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Using workers compatibility to predict labor productivity through cluster analysis

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Abstract

Masonry contractors seek to increase labor productivity by collecting detailed information on the workers productivity and the factors that influence productivity. Quantitative factors such as hours, activities, and tasks are often measured on site and are used to estimate productivity and determine times of construction. However, there may be qualitative factors such as personality that may also need to be measured on site because it can have a profound impact on the productivity of a crew. This paper proposes a mathematical framework that uses the personal compatibility between the workers in a crew to better estimate productivity. An instrument to measure and quantify personality is proposed to determine the compatibility of the workers in a crew. Cluster analysis principles are applied to group crews that share similar compatibility and productivity scores and use this information to empirically define a probability density function that will determine, for a given cluster, its average productivity. To illustrate how the function is used to predict the productivity of a crew, this paper presents an example applied in masonry construction in which times of construction and productivity are determined using the personal compatibility between the workers in the crew.

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Keywords: Masonry construction; cluster analysis; probability density; productivity

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1. Introduction

Personality factors have been demonstrated to be useful for explaining and predicting attitudes, behaviors, job performance, and outcomes in many organizational settings (Ones et al, 2007; Shuck and Reio, 2013; Hogan and Holland, 2003; Campion et al, 2005; Cohen and Bailey, 1997). The big five personality dimensions (Goldberg, 1993) are: openness to experience (O), conscientiousness (C), extraversion (E), agreeableness (A), and neuroticism (N), commonly known as OCEAN, and are used to indicate human personality (Ones et al, 2007). The OCEAN dimensions have been investigated in meta-analytic studies (Hogan and Holland, 2003; Cohen and Bailey, 1997), and have been used in applied psychology and human resource management to determine the relationship between personality and job performance. Results of these studies have shown that organizations use personality factors not only for recruitment and personnel selection, but also to support decision making when forming effective groups of workers (Kristof-Brown and Stevens, 2001).

In construction, groups of workers are known as crews. Crews specialize in a given skill to complete a task (Ng and Tang, 2010), and the foreman in the jobsite is responsible of forming crews to maximize productivity. Decisions on how to form crews and what is the proper grouping of workers to increase productivity in construction have been addressed by a number of studies (Nerwal and Abdelhamid, 2012; Mitropoulos and Memarian, 2012; Rojas 2008). These studies provide clear guidelines and specific characteristics that need to be considered to form lean and effective crews.

However, the current crew formation literature in construction lacks of a framework that considers personality factors and how the interpersonal compatibility between workers in a crew can be used to predict productivity. This paper proposes a mathematical framework that uses the personal compatibility between the workers in a crew to better estimate productivity. An instrument to measure and quantify personality is proposed to determine the compatibility of the workers in a crew. Cluster analysis principles are applied to group crews that share similar productivity values and use this information to empirically define a probability density function (PDF). The PDF determines, for a given cluster, the average productivity. The proposed PDF can enable foremen and project managers to use the information from the clusters to make more realistic predictions, by calculating confidence intervals, of the productivity of a crew and to better estimate times of construction.

2. Personality factors

2.1. The Big Five personality dimensions

It is well known that group work is organized by determining what will be done and who will do it, and in this process, group members make a big effort to get along (Mach and Baruch, 2015). In order to get along with a group, people cooperate and seem compliant, friendly, and positive, and people that get along usually have similar personality factors. The big five personality dimensions (Goldberg, 1993) are: openness to experience (O), conscientiousness (C), extraversion (E), agreeableness (A), and neuroticism (N), commonly known as OCEAN. Openness (O) describes the breadth, depth and complexity of an individual's mental and experiential life. Conscientiousness (C) describes socially prescribed impulse control that facilitates task and goal-directed behaviour. Extraversion (E) summarizes traits related to activity and energy, dominance, sociability, expressiveness, and positive emotions. Agreeableness (A) contrasts a prosocial orientation toward others with antagonism and includes traits such as altruism, kind mindedness, trust, and modesty. Neuroticism (N) contrasts emotional stability with a range of negative affects including anxiety, sadness, irritability, and nervous tension (John et al, 1991).

This five factor structure is used to describe human personality (Ones et al, 2007) and can capture much of the variance in personality trait ratings. The OCEAN dimensions do not imply that personality differences can be reduced to five traits (Goldberg, 1993), rather they represent personality at the broadest level of abstraction. Each dimension includes a large number of distinct more specific personality characteristics that help to create the taxonomy of personality. The big five personality dimensions OCEAN have been used in meta-analytic reviews in applied psychology since personality factors are useful predictors of job performance (Hogan and Holland, 2003).