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## ASSESSING PERSONALITY PROFILES OF SOFTWARE DEVELOPERS IN AGILE DEVELOPMENT TEAMS

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### ABSTRACT

Agile methodologies are changing the way we develop software. Their emphasis on team-oriented development, joint code ownership, and reliance on people rather than predefined processes to guide activities, is transforming software development into a socio-technical process. As methodologies become increasingly more people and team-oriented, there is an urgent need to investigate the personality profiles of software developers and their likely impact on the productivity of the development team. A review of the IS research literature on personality studies found Jungian typology operationalized as Myers-Briggs Type Indicator (MBTI) to be the most popular approach for assessing personality profiles. We compared the Five Factor Model (FFM) of personality, which is currently gaining popularity among personality psychologists, with MBTI. Our analysis, based on extant research literature in personality psychology and group behavior, suggests that FFM not only provides better measures for all factors that are measured by MBTI, but it also allows us to assess Neuroticism, an important personality trait that is of interest to researchers studying work groups, such as the agile development team. Our finding has important implications for researchers studying the agile development process. It is also highly relevant to studies investigating the personality profiles of IS professionals. Thus, our study attempts to bring in fresh insights from Personality Psychology, our reference discipline, to enrich IS research.

**Keywords:** Five Factor Model of Personality; Myers-Briggs Type Indicator; Agile Methodologies; Software Development; Programmer Team

### I. INTRODUCTION

Agile software development methodologies have recently generated great enthusiasm among both practitioners and researchers [Orr, 2002; Larman, 2004; Erickson et al., 2005; Turk et al., 2005]. Extreme Programming (XP), Feature-Driven Development, Crystal Methods, Scrum, Dynamic Systems Development, and Adaptive Software Development are some of the popular agile methods. XP is by far the best documented and most widely practiced agile method [Orr, 2002]. The common principle underlying agile methods is their emphasis on cooperative

software development [Beck et al., 2001]. The focus is more on people and the dynamics of their interactions, rather than on elaborate requirements planning and rigid software development processes. Customers actively participate in the development process as full time members of development teams. Short iterations of planning, designing, coding, and testing are adopted along with continuous integration to accommodate changes throughout the system's life cycle. Software developers frequently iterate between these different phases of systems development and alter their roles accordingly. Thus, the roles and expectations of software developers involved in agile teams differ dramatically from those using traditional plan driven methodologies [Cockburn and Highsmith, 2001; Orr, 2002].

The traditional profile of the software developer as the specialist working predominantly individually within a software development team is giving way to the versatile team player that can frequently and effectively switch roles among analyst, designer, and coder. Traditionally, innate intellectual abilities [Rasch and Tosi, 1992] and programming experience [Chrysler, 1978; Benbasat and Vessey, 1980] were considered critical factors for the effectiveness of software developers. Agile methodologies, due to their critical emphasis on team-oriented development, make additional demands on the social and interpersonal skills of software developers.

Social skills of individuals are greatly influenced by their personalities [Hogan, 1991]. Personality traits are relatively enduring characteristics that are not easily changed with behavioral training [Kichuk and Wiesner, 1997]. Personality profiles of members are important predictors of team performance [Hackman and Morris, 1975; Ridgeway, 1983] and organizational success [Moad, 1994; Kichuk and Wiesner, 1997]. We know from small group research that the composition of a team affects the team's performance [Gist et al., 1987; Volkema and Gorman, 1998]. In general, heterogeneous teams perform better in unstructured creative tasks, whereas homogeneous teams do well in more structured tasks. The fit of a software developer's personality profile to the assigned role as well as his/her ability to effectively perform as a team member would have a large effect on the outcome of agile software development projects [Cockburn, 2000].

With software development methodologies becoming more people and team-oriented, there is an imperative need to investigate the personality profiles of software developers and the impact that personality dimensions may have on the effectiveness of agile teams. The objective of this study is to facilitate this stream of research by evaluating the extant research literature on personality and cognitive studies addressing software development. A review of the IS research literature on personality studies shows that Jungian typology operationalized in Myers Briggs Type Indicator (MBTI) [Myers et al., 1998] was the most popular approach used to assess personality and cognitive dispositions. These studies were also predominantly focused on the individual as opposed to the team. Introduced to the IS research community by the seminal paper by Mason and Mitroff [Mason and Mitroff, 1973], MBTI has served the community well in investigating the impact of individual personality traits on the development and deployment of information systems. However, it is imperative to revisit this issue in light of recent developments in the areas of personality psychology and software development.

The Five-Factor Model (FFM) of personality is currently gaining prominence among personality psychologists as the consensual model of choice in understanding personality traits [Digman, 1990; Costa and McCrae, 1992a; McCrae and John, 1992]. It measures individual personality traits in terms of five dimensions: Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (Please see Section 4 for more details). We compared FFM with MBTI with regard to their suitability in assessing personality profiles of agile team members. Our analysis, based on extant research literature in personality psychology and group behavior, suggests that FFM not only provides better measures for all factors that are measured by MBTI, it also allows us to assess Neuroticism, an important personality trait that is of interest to researchers studying work groups, such as the agile development team. We, therefore, recommend the use of FFM in studying the impact of personalities of team members on the performance of agile teams. Our finding has important implications for researchers studying the agile development process. It is also highly relevant to studies investigating the personality

profiles of IS professionals. The merit of our study lies in bringing fresh insights from Personality Psychology, our reference discipline, to enrich IS research.

The remainder of the paper is organized as follows. In the following section we compare agile software development methodologies with traditional plan driven methodologies and highlight the importance of studying personality profiles of software developers. We then present a review of the research literature on personality and cognitive studies of IS personnel. The FFM is then discussed and compared with MBTI with regard to its suitability for studying agile teams. The insights FFM could provide concerning agile team dynamics and performance are then briefly illustrated. Finally, some future research directions and conclusions of the study are presented.

## II. AGILE VS. TRADITIONAL SOFTWARE DEVELOPMENT METHODOLOGIES

Change is a constant in all product development efforts in organizations, including software development. Hyper-competitive environments, rapid technological changes, and changing business needs all call for changes in requirements during various stages of product development. Over the years it became apparent that these drivers of change affect software development to a greater extent than other product development efforts. The effect of rapid technological changes is particularly important in this regard.

Traditional software development methodologies are based on the premise that a software system should be specified to the fullest extent prior to implementation. These methodologies address change by emphasizing foresight and detailed upfront planning. The traditional methodologies are therefore referred to as plan-driven methodologies [Boehm and Turner, 2004]. In its purest form, the development process, based primarily on the *waterfall model* or its variation, follows a predominantly sequential approach [Beck, 1999]. Extensive requirements gathering is followed by detailed system design. The specifications thus developed guide implementation and testing. Developers specialize in specific tasks, such as analysis, design, and coding. Uncertainties in project management, such as time and cost overrun, are reduced through elaborate planning, documentation, and enforcement of strict process guidelines. Some variants of traditional development however involved a more incremental and iterative approach without diluting the documentation and traceability requirements [Boehm and Turner, 2004].

While traditional methodologies served the software community well in the past, they may not be appropriate for all contexts. Agile methodologies evolved in this setting through experimentation involving 'exploratory projects' that used frontier technologies [Highsmith, 2002]. Unlike traditional methodologies that attempt to address all foreseeable change at the analysis and design stages, agile methods are designed to work in an environment where the specifications of the software system continue to evolve throughout the development cycle. Thus, agile methods are philosophically and pragmatically different from traditional software development methods in important ways. Table 1 provides a summary of these differences. Though the contrast between the two approaches is striking, neither of them is considered a silver bullet. Boehm and Turner (2004) while highlighting the home grounds of each of the methodologies have attempted a synthesis of the two through a risk-based approach.

### PROCESS CHARACTERISTICS

Agile development methodologies emphasize incremental development of software in short iterative cycles. A typical cycle in XP is about 3 weeks. Each cycle involves analysis, design, coding, and testing, and results in working code that is added to the production system. Thus the system incrementally grows with the addition of a few new features during each cycle. This contrasts with the long development cycle spanning several months that characterizes traditional development approaches. The user participates as an active member of the agile development team and determines the features to be implemented in each cycle. He/she also provides constant feedback during development. The short development cycles combined with direct user participation make agile development highly adaptable to cope with constantly evolving requirements.

Table 1 – Differences Between Traditional and Agile Methodologies

	<b>Traditional</b>	<b>Agile</b>
<b>Focus</b>	Individual creativity Processes and tools Technical Optimization	Creative teamwork People and interactions Socio-technical Adaptation and Learning
<b>Process Characteristics</b>		
Change Readiness	Low	High
Process flow	Predominantly sequential	Parallel and iterative.
User Involvement	Partial	Complete
Coding standards	Useful but not critical	Highly important
Dominant mode of communication	Documentation	Barrier-free interpersonal interaction
<b>Project Management</b>		
Key decision maker	Project manager	Development team members
Management control	Through plans, processes, and verification	Trust based collaboration and self organization
<b>People Issues</b>		
Roles	Defined and relatively constant	Change, often at developer's discretion
Code ownership	Individual accountability	Team based collective ownership
Rewards	Individual	Team based

An important mode of communication among developers in traditional development methodologies is documentation. The outcome of each phase is captured in a set of documents that drives the next phase. Analysis results in requirement specification. Design documents are created based on these requirements, that guide implementation, and unit testing. Acceptance tests are designed based on requirements. Agile teams place little emphasis on documentation. Instead, they emphasize tacit knowledge and direct communication among team members, including the user representative. Collective ownership of code as against individual ownership in traditional software development is another aspect of some agile methods. This requires the agile developer to strictly adhere to coding standards so that others can easily understand the code.

### **PROJECT MANAGEMENT ISSUES**

In traditional development the project manager determines the schedule, assigns responsibilities to developers, and monitors progress. Accordingly, the authority and responsibility regarding timely completion of the project are vested with the project manager. Agile methodologies emphasize a team-based approach by delegating a number of key decision-making responsibilities to team members. Agile managers acting as facilitators set goals and constraints, and provide agile teams with overall boundaries. Teams themselves set priorities, determine schedules, design, test, and deliver the software [Orr, 2002]. This significantly redefines the role and authority of the project manager in agile development. Project management in agile development thus moves away from the verifiability and control requirements of traditional management style to a trust based collaborative decision-making involving self-directed teams.

### **PEOPLE ISSUES**

A major difference between agile and traditional methodologies occurs at the level of people and their roles, responsibilities, and rewards. A key concept promoted by the agile manifesto is that people (software developers and users) form the cornerstone of the software development process [Beck et al., 2001]. It argues that people working together in creative teams can

significantly enhance the success rates of software projects. This emphasis on the team, rather than the individual developer, entails a huge change for software developers and IS managers who, by practicing the tenets of traditional software development methodologies, have been trained to be individualists [Orr, 2002].

The traditional methodologies emphasize skill specialization. Software developers specialize in tasks such as systems analysis, database design, programming, etc. This role specialization breaks down in the agile team, which is collectively responsible for analysis, design, development, and delivery of working code. Agile methodologies consequently encourage “generalizing specialists” [Ambler, 2004]. The role played by an individual in the agile team changes frequently based on mutual agreement. In the absence of documentation, it is imperative that all the team members develop a tacit knowledge of the overall system. Such role changes foster understanding of the system and the code by agile team members and promote greater knowledge sharing. It also supports the notion of collective responsibility for and joint ownership of the code, the end product of software development. Team-based responsibility naturally leads to team-based rewards.

The emphasis on collaborative ownership and teamwork, which distinguishes agile methodologies from traditional development approaches, offers substantial scope for conflict. Such conflicts could be task or relationship based. Task conflicts arise over substantive issues, such as differences in ideas, opinions, and ways of approaching a task. Relationship conflicts, on the other hand, refer to interpersonal or socio-emotional disagreements related to feelings of animosity or annoyance [Bono et al., 2002]. While task conflicts within a certain limit could have a beneficial effect on a team’s performance, relationship conflicts are usually considered detrimental to the team’s effectiveness.

Aspects of agile methodologies, such as, pluralistic decision-making involving multiple stakeholders, self-organization, joint code ownership, etc., could trigger task related conflicts. Such conflicts, if not managed properly, could potentially contribute to relationship conflicts with negative consequences. For organizations migrating from traditional methodologies to agile methodologies, transition issues could also trigger conflicts [Nerur et al., 2005]. Change in work habits, transition from process and control environment to a more collaborative environment, lack of clear design documents to go by, giving up code ownership, and relinquishing individual rewards in favor of team-based rewards could all contribute to conflicts.

The above discussion underscores the fact that adoption of agile methodologies significantly changes the work environment of the software developer. Traditionally, innate intellectual ability is considered a critical factor in determining a person’s success as a software developer [Benbasat and Vessey, 1980; Rasch and Tosi, 1992]. While intellectual ability will continue to be a predictor of success, the personality profile of the software developer is likely to greatly influence the effectiveness of the agile team. Several recent meta analytic studies have highlighted the effect of personality on job performance [Barrick and Mount, 1991; Tett et al., 1991]. It is now widely accepted that people have stable dispositional traits that influence their behavior in work settings [Mount et al., 1998]. Personality could help predict job performance and career success over and above general mental ability [Day and Silverman, 1989; Tett et al., 1991; Judge et al., 1999]. Therefore, IS researchers interested in studying adoption of agile methodologies must consider, among other factors, the personality traits of software developers and their impact on the performance of the agile teams.

The following section reviews the extant research literature on personality factors in the context of traditional software development. This review will help us understand the current body of knowledge in this area and provide input to chart a path for future research on personality studies in the context of agile teams.

**III. PERSONALITY STUDIES IN IS RESEARCH**

We have categorized research on personality and cognitive dispositions of IS personnel using two dimensions: instrument type (Jungian vs. Non-Jungian) and the context of study (individual vs. team). Figure 1 lists IS research papers classified into four quadrants using this framework. Those papers that address multiple issues are appropriately listed in more than one quadrant. This list does not include studies that investigate cognitive issues outside the IS context. Also excluded from the list are papers on cognitive dispositions of end-users, which sometime ago formed a vibrant research stream in MIS and DSS design (see for example, [Bariff and Lusk, 1977; Benbasat and Taylor, 1978; Zmud, 1979]. While we have made an attempt to create a comprehensive list of research papers, we do not claim this to be an exhaustive list.

Much of the research on cognitive characteristics of IS personnel investigate typical cognitive profiles that are likely to predict success of individuals in the field of computing. Research in team context, on the other hand, try to unravel the differences between successful and unsuccessful IS teams in terms of the cognitive profiles of their members. The notion that personality and cognitive styles of members can impact team performance [Driskell et al., 1987] seems to have influenced research on IS teams.

	<b>Jungian Instruments</b>	<b>Non-Jungian Instruments</b>
<b>Individual</b>	MBTI profiles of Programmers & trainees [Barnes, 1975] Programmers & analysts [Bush and Schkade, 1985] IS professionals [Lyons, 1985] Programmers [Hardiman, 1997] Software engineers [Capretz, 2003] PSI and MBTI profiles of Students [Mawhinney and Lederer, 1988]	16PF Profiles of Programmers, analysts and managers [Moore, 1991] Data processing professionals [Larkin, 1983] SVIB Profiles Interest patterns of programmers [Mayer and Stalnaker, 1968] SVIB profiles of programmers and trainees [Barnes, 1975]
	User-Programmer differences [Bostrom and Kaiser, 1981] [Kaiser and Bostrom, 1982] Perceived stereotypes & actual Jungian (Kiersey Temperament Sorter) profiles of systems professionals [Sitton and Chmelir, 1984] Suitability of MBTI profiles for programming subtasks [Teague, 1998] MBTI dimensions predictive of computer proficiency [Evans and Simkin, 1989]	MMPI profiles of programmers and trainees [Barnes, 1975] FFM profiles of exceptional developers and IS students [Clark et al., 2003]
<b>Team</b>	User-programmer differences and team success [Kaiser and Bostrom, 1982] Jungian (Kiersey Temperament Sorter) profiles of students & performance [Rutherford, 2001] MBTI profiles of successful/unsuccessful teams [White, 1984a] Perceptual profile, task type and team effectiveness [White, 1984b]	

Figure 1. Research Literature on Personality and Cognitive Dispositions of IS Personnel

Instruments based on the Jungian typology were found to be most popular among IS researchers, with MBTI being the instrument of choice. Other instruments based on the Jungian typology or its variations used by IS researchers include Personal Style Inventory (PSI) [Hogan and Champagne, 1980] and Kiersey Temperament Sorter [Keirsey, 1984]. The Jungian typology describes human personality using eight factors that are arranged as bi-polar preferences along the following four dimensions:

Field of View:	Extraversion (E)	..... Introversion (I)
Perceptual dimension:	Sensing (S)	..... Intuition (N)
Judging dimension:	Thinking (T)	..... Feeling (F)
Way of Life:	Judging (J)	..... Perceiving (P)

Field of view describes the orientation of a person. Extroverts tend to be people oriented, while Introverts are more comfortable with the world of ideas. The Perceptual dimension reflects how a person perceives information. A Sensing type person prefers hard facts while searching for information, whereas an Intuitive person looks for relationships and patterns among data. The Judging dimension deals with decision-making. A Thinking type person makes decisions based on logic and analysis, while the Feeling type tends to rely on emotions and personal values. Finally, Way of Life relates to how a person deals with the world. The Judging type person tends to prefer a planned, orderly life, while the Perceiving type tends to prefer a more spontaneous and flexible life. Although a given individual's cognitive disposition may include all eight factors to some degree, usually one factor in each dimension tends to be dominant [White, 1984a]. The research findings are discussed below.

### **INDIVIDUAL AND JUNGIAN INSTRUMENTS**

IS personnel are found to be predominantly Introverted [Barnes, 1975; Bush and Schkade, 1985; Lyons, 1985; Capretz, 2003] and Thinking [Barnes, 1975; Lyons, 1985; Teague, 1998; Capretz, 2003] types. Programmers tend to be mostly Thinking types with the near exclusion of Feeling types. While some studies suggest no difference among IS personnel on the Perceptual dimension (Sensing vs. Intuition) [Kaiser and Bostrom, 1982; Lyons, 1985], others claim Sensing to be a dominant characteristic [Smith, 1989; Teague, 1998; Capretz, 2003]. Sensing dimension is also found to be predictive of computer proficiency [Evans and Simkin, 1989]. With regard to Judging vs. Perceiving dimension, some studies suggest IS personnel to be predominantly Judging type [Lyons, 1985; Smith, 1989; Teague, 1998] while others indicate no dominant characteristic on this dimension [Kaiser and Bostrom, 1982; Sitton and Chmelir, 1984]. It is unclear whether the conflicting results among these studies reflect a change in the profile of IS personnel over time. With regard to combination of dimensions, programmers tend to be predominantly Introverted and Thinking types [Bush and Schkade, 1985; Lyons, 1985; Teague, 1998]. Systems analysts, on the other hand, while being predominantly Thinking types tend to include both Introverts and Extroverts [Lyons, 1985]. It is also reported that people with NT and SJ profiles make the best programmers [Hardiman, 1997; Teague, 1998].

### **INDIVIDUAL AND NON-JUNGIAN INSTRUMENTS**

Non-Jungian instruments used by IS researchers include the Minnesota Multi-Phasic Inventory (MMPI) [Barnes, 1975], the Strong Vocational Interest Bank (SVIB) [Mayer and Stalnaker, 1968; Barnes, 1975], the Sixteen Personality Factor Test (16PF) [Larkin, 1983; Moore, 1991], and the Five Factor Model (FFM) [Clark et al., 2003]. Studies that used non-Jungian instruments suggest that IS personnel are conscientious and persistent, self-assured and self-confident, cool and reserved, assertive and dominant, adaptable and trusting, and are good at abstract thinking [Larkin, 1983]. Programmers are categorized as defensive [Barnes, 1975] and conservative [Moore, 1991]. They share interests with persons engaged in scientific and professional occupations [Mayer and Stalnaker, 1968] and with persons whose vocations include mathematics, nature, and music [Barnes, 1975]. Their interests differ from those engaged in



occupations associated with gregariousness such as public speaking or politics [Barnes, 1975]. Their personality profiles are more similar to that of chemical engineers, electricians, and airline pilots, but are very different from that of professors, writers, and farmers [Larkin, 1983]. Exceptional IT professionals tend to be extroverts, while exceptional IT students in terms of GPA tend to be introverts. Both groups however tend to be conscientious [Clark et al., 2003].

IS managers were found to be less warm and outgoing, more aggressive and assertive, less adventurous, less trusting and accepting of conditions, more self-sufficient and resourceful, more impulsive and more tense than other business executives [Moore, 1991]. They do not share characteristics traditionally associated with management, but have profiles similar to programmers and systems analysts. This could be explained by the fact that IS managers tend to rise from the ranks of programmers/analysts [Moore, 1991]. However, unlike programmers who are generally cool and reserved, they are outgoing and warm. Information Systems managers are also found to be emotionally stable, socially bold and venturesome, experimenting and liberal, and self-sufficient [Larkin, 1983].

## TEAM

Research on IS teams has almost exclusively relied on the Jungian typology. A significant finding in this research stream emphasizes the value of diversity in team composition as a predictor of success. Inclusion of Feeling types to supplement Thinking types in the project team is found to be critical for the success of programmer teams [Kaiser and Bostrom, 1982; White, 1984a]. Heterogeneous teams with diverse cognitive dispositions have been found to employ more open and varied approaches to problem solving compared to homogeneous teams [Rutherford, 2001]. Heterogeneity is found to be a useful team characteristic while solving unstructured tasks, whereas homogeneity in team composition is desirable for structured tasks [White, 1984b]. Team members with complementary cognitive profiles have been found to make up for one another's limitations, thus further reinforcing the importance of diversity in the context of IS teams [Shneiderman, 1980].

The study of personality of IS personnel in the past has yielded valuable insights regarding the personality and cognitive profiles that offer a good fit with the roles and requirements of traditional software development. With the advent of agile software development methodologies, the roles and responsibilities of software developers are however undergoing rapid transformation. There is a need to take a fresh look at the personality profiles of IS personnel and their fit with the new roles and job descriptions in agile teams. While existing approaches such as MBTI could be used for this purpose, it is prudent to evaluate new theoretical frameworks and instruments from personality psychology that might satisfy the requirements better. In the next section, Five Factor Model of personality, which is the new consensual personality framework for cumulating research findings in personality research is briefly discussed and compared with the MBTI and Jungian approach. Its utility for researching personality in agile software development teams is then discussed.

## IV. FIVE-FACTOR MODEL OF PERSONALITY

The Five Factor Model is a hierarchical organization of personality traits in terms of five basic dimensions: *Neuroticism*, *Extraversion*, *Openness to Experience*, *Agreeableness*, and *Conscientiousness* [McCrae and John, 1992]. *Neuroticism* denotes level of personal adjustment and tolerance for stress. It represents the tendency to express negative emotions such as anger, guilt, fear, and sadness. Individuals that score low on this dimension exhibit higher emotional stability and are better prepared to cope with stressful situations. *Extraversion* measures the degree of sociability and gregariousness of a person. People scoring high on this dimension tend to be more outgoing and enjoy interacting with others. On the other hand, those scoring low on *Extraversion* are apt to be reserved and introverted. *Openness to Experience* indicates being open to new ideas. Individuals scoring high on this dimension show the tendencies of inquisitiveness and creativity. Those with low scores on *Openness* are characterized as overly

practical and show less sensitivity to others' feelings. *Agreeableness* measures friendliness and degree of trust exhibited by individuals. People high on this dimension tend to be trusting and cooperative, and are moved by others' needs. Finally, *Conscientiousness* measures the level of organization, commitment and persistence exhibited by individuals. It is manifested in qualities such as dutifulness, self-discipline and goal orientation.

The FFM has been well researched by personality psychologists and its dimensions have been found to demonstrate convergent and discriminant validity across instruments and observers [McCrae and John, 1992]. These dimensions have also been shown to be stable over time and generalizable across cultures. A number of FFM-based instruments are available for use by researchers. Some of the more popular ones are NEO-PI-R [Costa and McCrae, 1992b], the Five Factor Personality Inventory (FFPI) [Hendriks et al., 1999a; Hendriks et al., 1999b], the Big Five Questionnaire (BFQ) [Caprara et al., 1993], Structured Interview for the FFM (SIFFM) [Trull and Widiger, 1997], and the Five-Factor Nonverbal Personality Questionnaire (FF- NPQ) [Paunonen et al., 2001]. De Raad and Perugini [De Raad and Perugini, 2002] offer an excellent overview of these and other instruments to measure FFM dimensions.

## V. FFM VS. MBTI

This section compares FFM with the Jungian typology, as measured by MBTI, with regard to their appropriateness in studying software developers participating in agile development.

### EMOTIONAL STABILITY (NEUROTICISM)

Agile teams are conceived as complex adaptive systems, wherein "decentralized, independent individuals interact in self-organizing ways, guided by a set of simple, generative rules, to create innovative emergent results" [Highsmith and Cockburn, 2001]. Agile development advocates a minimalist management strategy [Orr, 2002]. It stresses generative rules rather than inclusive rules. While working in conditions guided by inclusive rules, teams look for rules and practices that are laid down a priori for every situation. Teams working with generative rules on the other hand, depend upon individuals and their creativity to solve problems as and when they arise [Highsmith and Cockburn, 2001]. Interaction and communication are integral to working in agile teams.

Neuroticism or lack of 'Emotional Stability' is associated with traits such as anxiety, hostility, depression, self-consciousness, vulnerability, and impulsiveness [McCrae and John, 1992]. Meta-analytic studies demonstrate a positive correlation between Emotional stability of employees and their job performances in jobs that involve considerable interpersonal relationships [Mount et al., 1998]. Emotional Stability of software developers would be an important factor affecting their effectiveness in such teams. In general, Emotional Stability is expected to be positively associated with group performance [Driskell et al., 1987]. Research on small groups suggests that successful teams have members with higher Emotional Stability compared to those in unsuccessful teams [Kichuk and Wiesner, 1997]. The empirical evidence is still mixed and is actively being researched. Emotional Stability is thus an important factor of interest to researchers who wish to study agile teams. Unfortunately, this factor is not included in the Jungian typology and, therefore, cannot be measured directly by MBTI.

### EXTRAVERSION

Agile development relies on collaborative teamwork and close interaction among team members. Team members frequently switch roles and an individual developer may be required to perform a wide array of tasks from analysis and design to coding and testing. Software development, in the agile approach, becomes a socio-technical process. This also entails dealing with diverse stakeholders who often have conflicting interests. In agile teams, a climate that facilitates social inquiry and cogeneration of knowledge through open and honest collaborative efforts has to be fostered. Extraversion, which underscores people orientation and external focus, could be an important factor influencing the success of agile teams.

Extraversion measures warmth, gregariousness, assertiveness, activity, excitement seeking, and positive emotions. It is known to be positively associated with employee performance in jobs that have a large social component [Barrick and Mount, 1991; Tett et al., 1991]. Traits such as being sociable, talkative, energetic, and assertive contribute to enhanced performance in such jobs [Barrick and Mount, 1991]. Extraversion is found to be positively related to self-efficacy [Thomas et al., 1996; Kichuk and Wiesner, 1997], which influences performance. Extraversion, measured by MBTI, is clearly related to this dimension but is measured as a dichotomous preference between Introversion and Extraversion. The question of psychological 'types', measured as dichotomous types in MBTI is contested by researchers for lack of clear proof of bimodal distribution of MBTI scores [Bess and Harvey, 2002]. Though the recent versions of MBTI adopt a continuous dimensional scoring system, its developers still insist on using dichotomous types in making assessment decisions [Bess and Harvey, 2002]. Therefore, in the context of agile teams, Extraversion in FFM measured as a trait dimension is more acceptable in view of its continuous dimensional approach.

### **AGREEABLENESS**

Collaborative teamwork forms the very foundation of success of an agile team. Decision-making in agile development devolves down to the team level. The agile team is jointly responsible for various key aspects of the project, including the features to be implemented in each iteration, timeline for implementation, and quality assurance. A key requirement for effective collaboration is trust and goodwill among team members. Joint code ownership is another key practice in agile development. Unlike in the traditional approach, where an individual developer 'owns' the code that he/she writes, in agile development the team owns the code. Thus, every agile team member has the right as well as responsibility to maintain the code. Complying with coding standards and making the code understandable to other developers are essential requirements to facilitate joint ownership of code. Similar to the collectivist organizational culture practiced by Japanese corporations [Hofstede and Bond, 1988], agile methodology encourages collective accountability. This requires the team members to subordinate personal goals to that of the overall team objective. The Agreeableness dimension of FFM includes personal qualities of an individual, such as, altruism, compliance, modesty, and trust. Thus, Agreeableness is likely to be a good predictor of success in the context of agile development.

Agreeableness is associated with being courteous, trusting, forgiving, cooperative, and tolerant. Small group research findings suggest that successful teams are associated with higher levels of Agreeableness than unsuccessful teams [Kichuk and Wiesner, 1997]. Agreeableness has also been found to be a predictor of success in jobs involving interpersonal relationships [Barrick and Mount, 1991]. The Thinking-Feeling dimension of MBTI captures some aspects of Agreeableness such as tough versus tender-mindedness. But it does not directly measure interpersonal aspects of Agreeableness such as trust, altruism, and cooperativeness [McCrae and Costa, 1989]. Hence, in agile development that puts considerable emphasis on interpersonal relationships and collaborative decision-making, Agreeableness aspect of FFM is a more complete and appropriate dimension to study than Thinking-Feeling dimension of Jungian typology.

### **CONSCIENTIOUSNESS**

The agile development approach relies on the notion that competent and motivated software developers collaborating in an emergent setting are capable of achieving significantly higher levels of productivity and quality compared to these individuals working independently in a more structured environment with well-defined roles and responsibilities. The agile team operates under a small set of guidelines and is allowed to adapt to changing demands. The transition to agile development, therefore, involves changing from a deterministic mindset to an emergent one. An absence of rules to deal with every possible situation could be discomfoting to those who prefer a more orderly work environment.

The Conscientiousness dimension of FFM measures competence, order, dutifulness, achievement striving, self-discipline, and deliberation. Of the five factors, Conscientiousness is considered to be the most stable disposition [Judge et al., 1999]. In management research Conscientiousness has been found to predict intrinsic and extrinsic career success [Judge et al., 1999]. It has been consistently found to be related to higher job performance [Barrick and Mount, 1991]. Competent, organized, goal oriented, and persistent individuals (those scoring high on Conscientiousness) are likely to perform well. Conscientiousness is related to Judging preference of Jungian typology, as both measure orderliness and self-discipline. Judging individuals may be construed as high in Conscientiousness and perceiving types as low in Conscientiousness. However, Conscientiousness is also correlated to Thinking/Feeling and Sensing/Intuiting dimensions of MBTI [Furnham, 1996]. Other sub-dimensions of Conscientiousness such as competence, dutifulness, achievement striving, self-discipline and deliberation would be highly valued dispositions in the context of agile teams. It is also worth noting that agile methodologies place a high premium on the levels of competence of software developers. Thus, the Conscientiousness dimension of FFM is likely to be a better predictor of performance in the context of agile development compared to the Judging-Perceiving dimension of the Jungian typology.

### **OPENNESS TO EXPERIENCE**

An agile team comprises persons with diverse skill sets, exposing team members to a wide range of views and personalities. Also, agile development encourages developers to be creative in finding solutions to abstract problems. The reliance on generative rules to guide day-to-day operations places added emphasis on creativity, ability, and motivation to learn. A person with a high score on openness is likely to perform better in an agile team. However clear empirical evidence is still lacking as researchers have used the factor less frequently in teams [Peeters, 2006].

Openness to Experience is a measure of a person's aptitude to explore new ideas. It signifies being creative, introspective, inquisitive, and attentive to inner feelings. Openness to Experience is found to be highly correlated to cognitive ability, possibly indicating that it is capturing both ability to learn and motivation to learn [Barrick and Mount, 1991]. It is a good indicator of argumentativeness [Blickle, 1995; Bono et al., 2002] and performance on tasks requiring creativity or ability to deal with abstract problems [Driskell et al., 1987; Kichuk and Wiesner, 1997].

Intuition in the Jungian typology is related to the Openness dimension of FFM, as both are predictors of creativity. Although Sensing/Intuiting dimensions of MBTI and Openness to Experience of FFM are both related to taking in information, the contrast between Sensing and Intuiting types in MBTI does not capture the essence of openness. While Sensing and Intuiting people differ in the type of information they prefer, open individuals differ in the quantity of information they prefer over less open individuals [McCrae and Costa, 1989]. In agile teams there is a need for team members to be receptive to large amount of new information. Minimal upfront design, as practiced in agile development, and the change readiness demanded by such practice require successful agile team members to score high on openness to experience. The Sensing dimension of MBTI indicating a perceptual preference for hard facts does not map directly to the requirements of agile methodologies. Thus Openness to Experience of FFM is a more appropriate dimension to study agile software development than Intuition preference in Jungian typology.

The Jungian typology and MBTI have served researchers well in studying personality dimensions of IS personnel. With the advent of agile methodologies, software development has become a socio-technical phenomenon. While individual competence, in terms of technical knowledge, application domain knowledge, and experience, continues to be a necessary condition of success, it is no more sufficient to predict success in the new environment. The ability of the software developer to work effectively in a team, to communicate and collaborate in an emergent environment, to subordinate individual goals to team objectives, and to share responsibilities as

well as rewards with team members are critical determinants of success in this environment. Researchers interested in studying personalities of agile team members and their influence on successful software development are likely to benefit by using FFM, which covers a wider spectrum of personality dimensions that are relevant in this context.

FFM-based instruments such as NEO-PI(R) [Costa and McCrae, 1992b] have superior psychometric properties in terms of construct and predictive validity than MBTI [Furnham, 1996]. Unlike MBTI, which gives only a global picture of the four dimensions, FFM based instruments such as NEO-PI(R) provide comprehensive information on the sub-dimensions of the factors. For individuals scoring the same overall scores on a trait, differences could still be identified and examined among the sub-traits. It is also worth mentioning that FFM is the framework of choice in personality psychology to cumulate research findings [Digman, 1990; Costa and McCrae, 1992a; McCrae and John, 1992]. Thus, adoption of the FFM approach and related instruments will also help IS researchers to draw on the stream of research on personality psychology. This will enrich the research on agile development. In the following section we discuss how FFM may be helpful in investigating conflict in agile teams by presenting related research from the fields of management and group research.

## **VI. FFM AND AGILE TEAMS**

Software development requires effective collaboration among persons with diverse skill sets and from different backgrounds. For example, a development team is likely to include technical professionals such as systems analysts, programmers, and database and network designers. This team has to collaborate with end-users from various functional units and organizational levels in order to develop and deploy an information system. Even though teams play a key role in the development of information systems, very few research studies have attempted to understand the software development team [Trimmer et al., 2002].

The diversity of skills and background among team members is a potential cause of conflict in a software development team [Trimmer et al., 2002]. Further, the roles and expectations of individual team members need not always be aligned with each other. For instance, the goals and expectations of systems analysts could be in direct conflict with those of end-users [Newman and Robey, 1992]. Similarly, the quality assurance engineer often has an adversarial relationship with developers [Cohen et al., 2004]. Hence, the software development process is inherently prone to conflicts.

The clear demarcation of roles and responsibilities laid down in the traditional plan driven software development process, to some extent, helps minimize the scope of conflicts and contains its adverse effects. Unfortunately, the nature of teamwork in agile methodologies calls for additional demands on the teams and its members and is likely to create additional stress, a potential source of conflict. In agile development, self-organizing teams with embedded customers are vested with much higher responsibility and decision-making powers. Simple and generative design, minimal documentation, continuous collaboration involved in developing code to functionalities prioritized by the customer representative, testing, refactoring, and frequent code releases all entail a highly stimulated and charged team environment. Practices such as pair programming, as in XP, also call for greater understanding among team members.

While low to moderate levels of conflict may contribute to enhancing the performance of an agile team, high levels of conflict are likely to be detrimental to team effectiveness [Domino et al., 2003]. The abilities of team members to cope with conflict depend on their personalities [Trimmer et al., 2002]. Knowledge, skills, abilities, and experience of members are the factors traditionally considered in forming software development teams. Due to the elevated risk of conflicts in agile teams, the personalities of team members may be an additional factor to be considered while creating successful agile teams. Unfortunately, very little research data are available to guide managers in scheduling successful agile teams based on the personalities of team members. Investigating the personality profiles of both successful, and not so successful, teams within the organization would be a logical first step. With cumulative evidence, organizations could fine-tune

their team-scheduling criteria. This stream of research will immensely benefit from using the FFM.

Two measurement approaches may be used for measuring personality traits of team members, elevation and variability. Elevation of a trait involves measuring the aggregated or average individual scores within an IS project team. Implicit in this approach is the assumption that the high score of a team member on a particular trait would compensate for the low score of another team member. Elevation may also be measured as the proportion of high scoring individuals in a team or as the highest or lowest trait level in a team. This is based on the notion that a single individual could significantly affect a group [Barrick et al., 1998]. Variability indicates the homogeneity or heterogeneity of a particular trait in a team and is measured as the variance or standard deviation [Peeters, 2006]. Popular team outcome measures include supervisor/observer ratings or objective determination of quantity and quality of team productivity, team member satisfaction, and team viability. Team viability captures the ability of a team to continue to perform as a unit [Barrick et al., 1998].

Personality traits of individuals are of interest in organizations both for their effect on individual job performance and on team processes/outcomes. While there have been several meta-analyses relating the big five personality dimensions and individual job performance [Barrick and Mount, 1991; Tett et al., 1991], the research on team composition in terms of personality traits and team performance is still in its nascence. The effect of personality composition of agile teams on team outcomes may be researched as an input-output approach using the big five dimensions. Some of the research evidence generated using this approach from management and small group research is briefly presented here along with implications for agile teams. The findings should however be treated as tentative requiring empirical confirmation in the agile context as the effect of personality on the team processes and outcomes is highly dependent upon the team task.

Neuroticism (or its converse Emotional Stability) is an important factor in the team context. Low levels of Neuroticism is related to cooperation and relaxed team atmosphere [Barrick et al., 1998], improved coordination, and stability within team [Neuman et al., 1999], task cohesion [Van Vianen and De Dreu, 2001] and team performance [Barrick et al., 1998; Kichuk and Weisner, 1998]. A recent meta analysis however failed to support the positive relationship of Emotional Stability with team performance [Peeters, 2006]. Variability in this trait may not be conducive to team working as even one emotionally unstable member could impair team performance by affecting cohesion and cooperation within team [Barrick et al., 1998; Neuman et al., 1999; Van Vianen and De Dreu, 2001]. However, evidence has been mixed in this regard with some studies finding support for such an effect [Neuman and Wright, 1999] while other studies reporting a positive effect of variability of Neuroticism on team performance [Mohammed and Angell, 2003]. Future research should help clarify the role of this important trait on team outcomes.

Extraversion of team members is considered important for facilitating social interactions of teamwork as Extraverts stimulate discussion [Mohammed and Angell, 2003] and create a climate for free expression [Barry and Stewart, 1997]. Too many extraverts in a team could however be harmful, as extraverts like teamwork primarily for the social interaction it affords. As extraverts tend to dominate, there could be team conflict. Hence elevation of Extraversion in a team is expected to have a U-shaped relationship with intermediate levels considered optimal for team performance [Barry and Stewart, 1997]. Variability of Extraversion is found to be positively related to performance [Neuman et al., 1999] though a recent meta analysis could not substantiate this finding [Peeters, 2006]. Agile teams with moderate elevation of Extraversion with a mixture of Extroverts and Introverts could be a good combination for optimal team performance.

Agreeableness is an important personality trait particularly in the team context. Elevation in Agreeableness is expected to promote interpersonal attraction [Neuman and Wright, 1999], cooperation [Barrick et al., 1998; Neuman and Wright, 1999], open communication [Neuman and Wright, 1999], group cohesion [Barrick et al., 1998], task cohesion, compliance with team goals [Van Vianen and De Dreu, 2001] and team performance [Barrick et al., 1998; Neuman and Wright, 1999;]. Variability in Agreeableness in teams is however considered detrimental to team performance [Peeters, 2006] as the presence of even one disagreeable team member could

disrupt cooperation [Barrick et al., 1998]. In agile teams presence of agreeable team members who are not very different from each other on this trait would be highly desirable.

Conscientiousness is found to be an important predictor of individual job performance [Barrick and Mount, 1991]. In teams, elevation in Conscientiousness promotes perseverance towards team goal completion [Neuman and Wright, 1999; Van Vianen and De Dreu, 2001], focus on and commitment to the task [Barry and Stewart, 1997] and team performance [Barrick et al., 1998; Neuman et al., 1999; Neuman and Wright, 1999; Van Vianen and De Dreu, 2001]. Lack of this trait may lead to social loafing [Neuman et al., 1999; Mohammed and Angell, 2003] while its variability in a team is expected to lower team performance [Barrick et al., 1998; Kichuk, 1999] as members high on this trait may detest loafing by low conscientious members. Conscientiousness is a positive personal trait for any work situations including agile teams.

Openness to Experience is used less frequently by researchers in teams. Researchers expect a positive relationship between elevation of this trait and team performance, but the research results so far have been mixed [Neuman et al., 1999; Van Vianen and De Dreu, 2001]. Also no clear benefits have been reported by any of the studies for either homogeneity or heterogeneity of this trait [Peeters, 2006].

## VII FUTURE RESEARCH DIRECTIONS

Studying the effect of personality traits on agile team outcomes using an input-output approach is a logical first step to gain preliminary insights. As we gain a better understanding of the impact of personality on agile team performance, researchers may use the input-process-output approach to get deeper insights about the intervening processes, as personality impacts team processes to a greater extent than team outcomes. Some process variables of interest in this regard include conflict [Trimmer et al., 2002], cohesion [Zaccaro, 1991; Barrick et al., 1998], collaboration [Vinokur-Kaplan, 1995], commitment, backing up behavior [Porter, 2005], communication, social integration [Smith et al., 1994], group potency [de Jong et al., 2005], team-member exchange [Seers et al., 1995], and interpersonal affect [Barry and Stewart, 1997].

As two individuals who score similarly on an FFM trait may differ substantially on some of its sub-traits, examining the differences in the effects of these sub-traits on team processes and outcomes is one possible research extension to the factor level studies. For example, Agreeableness has sub-traits of Straightforwardness, Altruism, Compliance, Modesty, and Tender-Mindedness. Any seeming discrepancies in the relationships at the factor levels could possibly be traced to differences at the level of sub-traits. Examining the interaction effects between factors is another logical extension. Though such interactions offer great promise, the complexity inherent in such studies could be truly daunting. Another interesting avenue to pursue is to design different measures for team level trait measurement to supplement the existing measures of elevation and variability.

As an illustration of current research in the FFM domain, we showcase a recent exemplary dissertation on personality composition of design teams by Miranda Peeters [Peeters, 2006]. This study included a meta-analysis on the effect of elevation and variability of FFM traits on team performance. The results of this meta-analysis suggest that elevation in Agreeableness and Conscientiousness positively relates to performance while variability in these traits negatively affects performance. The moderating effect of the type of team (students versus professionals) on the trait-performance relationship was also separately examined. The results show that performance of student teams is negatively impacted by both elevation and variability of Openness to Experience, while performance of professional teams is impacted negatively by only variability of this trait. To capture the design processes in multidisciplinary product design teams, a Design Behavior Questionnaire for Teams (DBQT) was designed and validated. DBQT measures twelve sub-categories of design behaviors and groups them under three broad categories of design creation, design planning and design cooperation. The study also examined the differences in the effect of personality traits of team members in two different phases of the design process, that is, the concept phase and the elaboration phase. Results suggest that elevation in Agreeableness mainly affects design processes in the concept phase (involving

information gathering) while Conscientiousness affects design processes in the elaboration phase (involving detailing and developing the design).

## VIII. CONCLUSION

The need to deliver high-quality software in a cost-effective and timely manner has ushered in a new breed of methods called agile or lightweight methodologies. These methodologies place a premium on people and their collaboration to foster creativity and rely less on rigid processes. Proponents of agile methodologies claim that these methodologies not only deliver high quality software within time and budget, but also that the development process contributes to higher satisfaction among developers. As we know from group research, the effectiveness of a team depends, among other factors, on the personalities of the team members. The abilities of individuals to collaborate effectively on problem solving tasks are influenced by their personalities. Researchers interested in studying agile teams and their effectiveness need to understand how to evaluate the personalities of agile team members. The fact that most programmers and many analysts are little accustomed to sustained collaborative efforts makes it all the more necessary for managers to appreciate the implications of personalities of IS personnel on their performance as agile team members.

This paper reviewed the extant research on cognitive dispositions and personalities of IS developers to foster our understanding of this research stream. It showed that scant attention has been paid to the issue of personality in software development teams. This finding is not surprising considering the fact that software development is perceived to be an individual effort. This perception, however, is changing with the advent of agile methodologies. The review also found that MBTI is the instrument of choice among researchers in this stream of research.

Our analysis of the Jungian typology vis-à-vis the FFM, in the context of studying agile software teams, demonstrates that FFM provides a more comprehensive measure of personality. We also present FFM related research from management and discuss its implications on studying agile teams. Though agile software development teams is the focus of interest in this paper, we feel that FFM could be the framework of choice to study personality of IS personnel in the context of other contemporary IS phenomena where interpersonal dynamics and personality variables are of interest. IS team success, effectiveness of virtual software teams, user acceptance of technology are some IS research areas that could potentially benefit from the adoption of FFM. Use of FFM by IS researchers will also open up the opportunity to draw on the findings of a large and growing body of research on personality psychology that relies on FFM.

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