ASSIGNING PRODUCT DEVELOPMENT ROLES TO SOFTWARE ENGINEERS BASED ON PERSONALITY TYPES AND SKILLS

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Software engineering is a scientific discipline that has come to prominence with its technical aspects. Human-related effects that are important in the software development process, but not technically defined, are often ignored. The software is essentially an abstract product produced by a person, and a number of factors affecting the human being directly or indirectly affect the software. Human behaviors, decision-making ability, problem solving ability, learning methods, human cognitive biases, professional skills and personality traits are the ones that affect people's work performance. In addition, factors such as stress, working environment, salary, harmony and meetings among team members are external factors that affect human performance and software development process. Therefore, to create productive software teams, it is important that assign right person to the right task position. Software life cycle is a series of stages and software engineers working every stage do different tasks. Each task requires its own skills were determined. In this study, the roles of software engineers and required skills for each role. International personality inventory was used to associate personality types with role skills in software development by matching personality and role skills. Then, an empirical study to validate the approach was carried out at a medium sized software company.

Keywords: Software engineering, Personality types, Software project roles, Personality skills.

Introduction

Software engineering can be defined as a chain of processes managed by experts to bring about a probing solution based on specific tools and methods. Software engineering provides not only software development, but also the continuity of software. In the field of Software Engineering (SE), non-technical effects that affect software are often ignored because software engineering is a science that stands out with its technical aspects. But social aspects are crucial for SE because software is developed for people and by people. Especially personality factor of human is becoming one of the important are of focus in SE in parallel with the acceptance of SE as social-technical issue.

Human behaviors, ability of problem solving and decision making, learning methods, cognitive biases, professional skills and personality traits are the ones that affect software development process. In addition, some factors such as stress, working environment and conditions, salary, meetings and team spirit are external factors that affect software development process. Therefore, human factors should not be ignored in order to improve work performance and achieve efficient business outcomes. Assigning right person to the right task position is important to create productive software teams. Software life cycle is a series of stages and software engineers working every stage do different tasks. Each task requires its

own skills. In this study, personality types and personal skills which are important factors and have a direct impact of software development life cycle have been examined. Software task roles and responsibilities of each role are defined, after that how the right person can be assigned to suitable project role based on their personality skills is revealed. Assignment of the right person to the right role directly affects the quality of software processes. This is important in terms of motivation of software engineers, software cost and planning. We used IPI (International Personality Inventory) test questions to associate with role skills. We carried out an empirical study to validate our method at a medium sized software company.

Literature Review

In the field of software engineering numerous academic and empirical studies have been carried out related to human and personality characteristics. The studies can be grouped under the personality characteristics, motivation, software complexity and program comprehension and the project meetings. Table 1 shows the studies carried out at last decade related to human factors in SE.

Dick and Zarnett studied on critical personality traits needed to successful pair programming. These features were defined as communication, comfort, trust and compromise [1]. Acuna and Juristo carried out a study on the assigning of people for suitable project roles. They used 16PF personality test in this study [3]. In studies of Karn and Cowling, it was revealed that software project teams could work satisfactorily despite their significant ethnic, religious and personality differences [5]. In the study of Chao and Atli, a link between the personality type and pair programming is not established [6]. In Cunha and Greathead's study, the ability to find the bugs in the code was associated with MBTI personality types. It has been found that individuals with the type of NT (Intuition-Thinking) personality type are more successful at detecting the code bugs [7]. O'Neill and Kline's empirical study with 87 people shows that the neurotism dimension which is one of the dimensions from five factor personality model plays an important role in task performance [9]. Salleh and his colleagues found that the differences in personality types do not have an impact on the academic performance of the students who working in pairs during programming [11]. In the study performed by Sfetsos et al., the personality types measured using the Keirsey Temparement Sorter personality test were found to be associated with pair programming success [12]. Feldt and colleagues when they are trying to find out the links between the types of personality and job attitudes of software engineers have shown that engineers with an extroverted personality type are more successful in planned work, engineers with an openness type of personality can take responsibility for the whole project [15]. Martinez and colleagues conducted a study on task assignment in software projects using the IPIP personality test [16]. Capretz and Ahmed used the MBTI personality test to theoretically identify suitable personality types for project roles [27]. Martinez and colleagues have developed an application for software engineering courses to be used in role assignment using fuzzy logic [21]. Capretz et al., demonstrated the effects of personality types in task selection in software projects [20].

Table 1. Studies on human-related features in the field of software engineering

Authors	Field of study	Year	Reference
Dick & Zarnett	Personality Traits	2002	[1]
Rilling & Klemola	Software Complexity and Program Comprehension	2003	[2]
Acuña & Juristo	Personality Traits	2004	[3]
Xu	Software Complexity and Program Comprehension	2005	[4]
Karn & Cowling	Personality Traits	2006	[5]
Chao & Atli	Personality Traits	2006	[6]

Cunha & Greathead	Personality Traits	2007	[7]
Beecham et al.	Motivation	2007	[8]
O'Neill,& Kline	Personality Traits	2008	[9]
Sharp et al.	Motivation	2009	[10]
Salleh et al.	Personality Traits	2009	[11]
Sfetsos et al.	Personality Traits	2009	[12]
Walle & Hannay	Personality Traits	2009	[13]
Acuña et al.	Personality Traits	2009	[14]
Feldt et al.	Personality Traits	2010	[15]
Martinez et al.	Personality Traits	2010	[16]
Bell et al.	Personality Traits	2010	[17]
Salleh et al.	Personality Traits	2010	[18]
Salleh et al.	Personality Traits	2010	[19]
Capretz & Ahmed	Personality Traits	2010	[20]
Martinez et al.	Personality Traits	2011	[21]
Misra & Akman	Project Meetings	2011	[22]
Rehman et al.	Personality Traits	2012	[23]
Salleh et al.	Personality Traits	2012	[24]
Kosti et al.	Personality Traits	2014	[25]
Cruz et al.	Personality Traits	2015	[26]
Capretz et al.	Personality Traits	2015	[27]

Methodology

In this study, a new method to determine appropriate task roles for software teams during software development life cycle was proposed. Assigning right person to the right task position is important to create productive software teams. We used Turkish version of IPI personality test questions to determine personality types to match personality skills and role skills. We carried out an empirical study at a medium sized software company to validate our method. Our study steps are as follows:

- Defining project roles of software engineers
- Determining required skills for each role
- Defining personality types using Turkish version of IPI personality test [29]
- Defining required skills of each personality type based on IPI test.
- Mapping personality types and project roles based on required role skills.
- Determining required personality type of each project role
- Conducting an empirical study to validate personality type – role mapping.

Software Development Life Cycle and Required Skills

In Software Engineering Body of Knowledge (SWEBOK) [15] the five basic phase of software engineering are defined as requirement analysis, system design, coding, testing and maintenance. The

requirement analysis simply refers to a limitation on system or a service that the system must provide [16]. In this phase, user needs are determined, essential features of system are defined and project boundaries are estimated. A feasibility report is an output of this phase. Management decides whether to proceed the project with this report. System analyst takes part in system design phase. All the components of system and the general structure are designed in this phase. With the help of information that revealed from the requirement analysis phase a design document is created. The document includes project purpose and scope, system design information, data models, user interface designs and UML (Unified Modeling Language) diagrams. System designer is responsible for this phase. In coding phase actual coding of software is started. The algorithms specified in the design phase are turned into codes. Programmers develop software in the direction of coding standards that determined by their organizations. If the design of software is done properly and detailed, code generation will be easier. Testing is an important activity in software development life cycle. In this phase, software is checked to see whether it behaves as intended. Potential software failures are identified at this stage. If any bugs are caught, it will be reported to the programmer. Testers are take role in this phase. The maintenance phase is the last phase of software development life cycle. After software is running maintenance can require in the direction of changing demands or business rules. In the maintenance phase, new features are added to software or some bugs are fixed. The main purpose is to provide the continuity of software. Maintainers take role in this phase.

System analyst deals with the problems about software project and produces the solutions. Therefore, *critical thinking, analyzing and problem solving skills* are essential for system analysts. System analyst should be in direct contact with customers, clients and the team which will design software. This contact requires frequent *communication*. System analyst has to able to deal with uncertainties. Therefore, he/she has to be *ready for re-plan and evaluate in a short time*. Also, the system analyst should have *leadership skills* because he/she assumes leading role in software team. The system analyst needs doing *empathy* to respond customer needs and understand problems with details. Looking from customer perspective provides to produce efficient solutions. In negative situations with customers, system analyst needs to be patient and soothe customers. So, *conciliation* is significant skill for system analysts.

During design process, system designers need to be contact with software developers and system analysts. Therefore, *communication skills* are needed. When designing the part of the software related to the end user, system designer should be *emphatic* to do user –friendly designs. The design refers to the entire system. So, the designer should be able to *see the big picture of the system*. Also, system designer should be *creative* and *imaginative* to model system. He/she is able to *do successful visuals, models and graphical designs* to figure the system. In addition to these, the system designer is able to *work in detail and carefully* not to miss important points during entire system design.

During coding phase, many programmatic and logical errors may be encountered. Programmers should be able to take quick action against to these mistakes. Therefore, they need *to think analytically and be solution oriented*. Also, programmers should be punctual for project deadlines and *manage time* to complete the work on time. Programming languages and tools are constantly changing and evolving. Therefore, programmers should be *open to learning* and nested with technology to follow recent software development

Testing activity requires *attention to details* to find bugs in software. Software tests should be done properly and detailed to ensure to complete project without error. Also, tester determines preferential properties for testing and test software in accordance with testing time. Therefore, *time management* is one of the important skills for testers. Testers need to think as customer during test. They should be testing software from customer perspective. Therefore, *empathy* is important skill for testers. Tester does documentation for stakeholders about testing process and test results. They maintain test result on database and share critical milestones such as testing timeline, budget and staffing with project managers. For these activities, *organizational skills* are needed.

Software field engineers (SFE) who are responsible for system maintenance should be able to comment on existing and old systems instead of new and abstract concepts. They make changes on existing codes therefore openness *to changes* is required skill. They should understand the existing system and *solve the complex problems* of users quickly and accurately. The maintainers provide coordination between business departments and clients. It requires organizational *skills*. They need to contact with other members of software team to decide required changes for software. Therefore, *communication* skill is important for maintainers. Table 2 shows the required personality skills for software project roles.

Table 2. Required personality skills for software project roles

Required Skills For System Analyst	Required Skills For System Designer	Required Skills For System Programmer	Required Skills For Tester	Required Skills For SFE
Critical thinking	Communication	Critical thinking	Studying detailed and carefully	Communication
Analyzing	Empathy	Problem solving	Empathy	Problem Solving
Problem solving	Seeing big picture	Analyzing	Time management	Organizational skills
Planning and evaluation	Creativity	Time management	Organizational skills	Operation in a complex system
Communication	Doing visual designs	Openness to learning		Openness to changes
Empathy	Careful and detailed study			
Leadership				
Conciliation				

International Personality Inventory

In the previous section, role skills for each project role are introduced. We need to determine personality skills to match personality skills and role skills. To do this, IPIP-NEO personality test was used. This test is used for measuring personality types. The decide personality skills we analyzed the studies related to personality types and psychology and revealed skills behind these types.

IPI is developed by Goldberg at the scope of the IPIP (International Personality Item Pool) project and accepted worldwide as one of the most highly regarded and accurate personality test [29]. This test is based on the five factor personality model. This model includes 5 different personalities. These are, Extraversion, Agreeableness, Conscientiousness, Openness to experience and Neurotism. There are 50 questions in short version of the test. This version was translated into Turkish by Guneri [29]. During translation 10 of the 50 questions were eliminated because of the validation and reliability reasons. There are positive and negative questions for measurement each of the personality types. All of the positive questions of neurotism type were eliminated during translation therefore we didn't use neurotism while mapping personality and software role skills.

Personality traits of these types are shown on Table 3.

Table 3. Personality Traits of IPI

Extraversion	Agreeableness	Conscientiousness	Openness to Experience
Talkative	Friendly	Organized	lntelligent
Brave	Kind	Resistant	Awake
Uproarious	Cooperative	Careful	Curious
Compelling	Unselfish	Responsible	Imaginative
Sociable	Responsive	Hardworking	solution- oriented
Natural	Honest	Effective	Deep-minded
Exhibitionist	Polite	Qualified	Artistic
Energetic	Forgiving	Cautious	Explorative
Adventurous	Helpful	Solicitous	Smart
Friendly	Satisfied	Punctual	Humoristic
Outspoken	Adoring	Practical	Creative
Loud-voiced	Nice	Excellent	Complex-thinker
Noisy	Kind-hearted	Sharing	Knowledgeable
Ambitious	Sympathetic	Cautious	Intellectual
Dominant	Reliable	Serious	Multidirectional
	Generous	Economical	Original
	Thoughtful	Reliable	Cultured
	Compatible	Businesslike	Analytical

Personality types for IPI are briefly explained below [30].

Extraversion: Extraverts get their energy from interacting with others, while introverts get their energy from within themselves. They are energetic, talkative, and assertive.

Agreeableness: Individuals with high agreeableness are friendly, cooperative, and compassionate. People with low agreeableness may be more distant.

Conscientiousness: People that have a high degree of conscientiousness are reliable and prompt. Traits include being organized, methodic, and thorough.

Openness to Experience: People who like to learn new things and enjoy new experiences usually score high in openness to experience. Openness includes traits like being insightful and imaginative and having a wide variety of interests.

Determining Appropriate Personality Type for Software Project Roles

Required role skills and personality skills and characteristics of IPI personality types are shown in Table 4. We chose skills similar to software project role skills between them. Required skills for software project roles are matched suitable personality types based on personality traits of Five Factor Model.

Table 4. Required skills for software project roles are mapped suitable personality type

Required Role Skills	Personality Skills	Analyst	Designer	Programmer	Tester	Maintainer	Personality Types
Communication	Talkative, Sociable	X	X			X	Extraversion
Planning and Evaluation	Organized	X					Conscientiousness
Leadership	Sociable, Dominant	X					Extraversion
Critical Thinking and Problem Solving	Analytical, Solution Oriented	X		X		X	Openness
Conciliation	Cooperative, Unselfish	X					Agreeableness
Visual Design	Creative		X				Openness
Creativity	Creative		X				Openness
Empathy	Unselfish	X	X		X		Agreeableness
Seeing Big Picture	Imaginative		X				Openness
Carefully and Detailed Study	Careful ,Organized		X		X		Conscientiousness
Analyzing	Analytical	X		X			Openness
Time Management	Punctual			X	X		Conscientiousness
Willing to learn	Curious			X			Openness
Organizational Skills	Responsible, Organized, Business-like				X	X	Conscientiousness
Operation in complex system	Complex Thinker					X	Openness
Openness to change	Curious					X	Openness

We have identified a type of personality for each role based on role skills and personality types. We developed a model based on the dominance of personality types that match software project roles. Number of personality types refers to the dominance. We have arranged personality types in ascending order. We will explain suitable personality types arrangement for each project role. Tables 5 thru 9 shows the personality types for each software role skills.

Table 5. Personality Types for System Analyst

Required Role Skills	Personality Types
Communication	Extraversion
Planning and Evaluation	Conscientiousness
Leadership	Extraversion
Critical Thinking and Problem Solving	Openness
Conciliation	Agreeableness
Empathy	Agreeableness
Analyzing	Openness

For system analysts, Extraversion, Conscientiousness and Openness are right personality types. If we define a weighting methodology or function for each of the personality types Extraversion(E), Openness(O), Agreeableness(A) and Conscientiousness (C), we can define the personality type best fit for the system analysists. For the simplicity we use a linear weighting. This weighting shows that Extraversion, Openness and Agreeableness have equal weights. Therefore, we can form suitable personality types for this role like that: EOAC, EAOC, OAEC, OEAC, AEOC and AOEC.

Table 6. Personality Types for System Designer

Required Role Skills	Personality Types
Communication	Extraversion
Visual Design	Openness
Creativity	Openness
Empathy	Agreeableness
Seeing Big Picture	Openness
Carefully and Detailed Study	Conscientiousness

For system designer Extraversion, Openness, Agreeableness and Conscientiousness are right personality types. If we define a weighting methodology or function for each of the personality types Extraversion(E), Openness(O) Agreeableness(A), Conscientiousness (C), we can define the personality type best fit for system designer. For the simplicity we use a linear weighting. This weighting shows that This weighting shows that Openness is the most weighting personality type for System Designer. Extraversion, Conscientiousness and Agreeableness have equal weights. Therefore, we can form suitable personality types for this role like that: OEAC, OECA, OACE, OAEC,OCEA,OCAE.

Table 7. Personality Types for Programmer

Required Role Skills	Personality Types
Critical Thinking and Problem Solving	Openness
Analyzing	Openness
Time Management	Conscientiousness
Willing to learn	Openness

For programmer Openness and Conscientiousness are right personality types. If we define a weighting methodology or function for each of the personality types, we can define the personality type best fit for programmer. By using a linear weighting Openness is the most dominant personality type for programmer. There is no skill matching with Conscientiousness and Agreeableness personality types. Therefore, we can form suitable personality types for this role as OC.

Table 8. Personality Types for Tester

Required Role Skills	Personality Types
Empathy	Agreeableness
Carefully and Detailed Study	Conscientiousness
Time Management	Conscientiousness
Organizational Skills	Conscientiousness

For testers Agreeableness and Conscientiousness are right personality types. If we count each of the personality types. With use of linear weighting Conscientiousness is the most dominant personality type for tester. There is no skill matching with Extraversion and Openness personality types. Therefore, we can form suitable personality types for this role as CA.

Table 9. Personality Types for SFEs

Required Role Skills	Personality Types
Communication	Extraversion
Critical Thinking and Problem Solving	Openness
Organizational Skills	Conscientiousness
Operation in complex system	Openness
Openness to change	Openness

For maintainer and Extraversion, Openness and Conscientiousness are right personality types. If we use linear weighting, Openness is the most dominant personality type for SFE. There is no skill matching with Agreeableness personality type. Therefore, we can form suitable personality types for this role as OCE or OEC.

Empirical Study

We carried out an empirical study to validate our method at a medium sized software company using IPI personality test. We asked them to reply survey questions from surveey.com. The study includes 88 participants. The demographic information of participants was not considered since it is considered as irrelevant for this study. 51 out of 88 of participants were software developers and 37 out of 88 were system analysts. We grouped software engineers for appropriate roles based on their personality skills.

The Likert scale where 1-strongly disagree 2-disagree 3-undecided 4-agree 5-strongly agree was used. For given answers we have defined the personality types of participants. Then we have classified

the participants according to their personality type. It has been observed that some participants are suitable for more than one project role. For example, a person can suitable for programmer and system designer at the same time. Table 10 shows distribution of project role between participants.

Table 10. Results of empirical study

Software Project Roles	Programmer	System Analyst
System Analyst	1	0
System Analyst-System Designer	6	3
System Designer	14	12
Programmer - System Designer	11	8
Tester	4	2
Maintainer – Programmer – System Designer	1	1
Programmer - Maintainer	0	2

Openness is the most common personality type among participants as first ranked personality type. Distribution of personality types at first-order like that: 72% openness, 19% agreeableness and 9% conscientiousness. We have observed that 66 out of 88 participants (74%) are correctly matched with the actual roles in projects they have already involved.

Conclusions

As in many studies personality types are not enough to identify appropriate role for each software engineer. We matched role skills and personality skills therefore the results are more effective. It has been observed by matching of personality types and project roles that openness is the most dominant personality type for all project roles. Openness personality type refers to person willing to learn new things, solution oriented, creative, complex thinker and analytical. Therefore, all of these traits are required for software project roles. System analyst has 3 dominant personality types. This shows that, system analysts should have multi directional personality. They work as decoder between customers and technical team. Therefore, they need to understand both sides. Some participants are suitable for more than one project roles such as programmer – system designer, system analyst- designer, maintainer - programmer – system designer and programmer - maintainer. It means that, project managers can choose these people for different project roles as needed. Software project managers can use this method to make right decisions for assigning team members on projects. Assigning the right role to right person decreases software cost and increases team performance.

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