A Sizing System for Big & Tall: Comparison between Proportional Sizing System and Linear Regression Model Approach

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Significance. In the United States, men's figures have grown much more muscular, approaching the scale of an athletic look. According to the Big & Tall Men's Apparel Needs Group (2001), sixteen million men in the United Sates define themselves as "big and tall". They often experience difficult finding the right size. One out of every thirteen American men finds that regular-sized clothing is too small (Kohl's Corporation, 2015; Werling, 2001). Some apparel retailers provide garments specifically for big and tall men by extending the sizes, with larger neck, waist and chest measurements. However, big and tall sizes are inconsistently defined by retailers, with no distinct sizing system for big and tall.

Literature Review. A sizing system can be define as a standardized range of sizes for apparel mass production. Setting up the size ranges and body measurements from a sample of the population, a proportional sizing system, a statistical approach based on proportions of the mean in a normal distribution is commonly used in the industry (Beazley, 1996; Davis-Meyers, 1992). However, several studies (Ball et al., 2001; Sindicich & Black, 2011; Shin et al., 2011) have found menswear fit problems because of various body dimensions in the United States. In another approach of sizing, a linear regression model has been used to identify appropriate body measurements from a sample of the population and develop men's clothing patterns in various sizes (Chan et al., 2005; Schofield & LaBat, 2005). Schofield and LaBat (2005) found that certain vertical body measurements were correlated. In the previous study (Chan et al., 2005), a linear regression model was applied to examine the relationship between men's shirt pattern parameters and body measurements. It was found that a linear regression model with correlation coefficient was better success in predicting men's clothing patterns from various body dimensions. These two approaches could be helpful in the development of a big and tall menswear sizing system. However, there are no published studies that evaluate the validity of the current menswear sizing systems for big and tall men. The purpose of this study was to identify applicable sizing systems for big and tall men by examining the current menswear sizing systems.

Methodology. A total of 301 men, height over 71.5 inches and weight over 215 pounds, were selected from the [TC]² SizeUSA national sizing survey data. A cluster analysis was used to identify similar characteristics of big and tall men's body shapes, applying the furthest neighbor method with square Euclidean. Descriptive statistics, a linear regression model, and t-test with fit comparison plots were employed to test two dominant sizing system approaches: 1) a size chart based on proportional sizing (ASTM D 6240) and 2) a size chart developed with a liner regression model.   Then, the following null hypotheses were programed in a database.

Hypothesis I: When big and tall men find a set of suits according to the size chart based on proportional sizing (ASTM D 6240), their chest, hips, and waist dimensions would fit for a jacket with a pair of the pants. Hypothesis II: When big and tall men find a set of suits according to the size chart based on a linear regression model, their chest, hips, and waist dimensions would fit for a jacket with a pair of the pants.

Results. According to the cluster analysis, three types of clusters were identified from big and tall men: a triangle shape (13.29 %), an invert triangle shape (28.24%), and a slightly inverted triangle shape (58.47%). While ASTM D 6240 menswear size chart provides the drop (waist minus chest) ranges from -5.50 to -3.50 inches, actual drops of big and tall men were found to be between -12.48 and 2.4 inches with a greater standard deviation (SD =2.99). For the first size chart (ASTM, proportional sizing system), the null hypothesis was rejected in the following: Chest (t=1.7106, p<0.05), Waist (t=1.7206, p<0.05), Hips (t=5.94409, p<0.05). Overall, big and tall men's hips were two inch smaller than ASTM sizes. When big and tall men attempted to find a pair of pants, 86.4% of the big and tall men could not find the correct fit of a suit. Of the big and tall men, 39.9 % could not find a suit that fits because the pants were too small for the paired jacket (45.5%).

For the second size chart based on a liner regression model, we found that certain body dimensions were correlated and that could be explained with certain equations. For instance, the waist of big and tall men was shown as strong relationship regressions with the hip (R-squared 78.00%) and crotch length (R-squared 48.87%) in a lower body with the following equations: $BT\_Waist = sqrt (-294.642 + 0.986222*Hips^2)$; $BT\_Crotch\ Length\ Total = -120.147 + 39.1054*ln (Hips)$; $BT\_Waist\ Height = sqrt (1377.11 + 0.524041* Crotch\_Length\_Total^2)$. When these equations were applied to develop the second size chart, about 40% of the pants fit problems were resolved with the regression analysis, and 56.7% were improved with the cluster analysis.

Conclusion and Implications. In conclusion, the proportional sizing system is not appropriate for defining big and tall sizes. Although proportion of the mean value might be an easy way to understand overall features of big and tall men, the sizing system displays increased deviations and fit problems. Interestingly, the newly developed sizing system using the liner regression model was better at predicting more of the actual big and tall men's body dimensions. The approach with a linear regression model might be strongly effective when similar characteristics of body shapes are pre-defined with the cluster analysis. Further study is suggested for defining body shapes and developing effective big and tall sizing systems for manufacturers and retailers to provide consistent clothing sizes based on needs.

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