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Compatibility of Personality and Productivity: An Analysis of the Relationship with Construction Crews

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Abstract

The labor productivity of a crew depends on how efficiently workers are used in the construction process. Skills, capabilities, resources, and even personality affect the efficiency of the workers and may have an impact on the productivity of their crew. This paper illustrates how the personality profiles of the workers in a crew can be used to determine the relationship between compatibility of personality and productivity. Masons working in eight live construction projects completed the big five of personality to indicate their personality traits. Based on the personality traits, the compatibility of the crews was calculated. Productivity at the task-level was measured to determine the performance of the crews. Various statistical analyses are performed to establish the relationship between compatibility and crew productivity and the true value of the coefficient (and its likeliness). The results indicate that there is a high positive correlation between compatibility of personality and productivity at the task-level ($r_s = 0.758$). Results also indicate that in the worst case scenario, there is a moderate correlation between compatibility and productivity ($r_s > 0.3$; probability: 0.728). The implications of the relationship for managing crews in construction projects is discussed.

Keywords: compatibility, crew productivity, personality, productivity, statistical analysis

1. Introduction

The productivity of a crew is fundamental to the success of any construction project. Crew productivity can be affected by numerous factors such as site characteristics [1] use of resources [2], management practices [3], and crew motivation [4]. Additionally, personal characteristics and the interrelationship between the workers in a crew also affect productivity [5]. One of such personal characteristics is personality.

Personality is used to describe behavioral regularities and the underlying structures, dynamics, processes, and tendencies of an individual [6]. When working in crews, the personality of the workers is combined and this often affects productivity [7]. Productivity is expected to be higher in crews in which the workers have compatible personalities. However, this assumption has yet to be tested in the construction field and in real live construction projects. In masonry construction, the compatibility of personality among the workers in a crew plays a key role. Masonry is labor intensive and masons have to constantly coordinate when to raise the line to complete a course. This results in constant interactions between the workers in a crew. Therefore, the success of a crew to work together and achieve high production rates might be impacted by the adequate combination of personality of the workers in the crew.

Personality dimensions are used to understand relationships and interactions between individuals, as these are a function of the personal characteristics of individuals [8]. Personality dimensions have also been used

for describing and predicting attitudes, behaviors, fit, and performance in many organizational settings [6, 9,10,11,12, 13]. A number of studies in construction have identified personal characteristics in crews that contribute to performance such as cohesion, motivation, affection, cooperation, and trust [3, 4, 5, 14, 15]. Other studies have gone further and investigated the effect of personal factors on performance such as personal confidence, job satisfaction, and self-organizing [16, 17, 18]. The effects of personality on teams and organizations have been studied for evaluating commitment, job satisfaction, attitude, and retention [3, 19, 20].

Personality is a psychological construct often used to describe the structures, dynamics, and tendencies that bring about behaviors and attitudes in individuals [21]. The personality of individuals is usually described in five dimensions (O=openness, C=conscientiousness, E=extroversion, A=agreeableness, and N=neuroticism) in a widely accepted theory among psychologists [22]. When individuals are grouped in teams, their personalities combine, and forming teams should follow a psychological approach. In other words, teams should be formed so that the different members in the team are compatible so that there is no conflict and workers can worker better together to increase their performance [11]. If it is expected that workers that have compatible personalities work better together and achieve higher performance, a manager on site would need to group workers with an adequate combination of personalities, as this can help the team be more productive.

However, the current construction literature has yet to determine and quantify the relationship between personal compatibility and crew productivity in actual real live projects. Factors that have been investigated that influence crew productivity are typically technical factors such as skills, capabilities, and qualifications. These factors typically have a low variation, as it can be assumed that the workers have the minimum skills, capabilities, and qualifications to be working on a construction site [23]. Since productivity has a high variability, it can be assumed that there are factors that also have a high variability and that can be used to explain such variability in productivity. This study explores whether personality and the compatibility of personality can explain some of that variation. To help determine the relationship, this study explores in isolation whether personality and the combination of personality between the masons in a crew has a relationship with productivity.

2. Model components

2.1. Compatibility of personality

In this study, compatibility was defined as a tendency of a crew to share similar personality characteristics. To measure similarity, the average of the dimensions of personality was calculated based on the method of operationalizing personalities for different team compositions [24]. Because masonry construction processes are additive tasks, that is, require summing of resources from different workers to achieve performance, the mean level of the personality factors was the most appropriate level. The mean guarantees that the contribution of each worker adds to the crew and helps achieve performance.

The principle of similarity theory was used to calculate compatibility. Compatibility will assess how similar in terms of personality the workers in a crew are. For this, it is assumed that workers with similar personalities are more compatible that workers with dissimilar personalities [25]. For calculating compatibility, explicit comparisons were used to measure similarity in each of the five dimensions of personality between the masons in a crew [26]. The distance measures using the Euclidean distance were used to determine similarity. A smaller distance reflected a higher similarity (higher compatibility) and a greater distance a higher dissimilarity (lower compatibility). For a further discussion about this procedure, the reader is referred to [23].

2.2. Productivity

Performance of the masonry crews was measured using productivity. Productivity is generally measured as the ratio between the output of a process over its inputs. The single-factor productivity at the task level was used as the measure in this study [27] because it is commonly used in labor-intensive operations such as masonry construction [5] and it is focused on the work being performed at the task and crew levels. The

work output was the quantity of composite cavity wall construction (measured in m^2) completed per crew on a weekly basis. The input were the work hours measured as productive time, that is, the summation of work hours minus unavoidable delays such as weather and meal breaks. Productivity was measured during 16 consecutive workweeks using the base line methodology framework to select the seven most productive weeks [28].

3. Relationship between productivity and compatibility of personality

This section is based on the eight masonry construction projects and results presented in [23], where 28 masons grouped in 20 crews working in the North West of England participated in the study. Data collection was done simultaneously across the projects to minimise the variability in weather conditions and the baseline methodology framework was used to average the most productive weeks and minimise other project conditions. All the projects had two-mason crews and the size did not change because workload was stable throughout the data collection process. Each crew was laying masonry units and installing rebar for reinforcement and was managed by a site manager and assistant site manager in the field. All the masons were experienced bricklayers that had worked in masonry projects for at least 5 years. Table 1 shows the five dimensions of personality and a sample of the assessment questions.

Table 1. Big Five personality factors

Dimension	Factor
Extraversion (E)	Talkative
	Reserved
	Full of energy
	Generates enthusiasm
Agreeableness (A)	Finds fault with others
	Helpful, unselfish with others
	Likes to cooperate with others
	Quarrelsomeness
Conscientiousness (C)	Does a thorough job
	Somewhat careless
	A reliable worker
	Disorganized
Neuroticism (N)	Nervous
	Depressed, blue
	Emotionally stable, not easily upset
	Remains calm in tense situations
Openness (O)	Ingenious, a deep thinker
	Shows an active imagination
	Prefers work that is routine
	Inventive

Twenty-eight subcontracted masons working for a general contractor participated in the study. The masons were grouped in 20 crews. All the masons were male with a minimum age of 18 years and the mean age was 36.12 years. The experience in masonry construction ranged from five to 47 years with a mean of 23.3 years. The BFI adapted from [29] was completed by each mason early during the data collection process. With the questionnaire responses provided by the masons for their individual personality profiles and using the Euclidean distance, the compatibility for each of the 20 crews was calculated as shown in Table 2. Note that the range of the compatibility coefficient was between 0.36 to 0.78 (with a mean of 0.53 and a standard deviation of 0.12). The results also pointed out different facts. Crews with a significantly elevated score on neuroticism for a mason had low compatibility. Two masons had the highest level of neuroticism (m4 and m23) and these two masons had little variation in their personality profiles. Additionally, the two masons that displayed the lowest level of extraversion also had very low levels of compatibility within the crew sample (see Table 2). Productivity data are also presented in Table 2 for the seven most productive weeks, using the baseline productivity method [28]. Every week the productivity of the 20 crews was measured in

the eight projects totalling about 273 hours per crew. Productivity per crew ranged between 0.887 m² to 1.494 m² per hour.

Table 2. Big Five personality factors (Adapted from [23]).

Crew	Masons	Compatibility	Productivity	Crew	Masons	Compatibility	Productivity
1	m1 m2	0.55	1.36	11	m21 m22	0.46	1.33
2	m3 m4	0.39	0.96	12	m23 m24	0.46	1.03
3	m5 m6	0.55	1.23	13	m25 m26	0.39	1.18
4	m7 m8	0.65	1.23	14	m27 m28	0.55	1.23
5	m9 m10	0.41	1.11	15	m22 m25	0.46	0.99
6	m11 m12	0.43	0.88	16	m21 m26	0.50	1.06
7	m13 m14	0.59	1.19	17	m23 m28	0.57	1.16
8	m15 m16	0.54	1.17	18	m9 m17	0.76	1.50
9	m17 m18	0.63	1.48	19	m24 m27	0.36	0.95
10	m19 m20	0.59	1.40	20	m12 m16	0.78	1.30

3.1. Data analysis

The main objective of this study was to determine whether greater compatibility of personality between the masons in a crew results in higher productivity. To test this, a hypothesis was establihsed:

H_o: Greater compatibility in the crew does not increase productivity

H_1: Greater compatibility in the crew leads to higher productivity

The first step in the analysis was to determine the reliability of the questionnaire responses.The internal reliability was examined and the results displayed high reliability across the factors (Cronbach alpha ranged from 0.64 to 0.85). The second step was to perform a correlation analysis to assess the relationship bewteen compatibility of personality and crew productivity. Spearman's correlation analysis was used since the Spearman's rho coefficient (r_s) determines the direction and strenght of the relationship between two variables. The Spearman's coefficient correlation between the big five factors are shown in Table 3. Note that neuroticism was negatively correlated with the other personality dimensions. Similar findings have been reported in previous studies in non-construction domains [31]. The strongest negative correlation was between neuroticism and conscientiousness ($r_s = -0.686$). The most significant positive correlations were observed between agreeableness and conscientiousness ($r_s = 0.575$) at the $p < 0.05$ significance level.

The null hypothesis was tested unsing a one-tailed test to determine whether greater compatibility of personality leads to higher productivity in the crews. The Spearman correlation analysis was performed and it showed a positive correlation between compatibility and productivity ($r_s = 0.758$). A Spearman correlation coefficient ranging between 0.51 to 0.70 represents a good relationship and a coefficient ranging between 0.70 to 0.89 represents a high correlation [30]. Therefore, as $p < 0.01$ the null hypothesis was rejected, that is, the data supports the possibility of a positive correlation between compatibility and productivity.

Table 3. Correlation between the Big Five personality factors

Factor	E	A	C	N	O
Extraversion (E)	1.000	-	-	-	-
Agreeableness (A)	0.204	1.000	-	-	-
Conscientousness (C)	0.505**	0.575**	1.000	-	-
Neuroticism (N)	-0.438**	-0.373**	-0.686**	1.000	-
Openness (O)	0.255	0.340*	0.507**	-0.360*	1.000

** Correlation is significant at the 0.01 level (one-tailed)
* Correlation is significant at the 0.05 level (one-tailed)

A bit of Bayesian statistics was performed to give a better idea of what the data obtained is telling. The advantage of this approach is that in constrast to the common used approach (whose outcome is a p-value), the Bayes approach gives the possibility of computing how much more likely is a hypothesis compared to another given the collected data. Let's denote by H_ρ the statement "the correlation between compatibility and productivity is exactly ρ". Given any set of data of size N, let r be the correlation coefficient obtained in an experiment with this data set. The random variable $u_r = \operatorname{arctanh} r$ is approximately normally distributed (from the data we have $u_r = 0.6267$). Using Bayes theorem, the probability that the correlation is larger than 0.3 (that is, the correlation is at least moderate) is (see equation 1) :

$$\int_{0.3}^{1} p\left(H_\rho \middle| u_r = 0.6267(r = 0.724)\right) d\rho = 0.674672 \quad (1)$$

Hence, according to the data, it is led to believe that having a correlation of 0.3 (a moderate correlation) is twice as likely as having a correlation lower than 0.3 (a weak correlation). The reader is referred to [23] for the calculation details.

4. Concluding remarks

In construction research there has not been a study that evaluates the relationship between compatibility of personality and productivity. To fill this void, this paper presented an exploratory study using masonry crews working in eight construction projects in the UK. The study was conducted with 28 masons grouped in 20 crews working on residential projects. To determine whether higher compatibility of personality between the masons in a crew leads to higher productivity, a hypothesis was developed and tested. Compatibility of personality was quantified using a metric based on the Euclidean distance. Personality profiles were used to calculate the compatibility between the masons using an adapted questionnaire based on the big five of personality. Productivity at the task-level was measured in the eight projects during 16 consecutive weeks. Correlation analysis was performed to investigate the relationship between compatibility and productivity.

The first part of the analysis showed that the questionnaire for assessing personality had consistency and acceptable reliability across the factors. Further analysis showed that conscientiousness and agreeableness were the personality traits that had the strongest relationship with productivity. People high in conscientiousness plan or systematically work towards goal completion so in teams that spend a fairly amount of time completing interdependent tasks, conscientiousness has a positive effect on productivity. In the case of agreeableness, the effect of this personality trait is through interpersonal facilitation within the team. In this study, the crews in which both masons scored highly on conscientiousness (greater than 5.5) and highly on agreeableness (greater than 5.3) were the crews with the highest productivity. Significant correlations were observed between agreeableness and conscientiousness, openness and conscientiousness, and extraversion and conscientiousness. Another finding was that neuroticism correlated negatively with all the other personality traits and low compatibility between masons commonly occurred when neuroticism was significantly elevated in one mason in the crew. From this, it can be

established that crew members high in neuroticism can have an adverse effect on the productivity of the team by disrupting cooperation.

The correlation analysis showed that compatibility of personality has a moderate positive relationship with productivity at the task level. The correlation coefficient was found to be 0.724. This finding shows that personality influence productivity and need to be accounted for by foremen and managers when forming crews of workers. In this case, crews should be formed with workers that have similar personalities. Although the eight projects were located in the same region in the UK, weather conditions could differ in other geographical locations and this may have an effect on productivity that could be accounted for. In addition to weather, other human-related factors that affect productivity other than personality (e.g. skills, capabilities, cohesion, and experience) could be accounted for to develop a more comprehensive labor productivity function.

This result is significant, as it shows that personality characteristics influence productivity and need to be accounted by foremen and managers when forming and managing masonry crews. Through a series of statistical analyses, the evaluation of the coefficient and is true representation of the true coefficient (of the population) and its expected value were performed. Bayesian statistics was performed to evaluate how much more likely a hypothesis is compared to another. It has been shown through Bayesian statistics, based on the data, that having a correlation of 0.3 (moderate correlation) will be 67% more probable than having a correlation lower than 0.3 (weak correlation). This analysis shows that compatibility of personality and productivity are in a worst case scenario at least moderately correlated. These findings will support construction managers, contractors, and subcontractors in the process of forming teams of workers and structuring jobs with highly productive crews. Crews should be composed of workers that are highly agreeable and conscientious because personality offers unique potential for understanding and improving team work and for better predicting productivity. A natural extension of this work is to test the relationship with crews of larger (and different sizes) in masonry sites and other labour-intensive construction projects. By doing so, a wider scope of data can be analysed to further test whether the relationship still holds with other team size and construction tasks.

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