# A NEW APPROACH TO EVALUATE TOTAL HAND VALUE

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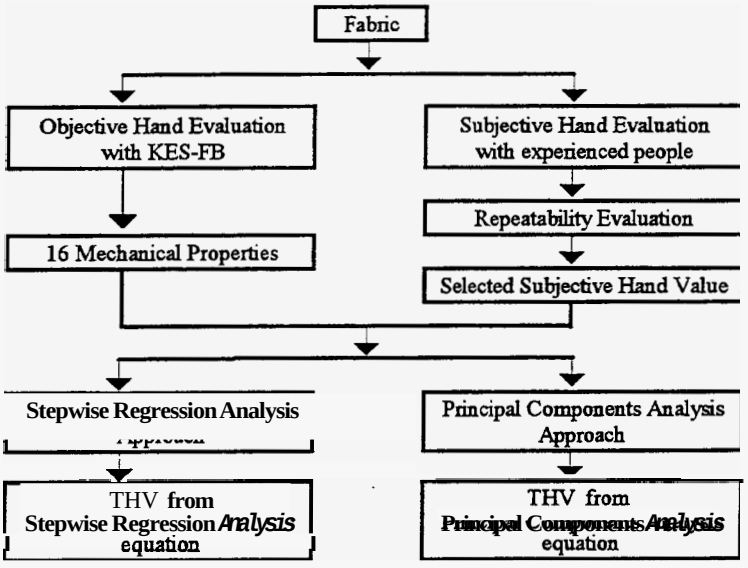
## INTRODUCTION

A simplified approach was proposed in this work to evaluate the fabric Total Hand Values(THV) which are based on subjective and objective evaluation of fabric hand. Two equations were formulated by stepwise regression and principal components analyses methods respectively. The variables selected from sixteen fabric mechanical properties as tested from KES-FB[1], an instrumentation system for measuring the mechanical properties of fabric at small deformations. It was found that the proposed equations showed high repeatability in the objective evaluation of local Total Hand Values. These equations therefore can be a valuable tool in textile product development and marketing.

## METHODS

1.The flow chart of the new approach to evaluate Total Hand Value as follows:




2.Objective Hand Evaluation:

KES-FB system was used here. The 16 mechanical properties from KES-FB system are as follows[2]:

| Legend | Properties | Unit | Legend | Properties | Unit |
|---|---|---|---|---|---|
| LT | Linearity | non | WT | Tensile energy | gf.cm/cm$^2$ |
| RT | Resilience | % | B | Bending rigidity | gf.cm$^2$/cm |
| 2HB | Histeresis | gf.cm/cm | G | Shear stiffness | gf/cm.degree |
| 2HG | Histeresis at $\phi$ =0.5$^O$ | gf/cm | 2HG5 | Hysteresis at $\phi$ =5$^O$ | gf/cm |
| MIU | coefficient of friction | non | MMD | mean deviation of MIU | non |
| SMD | Geometrical roughness | micron | LC | Linearity | non |
| WC | Compressional energy | gf.cm/cm$^2$ | RC | Regilience | % |
| T | Thickness at 0.5 gf/cm$^2$ | mm | W | Weight per unit area | mg/cm$^2$ |

3.Subjective Hand Evaluation-

Eleven ranks of fabric subjective hand vaiues were classified as follows[3]:


4.Repeatability Evaluation:

The repeatability of fabric subjective hand evaluating experts were tested by replication.

5.Stepwise Regression Analysis:
Alternative variables were selected by 16 mechanical properties from KES-FB system. Variables values were normalized first. Stepwise regression analysis (SRA) is a forward selection process that rechecks at each step the importance of all previously included variables[4]. The process stops when no more variable with P-value<0.15. The stepwise regression analysis equation (SRA equation) for total hand value (THV1) was obtained with regression model.
6.Principal Components Analysis:
The 16 mechanical properties as obtained from the KES-FB system were normalized as variables. The singular value decomposition was the first step in principal components analysis[5]. The Eigen-values over 1 were used. Therefore, the principal components were given. The goodness of fit of the model to the approximation is (84%). The Principal Components Analysis equation (PCA equation) for total hand value (THV2) was obtained with linear model.

RESULTS
*80* pieces of PET/Cotton jacket fabrics were used to develop the stepwise regression analysis equation and principal components analysis equation, two equations were obtained. Here the stepwise regression analysis equation is THV1=2.6922+0.2626*WT+0.1793*RT-0.2819*2HG+0.4630*MMD-0.5741*SMD+0.8653*WC-0.6383*T (coefficient of correlation *7* =0.8402), and principal components analysis equation is THV2=2.6922+0.0164x$Z_1$-0.3635x$Z_2$+0.1503x$Z_3$+0.0467x$Z_4$ (coefficient of correlation *7*=0.8336), which

$Z_1$=0.2260*LT-0.0035*WT-0.2507*RT-0.0058*B+0.1231*2HB+0.3321*G
+0.3932*2HG+0.3694*2HG5+0.1991*MIU-0.2550*MMD-0.2814*SMD
+0.3003*LC+0.09556*WC-0.4013*RC-0.1098*T-0.1147*W
$Z_2$=0.1218*LT-0.3270*WT-0.1127*RT+0.4262*B+0.4294*2HB+0.1740*G
+0.1555*2HG+0.2355*2HG5 -0.0752*MIU+0.3305*MMD+0.2924*SMD
-0.1980*LC-0.1023*WC+0.0192*RC+0.1370*T+0.3470*W
$Z_3$=-0.3281*LT-0.0124*WT+0.1749*RT+0.0803*B+0.1134*2HB-0.1691*G
+0.0148*2HG-0.0342*2HG5+0.4034*MIU-0.0046*MMD-0.0446*SMD
+0.2387*LC+0.5134*WC-0.0909*RC+0.5093*T+0.2436*W
$Z_4$=0.3677*LT+0.5282*WT-0.5370*RT+0.0073*B+0.0647*2HB-0.1849*G
-0.1174*2HG-0.0739*2HG5+0.2094*MIU+0.1926*MMD+0.2451*SMD
-0.1406*LC+0.1642*WC-0.0418*RC+0.1737*T-0.1417*W

Another set of 80 different pieces of PET/Cotton jacket fabrics were evaluated to test the reliability of the above equations. The coefficients of correlation of THV obtained from the stepwise regression analysis equation and the principal components analysis equation with subjective hand values are 0.80451 and 0.74313, respectively However, it should be mentioned that the coefficient of correlation of THV obtained from KES-FB with subjective hand value is 0.5842.

CONCLUSIONS
A new approach was developed with stepwise regression analysis and principal components analysis methods for KES hand value translation formulas. The coefficient of correlation of SRA equation with subjective hand values is better than that of PCA equation. Here, WT, RT, 2HG, MMD, SMD, WC, and T were selected as variables for SRA equation. This approach could be a valuable tool in product development and marketing.

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