:50) Red	1500	2	12	Normal	3.37	3.37
B6	NZ+CH (50:50) Red	1900	2	12	Normal	3.20	3.60
B7	NZ+CH (50:50) Red	2700	2	12	Normal	3.85	3.75
B8	NZ+CH (50:50) Red	3100	2	12	Normal	3.79	4.20
B9	NZ+CH (50:50) Blue	2300	2	12	Herbal	3.32	3.70
B10	NZ+CH (50:50) Brown	2300	2	12	Acid	2.40	3.15
B11	NZ+CH (50:50) Red	3100	2	12	Herbal	3.11	3.65
B12	NZ+CH (50:50) Red	1500	2	12	Normal	3.20	3.20
B13	NZ wool Blue	2300	4	12	Normal	4.20	3.75
B14	NZ wool White	2300	4	12	Herbal	3.00	3.60
B15	NZ wool White	2300	4	12	Acid	2.75	3.40
B16	South African wool	2300	4	12	Normal	3.15	3.15
B17	Black yarn	2300	4	8	Normal	2.20	2.05
B18	Chokla- Avikalin	2300	4	12	Normal	1.95	2.65
B19	Chokla Mutton	2300	4	12	Normal	1.75	2.15
B20	CH Wool Bikaneri White	2300	4	12	Normal	2.25	2.95
	Mean					3.18	3.37

NZ—New Zealand wool, CH—Chokla wool.

Table 3—Hand value of carpet C

Code	Source	Type of carpet	Type of wash	CAV	CHV
C1	Mughal carpet	Woollen	Normal	1.60	1.95
C2	Mughal carpet	Woollen	Normal	2.60	2.20
C3	Mughal carpet	Woollen	Normal	3.45	3.75
C4	Mughal carpet	Woollen	Normal	2.70	2.70
C5	Mughal carpet	Woollen	Normal	3.20	3.40
C6	Mughal carpet	Woollen	Normal	3.62	3.50
C7	Mughal carpet	Woollen	Normal	3.67	4.30
C8	Mughal carpet	Woollen	Normal	3.80	4.30
C9	Mughal carpet	Woollen	Herbal	4.00	3.95
C10	Mughal carpet	Woollen	Antique	3.75	3.95
C11	Maruti export	Woollen	Normal	4.25	4.25
C12	Maruti export	Woollen	Normal	2.95	2.70
C13	Maruti export	Woollen	Normal	3.62	3.55
C14	Anil export	Woollen	Normal	3.45	3.05
C15	Maruti export	Woollen	Normal	2.80	2.70
C16	Maruti export	Woollen	Normal	3.30	3.45
C17	Maruti export	Woollen	Normal	2.85	3.25
C18	Maruti export	Woollen	Normal	2.90	3.45
C19	Classic rug	Synthetic	Normal	3.10	2.00
C20	Machine made	Synthetic	Normal	2.00	1.70
C21	Machine made	Tufted	Normal	1.61	1.50
	Mean			3.18	3.18

Table 4—Mean and standard deviation of correlation coefficients of CAV among judges

Parameter	All judges	Manufacturers	Users
All Carpets			
Mean	0.37**	0.49**	0.34**
SD	0.137	0.108	0.106
Number	62	62	62
Carpet A			
Mean	0.25^{ns}	0.48**	0.22^{ns}
SD	0.232	0.116	0.210
Number	21	21	21
Carpet B			
Mean	0.48*	0.66**	0.38^{ns}
SD	0.205	0.111	0.175
Number	20	20	20
Carpet C			
Mean	0.45*	0.47*	0.38^{ns}
SD	0.219	0.189	0.198
Number	21	21	21

**Significant at the p>0.01 level (2-tailed).
*Significant at the p>0.05 level (2-tailed).
^{ns} Non-significant.

Table 5—Mean and standard deviation of correlation coefficients of CHV among judges

Parameter	All judges	Manufacturers	Users
All carpets			
Mean	0.55**	0.53**	0.52**
SD	0.109	0.052	0.069
Number	62	62	62
Carpet A			
Mean	0.40^{ns}	0.45*	0.28^{ns}
SD	0.191	0.194	0.201
Number	21	21	21
Carpet B			
Mean	0.50*	0.58**	0.49*
SD	0.162	0.148	0.161
Number	20	20	20
Carpet C			
Mean	0.55**	0.55**	0.57**
SD	0.094	0.078	0.092
Number	21	21	21

**Significant at the p> 0.01 level (2-tailed).
*Significant at the p>0.05 level (2-tailed).
^{ns} Non-significant.

groups of judges, the agreement between manufacturers is found higher than that of users, which is quite obvious since the manufacturers understand the colour and design aspects better than the users. From these observations, it could be concluded that the subjective assessment of manufacturers group is more appropriate than users group.

3.2 Carpet Hand Value

Carpet hand value of the samples is calculated from subjective assessment made by ten judges and the mean value is denoted as CHV. The CHV of all the sixty-two samples are shown in Tables 1-3. Carpet samples developed out of woollen yarn collected from industry (carpet B) possess highest CHV (3.37) followed by carpet A (3.20) and carpet C (3.18). The range of CHV is found to be 1.2-3.97 for carpet A, 2.05-4.57 for carpet B and 1.5-4.3 for carpet C. The preference for A and B groups of carpet may be due to better constructional parameters as compared to commercial carpets. The judges could sense the superiority of construction of these carpets while making an overall assessment. Among the carpet C, carpets of Mirjapur-Bhadohi region have higher CHV (3.82) than Jaipur region. It reveals that the carpet manufactured at Mirzapur-Bhadohi has an edge over carpets from Jaipur in respect of hand value.

3.2.1 Mean Correlation Coefficient and Standard Deviation

The mean values of correlation coefficient and standard deviation of subjectively assessed CHV for all carpets A, B, C and different groups of judges i.e. all judges, only manufacturers and only users groups are shown in Table 5. The measure of degree of agreement among judges, as given by the mean correlation coefficients for all carpet samples, is 0.55, 0.53 and 0.52 for all judges, manufacturers and users groups respectively. The correlations are highly significant at p>0.01, which indicates close agreement among their judgement. It could be concluded that all judges, irrespective of manufacturers or users, are in close agreement in awarding CHV to the carpet samples; the closeness being not by chance. The perusal of CHV indicates that the judges could distinct by differentiating different carpets having different constitutions. It concludes that the technique can be used to assess the quality of carpets taking 10 different judges, irrespective of their profession.

When these correlations are analyzed for different categories of carpets i.e. carpets A, B and C, the correlation coefficients in carpets A, B and C are found to be 0.40, 0.50 and 0.55 for all judges; 0.45, 0.58 and 0.55 for manufactures group; and 0.28, 0.49 and 0.57 for users group respectively. The correlation coefficients for carpet C are highly significant

($p>0.01$) for all classes of judges, irrespective of their profession. Correlation coefficients for carpets A and B are found to be lower as compared to carpet C. Among the groups of judges, the agreement between manufacturers is better than that of users, which is quite obvious because the manufacturers understand the carpet better than users.

3.3 Influence of Different Factors on CHV of Carpet

The carpet quality is mainly governed by fibre characteristics, yarn structures, constructional parameters and chemical finishing treatments. The CHV obtained subjectively was correlated with nominal carpet construction parameters, viz. pile height and density. Influence of fibre mix and finishing treatment on carpet quality is also studied.

3.3.1 Fibre Mix

The fibre characteristics are the major governing factors of carpet quality. Among the carpets of different wools, the carpet developed out of New Zealand (NZ)–Chokla (CH) wool blended yarn gives highest CHV (4.6) followed by pure NZ (3.6), imported wool (3.16) and CH wool (2.95). It reveals that the Indian wool blends with NZ wool could produce best carpet. Among carpet A, the carpets developed from different animal fibre mix with wool (wool-equine hair blended carpets) have highest CHV (3.6) followed by carpets of wool-camel hair blends (3.2) and wool-rabbit hair blends (2.6). It is mainly because of the presence of medullated fibres in Indian wools and its suitable fibre diameter and luster of NZ wool. Further, it is revealed that the equine hair blends with wool could produce good quality of hand knotted carpets. Carpets made from synthetic fibres is ranked very poor as compared to woollen carpets which is quite obvious because synthetic fibres (CHV~2.0) do not possess desirable characteristics for carpet construction.

3.3.2 Spinning System and Yarn Number

Since the yarn structure and its number significantly influences the carpet pile and overall quality of carpets, the samples developed from woollen and dref II spun yarns (4 Nm) as well as NZ wool yarns (2 and 4 Nm) were also assessed by judges. The carpet developed from dref II spun yarn was not preferred by judges and they awarded very poor ranking as compared to carpets made from woollen spun yarns (Fig. 1). This may be due to the presence of wrapper fibres in dref spun yarns which reduce compressibility of yarn as pile. The carpet

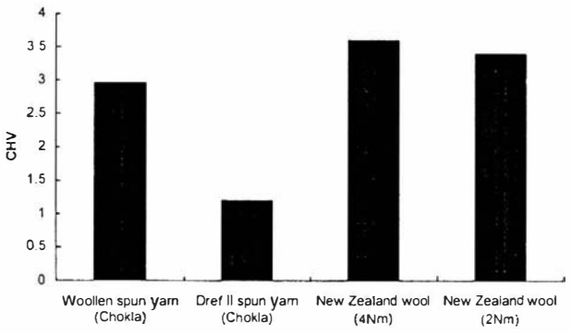

Fig. 1—Influence of different yarns on CHV

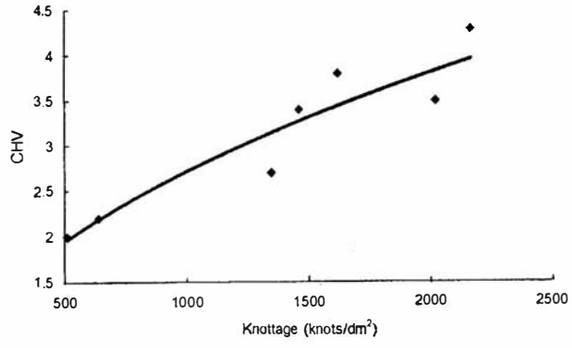

Fig. 2—Influence of knottage on CHV of carpet C

produced from finer yarns gives higher CHV than that made from coarser yarn (Fig. 1). This is due to more number of piles per unit area which improves the resiliency and appeal of the carpet.

3.3.3 Constructional Parameters

Constructional parameters of carpet, i.e. knottage and pile height, govern the performance as well as functional characteristics of the carpets. Among the carpet C, the carpets collected from M/s Mughal Carpets, Mirzapur-Bhadohi have knottage ranging from 512 knots/dm^2 to 2160 knots/dm^2. It is revealed from Fig. 2 that the CHV increases with the increase in knottage of the carpet. It is further confirmed by carpet B, in which the CHV increases with the increase in knottage upto a level of 2300 knots /dm^2 and then starts decreasing (Fig. 3). The influence of pile height on CHV is presented in Fig. 4. It is observed that for carpets prepared from NZ-CH wool blended yarn of 2 Nm with constant knottage of 2300 knots/dm^2 and varying pile height of 8-14 mm, the CHV increases up to 12 mm pile height and then starts decreasing. This is due to the fact that up to a

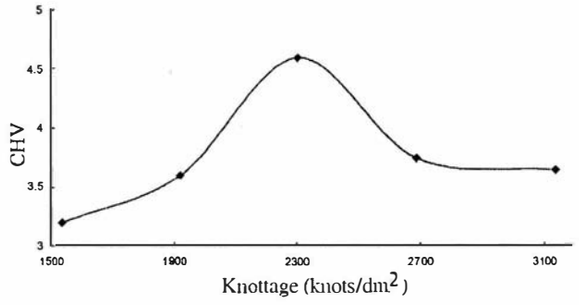

Fig. 3—Influence of knottage on CHV of carpet B

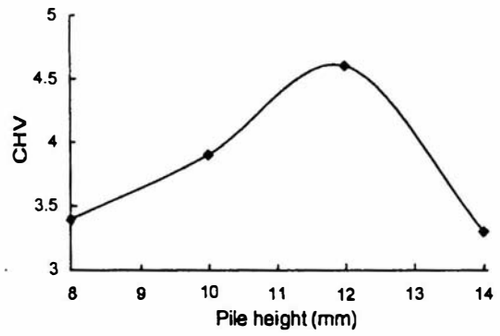

Fig. 4—Influence of pile height on CHV

level of 12 mm pile height, a compromise of compression and resilience is sought and after that though compression may persist the resilience reduces to a certain extent.

3.3.4 Finishing Treatment

Washing is an essential process of finishing of hand knotted carpets. The chemical washing generally consists of an alkali soak to soften the wool followed by scale removal with a chlorinating agent, mechanical finishing and clipping to remove loose fibres and develop luster. In order to enhance luster, carpets were given different kinds of treatments. Among the different chemical finishes, judges have shown their preference for normal wash carpets than herbal and antique wash (Fig. 5). This may be due to the mindset of judges for normal wash carpets having comparatively better sheen. Further, it is also observed that during herbal and antique wash, the pile is little damaged.

4 Conclusions

4.1 The subjective assessment awarding an estimated score on 0 - 5 scale after considering each sample individually can be successfully used for evaluation of the carpet.

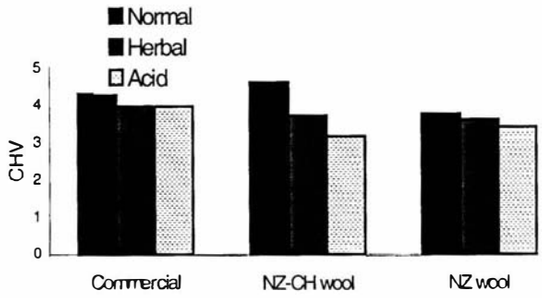

Fig. 5—Influence of chemical treatment on carpet quality

4.2 All judges, irrespective of manufacturers or users, agree in awarding CAV/CHV to the carpet samples; however, the agreement between manufacturers is higher than users.

4.3 Fibre mix significantly influences the CHV. Carpets possessing blends of New Zealand –Chokla wool give highest CHV followed by carpets made from Chokla, Avikalin and other imported wools.

4.4 The CHV increases up to a level with the increase in knottage and then starts decreasing. Similar trend is also observed with pile height.

4.5 Normal wash carpets show higher CHV than the herbal and antique wash carpets.

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