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PERFORMANCE UNDER REQUIREMENTS UNCERTAINTY: A PERSONALITY PERSPECTIVE

Sankara Subramanian Srinivasan
University of Arkansas, Fayetteville, ssriniva@uark.edu

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Abstract

Software project failure is rampant and is far reaching in its economic consequences. Prior studies have found that the contextual factors (requirements uncertainty, for example) are a major source of failure in software development. From prior research, it is known that personality traits have an impact on an individual's performance. The present research studies, how the personality trait of the software developer moderates the relationship between requirements uncertainty and performance of the software developer. The knowledge of this dynamics will help in better staffing of IT teams and more importantly in improving the success rate of software projects.

Keywords: *software projects, personality traits, developer performance, requirements uncertainty.*

1   INTRODUCTION

Prior research shows that 40 percent of capital expenditure of US corporate is towards software (Sawyer and Guinan 1998) and that 26 percent of all software projects fail and 46 percent experience cost and schedule over-runs (Jiang et al. 2006, Schmidt et al. 2001, Reel 1999, Keil et al. 1998). Cost and schedule overruns of software projects cost billions of dollars to corporations and government (Gorla and Lam 2004, Keil et al. 1998). According to a 1995 study in the USA, "31 percent of software projects will be cancelled before completion and more than half the projects will cost an average of 189 percent of the original estimates" (Whittaker 1999).

The key problem in completing the projects in time is the requirement uncertainty/conflict associated with software development (Wallace et al. 2004, Nidumolu 1996, Curtis et al. 1988). Due to the fast changing setting in which businesses operate, it is common for the requirements to change several times in the course of the development activity and software development teams have to be agile to address this scenario. According to Rasch and Tosi (1992), "Software developer's performance has a direct impact on software development productivity". Further, shortcomings in software development and implementation have been traced to shortcomings on the part of IS Personnel (Bartol and Martin 1982) and variations in team performance attributed to individual level differences (Sawyer and Guinan 1998).

Hence, when the performance of software developer is affected due to requirements uncertainty the outcome of the software project is also likely to be affected. Prior research has studied team level performance/productivity issues, attrition & turnover among IS employees and motivational factors of IS employees. There are other studies that deal with software development methodologies, control, outsourced system development and the issues surrounding it. However, these studies do not take in to account the impact of contextual factors surrounding software development on the IS professional's performance.

Consequently, there is little knowledge on how the contextual factors in software development (say, requirement uncertainty) actually impact the performance of software developers with various personality traits. There is a need to address this gap, as knowledge of how requirement uncertainty

impacts the performance of developers with various personality traits is of both practical and academic interest. This research seeks to address this gap in the literature by taking the personality perspective and attempts to understand how developers with various personality traits are impacted by the presence of requirement uncertainty.

Knowledge of this relationship between requirement uncertainty and the developer's performance can lead to better management of high risk software projects, especially through appropriate staffing. Effective management of IS personnel is vital for the success of the IT department and the organization (Baroudi 1985). Consequently a knowledge of the factors that impact the performance of IS personnel is very important. Especially, knowledge of the impact of contextual factors of IT projects on IS personnel's performance can help the Project manager(organization) to design appropriate intervention strategies to enhance the performance, productivity and resultantly the project's success. Hence, the objective of the paper is to understand how the personality of an IS developer moderate the relationship between requirement uncertainty and the IS developer's performance.

2   LITERATURE REVIEW

2.1   The Big Five Personality Traits

Personality literature has identified – Openness to experience, Conscientiousness, Agreeableness, Extraversion, and Neuroticism, as the various factors that characterize an individual's overarching personality. Table 1 lists the various personality traits and their salient characteristics.

Personality Trait	Salient Characteristics
Openness to experience	Curious, appreciation for ideas, creativity, sophistication
Agreeableness	Achieving social harmony, compliance, altruistic, sympathetic, helpful, self-sacrifice
Neuroticism	Emotionally reactive, anger, anxiety, depression, vulnerability, self-conscious
Conscientiousness	Orderly, achievement oriented, reliable, hardworking, determined, self-disciplined
Extraversion	Social, energetic, "life of the party", gratification seeking , assertive, active, bold, adventurous

Table 1.   Salient Characteristics of various personality traits

2.2   Personality traits and performance

Personality traits have been found to be significant predictors of job performance (Barrick et al. 2002) and an important source of performance motivation (Judge and Ilies 2002). Judge et al. (1999) found that personality was related to career success when controlled for general mental ability. John and Srivastava (1999) found that agreeableness and neuroticism predict performance in jobs where employees work in groups. In IS research, Gorla and Lam (2004) studied the relationship between personality composition of teams and the team performance. They found that the preferred personality for programmers on small teams as extrovertedness, for team leader as intuitiveness and for system

analyst as thinking. Further, personality composition of team members has been found to affect project performance (Faraj and Sproull 2000). Thus it has been established that individual characteristics are a major factor in predicting performance in software development (Curtis 1986). Barki and Hartwick (2001) list personality differences among system developers as one of the several antecedents to interpersonal conflict in systems development. Capretz(2003) says software systems are notorious for not meeting user requirements as the software field is dominated by introverts who can't communicate well with the customers.

2.3   Requirement Uncertainty and software projects

Requirement ambiguity/uncertainty or lack of clarity is a significant cause for software project failure (Wallace et al. 2004, Nidumolu 1996, Reel 1999, Keil et al. 1998, Curtis et al. 1988). The availability of exact specifications or requirements definition is very important for the success of a project. Developers were found to be more productive when they have a complete functional specification before starting to code (Cusumano et al. 2003). But, typically the requirements are not available completely well ahead of the project as the requirements evolve with time and they are more of a moving target (Reel 1999). Software development is uncertain because of incomplete specification availability which is contributed partly by limited domain knowledge of the developers (Kraut and Streeter 1995) and also due to multiple interpretations possible on a stated requirement (Curtis et al. 1988). Hence, lack of clarity and dynamic changes in the specifications of the software poses considerable challenge to software professionals (Kraut and Streeter 1995). Especially, dynamic requirement changes due to evolving clarity in requirements, requires software developers to be able to quickly cope up and align their efforts along the new direction. This involves leveraging on the knowledge of peers and other team members while also sharing knowledge to collectively overcome the new challenge. This demands a sense of belonging, trust and willingness to give and take ideas to achieve collective success. Also in complex projects that involve many developers and those in various locations, ensuring that all the developers understand the requirement specification exactly is a big challenge. Herbsleb and Mockus (2003) found that number of people involved in a project is related to the calendar time taken to complete the project, confirming previous qualitative research that distributed development may increase development time for individual work items. They also state that in the case of requirements change, information is quickly propagated informally than through formal mechanisms such as specification documents.

3   RESEARCH MODEL & HYPOTHESIS DEVELOPMENT

In this section, we present our research model and our theoretical rationale for it. Figure.1 depicts the research model:
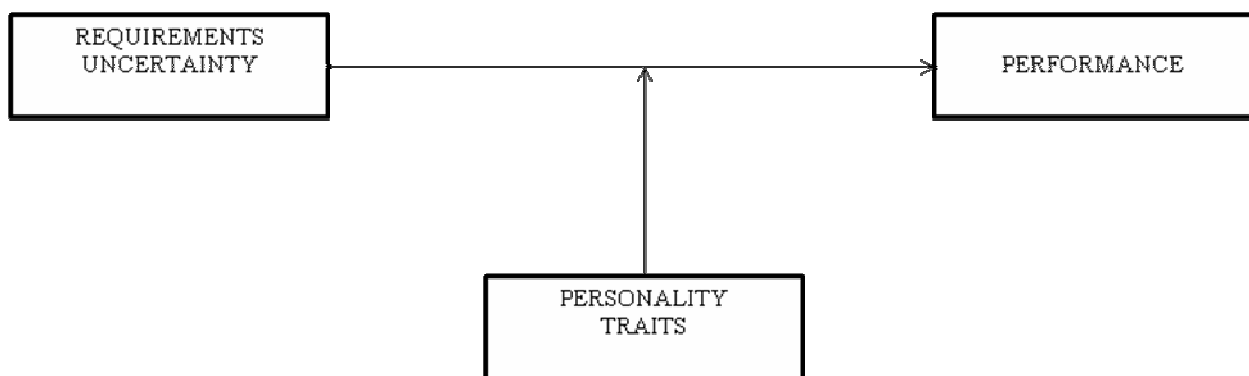

Figure 1.   Software developer contextual performance model

As can be seen from Figure 1, this research attempts to study the moderating effects of the personality traits of the developer (Conscientiousness /Openness to experience/ Extraversion/ Neuroticism/ Agreeableness) on the requirements uncertainty - performance relationship. As requirements uncertainty is a kind of crisis and one that has been found by prior research as a major factor affecting project performance (Wallace et al. 2004), it can be expected to have a negative impact on the software developer performance as well. How requirement uncertainty impacts the performance of developers with various personality traits is the subject of interest for this study. The hypotheses on this interaction are proposed in the following sub-sections.

3.1   Role of Agreeableness

Individuals with an overarching "Agreeableness" personality trait are characterized by sympathy, good-nature and cooperation (McElroy et al. 2007). It is a fundamental trait associated with the intention to strive for communion with others (Barrick et al. 2002, Gellatly and Irving 2001). Being such, they are more likely to be ready to share their knowledge with others to overcome the challenges in the project. They facilitate smooth knowledge sharing among team members. But in critical situations, like requirement uncertainty, where one is required to take a position of authority to proceed forward, people with an agreeableness personality trait are likely to avoid taking the appropriate actions to avoid being un-agreeable. Consequently they may have to follow the decision of the groups or "significant others" in tackling the new changes in the project as they comply (McCrae and John 1992) to outside pressures (John and Srivastava 1999). So it is very likely that they will be led by team or peer decisions than by their own, even if it is significantly better. Also prior research have shown a negative relation between agreeableness and external career success in people oriented jobs and that it could be a liability hampering one's own success at the cost of obliging others(Seibert and Kraimer 2001, Judge et al. 1999). Thus, we expect the performance of developers with agreeableness personality trait to be lower (than what they are capable of) in the presence of requirements uncertainty.

HYPOTHESIS 1: *The effect of requirements uncertainty on the performance of developers will be moderated by agreeableness, such that with increasing levels of agreeableness, the negative relationship between requirements uncertainty and performance will be stronger.*

3.2   Role of Openness to experience

Individuals with an "openness to experience" personality are characterized by curiosity and playfulness (John and Srivastava 1999), intellect and unconventionality (Judge et al., 1999). Due to the inherent curiosity it is very likely that such individuals will be more adventurous and explore various possible approaches to overcome the requirement uncertainty. Further, they can be expected to be more agile and be able to quickly adapt to changes (in requirement). Hence they are more likely to revel in situations such as dynamic changes in the project requirement and like the challenges that come with it. It can be expected that the challenge will motivate them to perform well under such conditions of uncertainty. Also, Barrick and Mount (1991) say that such persons are imaginative and original. So, it can be expected that they will use innovative approaches to solve the problem. Thus we expect developers with an "openness to experience" personality trait to perform well in the presence of requirements uncertainty.

HYPOTHESIS 2: *The effect of requirements uncertainty on the performance of developers will be moderated by openness to experience, such that with increasing levels of openness to experience, the negative relationship between requirements uncertainty and performance will be weaker.*

3.3   Role of Neuroticism

Individuals with a "Neuroticism" personality being emotionally unstable (John and Srivastava 1999) are not likely to be able to get along with others. Especially in software development, which requires working with others, developers with a neurotic personality trait may not be able to tap in to the expertise of others to overcome a challenge like uncertainty in requirement specifications. Further, neuroticism is characterized by feelings of fear, sadness, and difficulty in managing stress. (McElroy et al. 2007) So they may give in to the stress that comes with uncertainty in requirements. Further, as they are not sociable and are hostile they are not likely to acquire the knowledge and information that is required to handle the new challenges in the project. It is more like a hidden profile task for developers with a neurotic personality, as they neither share nor receive information that can help to leverage their abilities to deliver a high performance. Also, research in psychology has shown that people with neuroticism are less satisfied with the physical aspects of their work environments than stable individuals are and that there is a relation between neuroticism and negative traits like absenteeism, complaining and lower career satisfaction (Seibert and Kraimer 2001; Furnham et al. 1998; Furnham and Zacherl 1986). Hence, we expect developers with an overarching neurotic personality to be unable to perform well in the presence of requirements uncertainty.

HYPOTHESIS 3: *The effect of requirements uncertainty on the performance of developers will be moderated by neuroticism, such that with increasing levels of neuroticism, the negative relationship between requirements uncertainty and performance will be stronger.*

3.4   Role of Conscientiousness

Individuals with a "Conscientious" personality trait are goal oriented (John and Srivastava 1999) and are persistent and organize and actively plan, organize and carry out tasks (McElroy et al. 2007). They are able to align themselves to what a situation demands so as to achieve the goal. So it is logical to expect that those with a conscientious personality trait will exert themselves to do well on the project. Even in cases of extreme and frequent changes in project requirements, it can be expected that, being highly organized they can more systematically approach the challenge and emerge successful. Further, as they are of a "dependable" nature (John and Srivastava 1999, Wallace and Chen 2006), they will strive to go that extra mile to ensure the project is a success. They will also likely equip themselves well with knowledge required to overcome the challenge, to be able to be a point of reference/help to the team members. Research has also found that conscientiousness is a consistent predictor of job performance in various occupations (Wallace and Chen 2006). Thus we expect that conscientious individuals will perform well even in the presence of requirements uncertainty.

HYPOTHESIS 4: *The effect of requirements uncertainty on the performance of developers will be moderated by conscientiousness, such that with increasing levels of conscientiousness, the negative relationship between requirements uncertainty and performance will be weaker.*

3.5   Role of Extraversion

Individuals with an "Extraversion" personality type are sociable, cheerful, optimistic (McElroy et al. 2007) and status striving (Barrick et al. 2002). Further, as they want to be the "centre of attention" (John and Srivastava 1999) and as they are likely to be motivated by a desire to get ahead of others (Barrick et al. 2002) they will strive to perform well in situations involving uncertainty to establish themselves well among peers. Further, as requirements elicitation requires good interpersonal skills and the ability to relate to the customers, developers with an extraversion personality can be expected

to be able to elicit requirements better than people of other personality types. They are well suited for social and interpersonal demands of the contextual activities. Seibert and Kraimer (2001) found that extraversion was consistently related to career success which possibly was due to "greater visibility, influence and social/political skills". As working in teams requires the ability to be able to tap in to each other's expertise and knowledge, extraverted developers may be more successful at it due to their social/political skills. Hence, we expect that extraverted developers will perform well under conditions of uncertainty in requirement.

HYPOTHESIS 5: *The effect of requirements uncertainty on the performance of developers will be moderated by extraversion, such that with increasing levels of extraversion, the negative relationship between requirements uncertainty and performance will be weaker.*

4   METHODOLOGY

In this section, we describe the methodology we will adopt to operationalize and test our research model.

4.1   Setting and Participants

To test the research model, we propose a research design that involves student sample from a mid-western university. Student participants who have a significant programming component as part of their curriculum will be considered for the study. The student participants will be selected from a pool of both undergraduate and graduate programs. The students will be given the option to participate in the study for extra credit or given an alternative assignment option if they are not interested in the study.

4.2   Procedure

The study builds on top of the class project that is already assigned by the individual faculty member. The study will collect various data, such as the personality trait of the students, their performance scores in the project, the level of requirement uncertainty in the project and other demographic variables from/for each of the student participant. To ensure sufficient response, we plan to include student samples from various years of studies and batches.

4.3   Measures

The study will use the 60-item *Neo Five Factor model of the Big Five Inventory scale* (John and Srivastava 1999) to assess the personality traits of the student participant. Further, information on perceived requirement uncertainty (Nidumolu 1996), age, gender, prior programming experience will also be obtained. Performance measures will be obtained in two ways to avoid mono-method bias. Student's scores on the project as indicated by the course grades awarded by the instructor will be considered along with the peer-rating, by the individual's team members. A 360 degree evaluation as in this case, can help to ascertain a more accurate measure of the individual's performance. The analysis will control for the age and the prior programming experience of the participants.

5   IMPLICATIONS OF THIS STUDY

This study focuses on the important aspect of software developer performance, which is so fundamental for the success of software projects. By attempting to decipher the moderating effects of

software developer's personality traits on the *requirement uncertainty – performance* relationship, the study extends our knowledge on the dynamics that govern performance of software developers under uncertainties. Because software development is often shrouded in uncertainties, especially with more software development being offshored, it is very vital for both practicing managers and research scholars to understand how personality element can play a part in defining the performance of a developer. Knowledge of this dynamics can help researchers to extend the frontiers in the domain of software developer performance using personality traits as a lens. For practicing managers this can help in appropriate staffing, so that people with the personality traits that are most suited for optimum performance under uncertainties can be employed in complex development activities to ensure success and minimize chances of failure.

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