The following was taken from: Morrow, J. L., Jr., Joyce, P, McMahon, W., DeMaia, A., McVicker, C., Parsons, A., & Wilcox, K. (2017). Cooperation among Ugandan farmers: Cultivating social capital. *International Food and Agribusiness Management Review,* 20 (5): 673-688.

Development of Measurement Scales. In developing our measurement scales, we began with our theoretical definition of each construct and then wrote a series of questions that appeared to correspond to this definition. When measuring latent variables in the social sciences, one should avoid single-item scales because their psychometric properties are likely to be poor or unknown (Furr, 2011). We set a minimum requirement of identifying at least a three-item scale and evaluated the psychometric properties of each scale using factor analysis to assess construct validity, and where appropriate, discriminant validity. Factor analysis is a data analytic technique used to determine which questions in a survey are associated with a single construct, as known as a factor (Bagozzi, Yi & Phillip, 1991). For questionnaire data, factor analysis is used to determine the construct validity of the survey instrument with the resulting factors expected to correspond to the underlying constructs (Shumueli, 2010). In other words, if a group of questions that were written to measure a single construct all load together on a single factor, this provides evidence that we appear to be measuring what we expected to measure, which validates our measurement scales.

Once a scale has been validated, the scores from each item in the scale are averaged to yield the measure for that construct. Discriminant validity is used to assess whether survey respondents appear to be differentiating between two distinct but similar constructs and provides evidence that we successfully identified valid and unique measures for each construct (Bagozzi et al., 1991). Finally, Cronbach's alpha was used to determine the reliability of each scale by assessing the internal consistency or average correlation of the items within each scale (Shrout & Fleiss, 1979).

The following was taken from: Williams, B., Onsman, A., and Brown, T. 2010. Exploratory factor analysis: A five-step guide for novices. *Journal of Emergency Primary Health Care (JEPHC),* Vol. 8, Issue 3.

What is Factor Analysis?

Factor analysis is commonly used in the fields of psychology and education and is considered the method of choice for interpreting self-reporting questionnaires. Factor analysis is a multivariate statistical procedure that has many uses, three of which will be briefly noted here. Firstly, factor analysis reduces a large number of variables into a smaller set of variables (also referred to as factors). Secondly, it establishes underlying dimensions between measured variables and latent constructs, thereby allowing the formation and refinement of theory. Thirdly, it provides construct validity evidence of self-reporting scales.

Nunnally (1978), writes, "… *factor analysis is intimately involved with questions of validity … Factor analysis is at the heart of the measurement of psychological constructs*".

Among the Objectives of Exploratory Factor Analysis:

- Reduce the number of variables
- Examine the structure or relationship between variables
- Detection and assessment of the dimensionality of a theoretical construct
- Evaluates the construct validity of a scale, test or instrument
- Development of parsimonious (simple) analysis and interpretation
- Addresses multicollinearity (two or more variables that are correlated)
- Used to develop theoretical constructs
- Used to prove/disprove proposed theories

Rules for Interpreting the Factor Analysis Output

The only output that you need to interpret is the *rotated component matrix* ***unless*** there is only one component. Only in this case should you interpret the *component matrix*.

A component, a factor and a dimension all refer to the same thing.

A question and an item also refer to the same thing.

We look for a factor loading coefficient of at least .600. However, the higher the loading coefficient the stronger the question loads (or is associated with) a particular factor.

The goal here is to find a scale, composed of at least three items, that we can use to measure a unique construct. This means that we want to avoid items that are cross-loaded. This means that an item may load .689 on one dimension but .579 on another dimension.

Interpreting the factor loading coefficients to determine which items to keep and which to discard is part art and part science. The decision is ultimately up to the professional judgment of the researcher. However, when evaluating matrices to determine which items to keep and which to eliminate, be sure to discuss these questionable items and why you ultimately made the decision to either keep an item or delete it.