What's Personality Got to Do with It? A Case Study on the Impact of Personality on Requirements Engineering-related Activities

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ABSTRACT

Requirements engineering (RE) comprises human-centric activities requiring collaboration between different software development team roles. While prior research highlights the impact of personality on software development, there is limited empirical evidence on how team members' personalities affect RE. To address this gap, we conducted an exploratory case study in an 11-member software development team, observing 28 team meetings, conducting follow-up interviews, and analyzing the personality profiles of team members using the IPIP-NEO 120 assessment tool developed based on the standard five-factor model of personality. Analysis of the observed meetings and follow-up interviews revealed the potential impacts of team members' diverse characteristics on RE-related activities, along with a set of strategies that may be helpful in overcoming challenges due to team members' diverse characteristics. The personality test scores revealed that most team members obtained high scores on personality traits such as agreeableness, conscientiousness, and openness to experience but had average scores for extraversion and neuroticism. By integrating the findings from observations and interviews with team members' personalities, we found potential impacts of certain personality characteristics on RE-related activities. These findings may provide guidance for software teams looking to manage the impact of team members' diverse personalities on RE-related activities and for future researchers investigating these impacts in different contexts.

CCS CONCEPTS

• **Software and its engineering → Requirements analysis**; **Collaboration in software development**; **Software development techniques**.

KEYWORDS

Requirements Engineering, Software Engineering, Human Aspects, Personality, Team Collaboration

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1 INTRODUCTION

Software engineering (SE) comprises various interconnected activities, one of the most crucial being RE-related activities such as eliciting, analysing, prioritizing, and managing requirements [38]. It is widely acknowledged that inadequate performance during RE-related activities can make a software project highly vulnerable, e.g., inaccurate, incomplete or plain wrong software requirements [38] [39]. To ensure the success of RE-related activities, it is necessary to comprehend the needs of users, customers, and other stakeholders, grasp the contexts in which the software is to be developed, model, analyze, negotiate, and validate the requirements, and manage incremental changes to the requirements [10] [37] [46]. RE has evolved into a highly iterative and collaborative process where RE-related activities occur throughout the software development life-cycle, not just at the beginning of a project. This makes RE-related activities rely heavily on diverse team roles, such as business analysts, software developers, testers, customers, end users, and product owners [8] [40] [44]. Hence, effective collaboration between these individuals in these diverse roles in a software team is critical [52]. In other words, it is important to consider the influence of human aspects of the software team members on RE-related activities and project progress. Therefore, we initially conducted a systematic literature review (SLR) and identified *personality* as one such human aspect worthy of consideration [15]. Further, to determine whether our SLR findings are in line with the real-world experiences of software practitioners, we conducted studies to identify the most influential human aspects when involved in RE-related activities, where personality has been identified as one [16] and the impact of personality could be either positive or negative [17].

Personality is commonly referred to as *individual differences* with no universal accepted definition [13]. In our study, we used the definition by Mischel et al. *"a set of individual differences including personal habits, skills, memories, behaviours and social relationships that can be affected by the socio-cultural development of individuals"*

[31]. Personality can affect the efficacy of collaboration and lead people to perform less effectively in software-related and other activities [7] [14] [30] [35]. While investigating personality impact on software development has become a popular research area over the years, the majority of the studies have focused on general software development [54], specific practices such as pair programming [42] and software testing [23], or exclusively on SE education [12], with limited attention on RE-related activities [22]. As RE-related activities are considered to be one of the most human-centric and socio-technically intensive activities within SE [2], it is important to understand how software team members' personalities impact RE-related activities and the overall software development process and outcomes in the real-world industry environment [22] [48].

Inspired by the findings of our prior studies, we wanted to try to identify how software team members' diverse personalities might influence RE-related activities and the overall project. In particular, we aimed to answer the broad research question **How do the personalities of software team members influence RE-related activities?** To answer this research question, we conducted an exploratory case study [41] with a software development team of a public organization in Australia. We conducted observations of team meetings, follow-up interviews, and a personality test of team members with the aim of understanding how the team members' personalities influence their tasks, specifically focusing on RE-related activities. The software development team we studied consisted of eleven software practitioners who develop software systems and services for the education domain. We observed 28 meetings of the team, which included daily stand-ups, sprint planning, story walk-throughs and sprint retrospectives. After the observations, we conducted six follow-up interviews, including all team members who were mainly involved in RE-related activities (e.g., lead business analyst, senior business analyst, business analyst). We used socio-technical grounded theory (STGT)'s data analysis techniques of open coding, constant comparison, and memoing [18] to analyse observation and interview data to inductively identify potential impacts of personality-related characteristics in RE. We also collected their personality profiles via the IPIP-NEO 120 personality test based on the well-known five-factor model (FFM) of personality as a self-assessment of their personality and used the ranking scores defined in the IPIP-NEO 120 test to analyse the personality test data [21]. The integrated findings of our study show how the diverse personalities of software team members might influence RE-related activities. We also found various strategies used by the team members to mitigate perceived challenges due to the personality differences of the team. This research makes the following key contributions:

- we identify the potential impacts of team member personalities on RE-related activities and project progress;
- we develop a set of strategies for software teams to manage the impact of diverse personalities on their conduct of RE-related activities; and
- we provide a set of recommendations for software practitioners and researchers for future research into incorporating consideration of team members' personalities to improve RE-related activities software development in general.

2 BACKGROUND AND MOTIVATION

Investigating the impact of personality in software engineering has been a research topic for many years [12]. Various systematic mapping studies and literature reviews show that the majority of this attention has been given to several software development phases [5] [12] [13], where personality impact on pair programming [42] [43] [51], and personality impact on SE education [25] [32] [33] have been identified as the most recurring research topics. Other studies have been conducted to identify the personality impact on software testing [23] [45], decision-making style [28] [30], team climate [50] [47], and project success [53], focusing on software professionals. The reported findings of these studies indicate that the personalities of software team members significantly impact their team performance. Some studies [53] highlight the need to focus more on relationships between personality and diverse SE activities of team members, as research has only focused on the relationship between personality and project success. For example, [24] and [1] identified significant relationships between personality and work preference and job satisfaction. An SLR [47] provides insights into research on the effects of software engineers' personalities on their team performance and project success.

To date, limited studies have been conducted on the impact of personality on RE-related activities [12] [15]. Those that have tended to be investigations that concentrate on the impact of personality on identifying effective personality types for web development [4], with a few studies limited to the specific RE activity of requirement elicitation [26] [34]. Practitioners have reported that diverse characteristics, behaviours, personal habits, and skills of individuals involved in RE-related activities impact RE [3] [16] [34] [36]. From our prior studies, we identified that practitioners have rated personality as one of the most influential human aspects affecting RE-related activities, but very few empirical studies have been done to investigate personality impact on RE-related tasks [16] [17]. This limited set of previous works and the findings of our prior work on the influence of personality on RE-related activities motivated us to undertake an observational study. We want to provide insights into what these impacts are, how industry practitioners manage these impacts and what approaches they use to improve positive impacts and overcome potential challenges of diverse team personalities.

3 RESEARCH METHODOLOGY

This research uses an exploratory case study approach [41] to investigate how diverse personalities influence RE-related activities and to identify how we can improve RE by considering personality influence. The study was led by inductive qualitative approaches in the form of observations and interviews and corroborated by quantitative personality test results. Figure 1 shows the design of our study.

3.1 Study Design

3.1.1 The Case Company. After obtaining human ethics approval from our university[1], we contacted potential organizations and shared our study proposal. Two organisations expressed their interest in our study. Our primary criterion for this case study was to select a software development team actively following the software

[1]Monash Ethics Review Manager (ERM) reference number: 29072

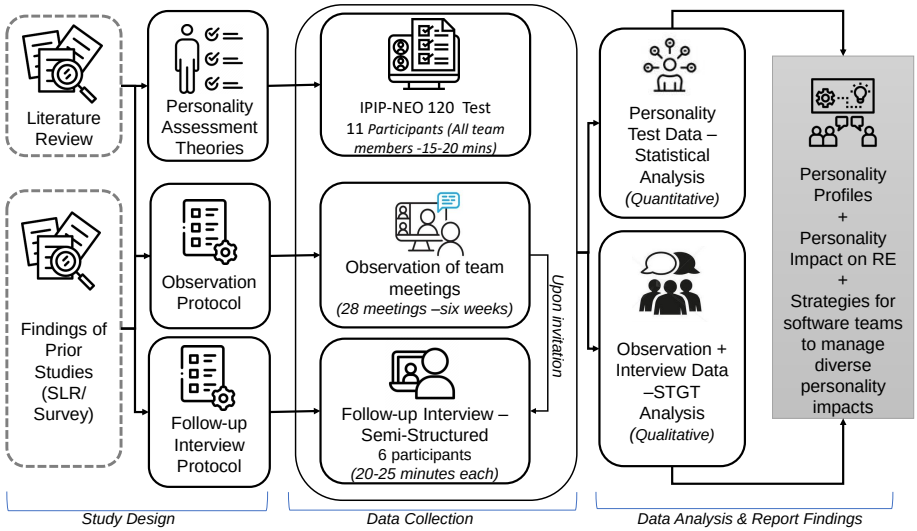

Figure 1: Overview of the Research Methodology

development process, including RE, and with considerable team size. This would enable us to investigate how different personalities influence the software development process, mainly focusing on RE-related activities. The selected case company is a large public organization in Australia and has significant SE operations. The organization mainly operates in the education sector, developing in-house software applications and offering various IT support services to diverse stakeholders. These include full-time/casual staff, students. Within the observed period, the team was working on a project for automating casual staff working hours based on their allocated work. Applying purposeful convenience sampling, we chose this company as they were highly interested in the study, had a large, diverse team available and provided their consent expressing their willingness to participate.

3.1.2 Observation study and follow-up interviews. : We designed our observation protocol[2] following the protocol proposed by Sprad -ley [49]. Our focus was to gather detailed information about each observed meeting. For our interviews, we developed a semi-structured interview protocol to obtain the software team members' perspectives on personality and its impact on RE-related activities, including their experiences working with their current team. The interview questions were related to their perceptions of how personality influences RE and their experience of working with diverse personalities when involved in RE-related activities. The semi-structured interview protocol is available in our repository[3].

3.1.3 Personality Test. To assess the personalities in our target software development team, we utilized the IPIP-NEO 120 personality test. This widely recognized test is based on the Five-Factor Model (FFM) of personality, a well-established framework in psychology and frequently used in software engineering studies [5] [54]. The FFM categorizes personality into five primary traits: *Openness to Experience, Conscientiousness, Extraversion, Agreeableness,* and *Neuroticism*, each comprising six subcategories ("facets"), totalling 30 facets in all. These facets help to increase the precision and scope of FFM, thus enabling more accurate predictions [11]. The five main traits can be explained in short as follows [27];

- **Openness to Experience:** individuals' intellectual, cultural or creative interests. High-scored individuals tend to be imaginative, broad-minded and curious. Those at the opposite end of this spectrum usually show a lack of aesthetic sensibilities, favouring conservative values and preferring routine.
- **Conscientiousness:** refers to individuals' focus on achievements. High-scored individuals tend to be hardworking, organized, able to complete tasks thoroughly on time, and reliable. Low-scored individuals tend to be irresponsible, impulsive and disorganized.
- **Extraversion:** relates to the degree of sociability, activeness, talkativeness, and assertiveness. The opposite end of this spectrum shows a lack of social involvement, shyness, and prefers to be alone more than extraverted people. But, this does not mean that they are unfriendly or antisocial; rather, they are reserved in social situations.
- **Agreeableness:** refers to positive traits such as cooperativeness, kindness, trust and warmth. Low-scored individuals on agreeableness tend to be sceptical, selfish and hostile.
- **Neuroticism:** refers to the state of emotional stability of individuals. Low-scored individuals tend to be calm, confident and secure, whereas high-scored individuals on neuroticism tend to be moody, anxious, nervous and insecure.

A detailed explanation of these five traits and their associated facets can be found in the sample personality profile (Appendix D) provided in our repository[4].

[2]https://zenodo.org/records/10565707 (Appendix A)
[3]https://zenodo.org/records/10565707 (Appendix C)
[4]https://zenodo.org/records/10565707 (Appendix D)

The standard personality test (IPIP-NEO 120) is a self-assessment quantitative instrument which is developed to operationalize the FFM of personality as a freely available instrument in the International Personality Item Pool (**IPIP**). We chose to use this specific personality test (IPIP-NEO 120) because of its open-source nature, user-friendliness, and higher reliability than other tests based on the FFM of personality. The test comprises 120 statements/items, and participants are required to indicate how accurately each statement describes them using a five-point Likert scale ranging from "very accurate" to "very inaccurate." For instance, the first statement is *"I worry about things"*, and participants must indicate how closely it relates to them via a Likert scale from "very accurate" to "very inaccurate". Each statement is linked to a specific personality trait and facet that describes an individual's personality. This personality test was distributed as an online survey designed using the *Qualtrics* platform, and apart from the 120 statements, it included basic demographic questions such as age range, gender, educational qualification, work experience, a summary of job responsibilities, and how frequently they engage in RE-related activities to understand their involvement in RE. The personality test used is available in our repository[5].

3.2 Data Collection

Upon receiving consent from all team members, we recruited a software development team from the above-mentioned organization that follows an agile approach using Scrum. The team consisted of 11 software practitioners working in diverse roles centred on developing a Curriculum Information Management software for the organization. We observed 28 team meetings for six weeks, including daily stand-ups, sprint planning, story walk-throughs, and sprint retrospectives. The observations took place during a transition period as the team members returned to the office after the COVID-19 pandemic, with some members joining from home and others from the office via Zoom in a hybrid situation. Table 1 summarises the investigated team's demographics and abiding by our human ethics approval guidelines; the organisation's and the team's details have been kept confidential.

The first author attended all 28 meetings remotely as an external observer, taking all the field notes following the observation protocol and engaged in several email discussions for clarifications. Meetings varied in duration, including daily stand-ups (10-20 minutes), sprint retrospectives (30-40 minutes), story walk-throughs (over 1 hour), and sprint planning (over 2 hours). Follow-up interviews, lasting around 20-25 minutes. Upon our invitation, 6 out of 11 team members provided their consent to participate in the follow-up interviews, including the lead, business analyst, senior analyst and business analysts and provided their perspectives on personality's influence on RE. All observed meetings were video recorded, and interviews were audio recorded with participants' consent. Apart from the recordings, the personality test, shared at the beginning, took 15-20 minutes for team members to complete at their convenience. Completed tests were collected at the end of observations and analysed at the end to avoid being led by those results in our inductive qualitative analysis. Table 2 summarises our study data collection.

[5]https://zenodo.org/records/10565707 (Appendix B)

Table 1: Demographics of the participants (*P-ID: Participant ID, *Ex. in SE: Experience in the software industry, INT: Follow-up interview participants)

P-ID*	Job Role/ Title	Age Range	Gender	*Ex.in SE (yrs)
P1-INT01	Lead Business Analyst	Above 50	Male	More than 10 years
P2-INT02	Business Analyst	21-30	Male	Between 1-5 years
P3-INT03	Iteration Manager Lead Agile Facilitator	31-40	Female	Between 1-5 years
P4-INT04	Software Engineer	31-40	Male	More than 10 years
P5	Quality Engineer	21-30	Male	Between 1-5 years
P6-INT05	Business Analyst / Senior Admin. officer	31-40	Female	Between 1-5 years
P7-INT06	Senior Analyst	41-50	Male	More than 10 years
P8	Senior Integration Developer	31-40	Male	More than 10 years
P9	Senior Automation Engineer	31-40	Male	More than 10 years
P10	Software Engineer	41-50	Male	More than 10 years
P11	Senior Quality Engineer	31-40	Male	More than 10 years

Table 2: Summary of data collection - Observed meetings and Follow-up interviews

Overall Meeting Count	Types of Meetings	Average Meeting Duration	No. of Follow-up Interviews	Interview Duration
28 Meetings	Daily Stand-ups (16) Sprint Planning (02) Story Walk-throughs (07) Sprint Retrospectives (03)	15-25 mins >2 hrs >1 hr 30-40 mins	06 Interviews	20-25 mins each

3.3 Data Analysis

Both qualitative and quantitative data were collected in our study. The analysis was led by inductive analysis on the qualitative data followed by statistical analysis of the quantitative data. We first conducted the **Qualitative data analysis**, where we employed *socio-technical grounded theory (STGT) for data analysis* procedures [18]. This method was selected for its suitability for analyzing the unstructured, open-ended data such as was gathered from observations and interviews and for gaining insights in socio-technical

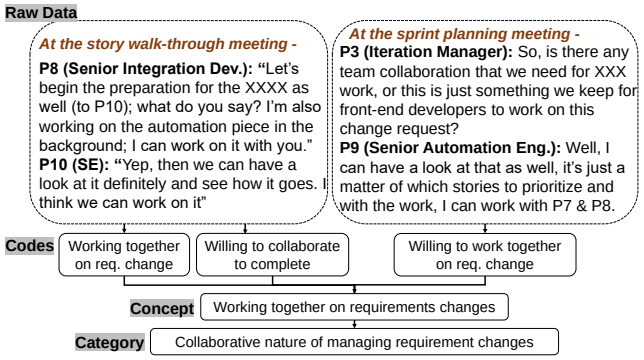

Figure 2: Example of qualitative STGT data analysis

contexts, such as our study on the impact of personality in RE-related activities. We used **otter.ai**, an online transcription tool, to transcribe the observed team meetings and interview sessions with participants' consent and stored and analyzed the data using **NViVo**. We followed an open coding approach and utilized constant comparison and memoing techniques to generate socio-technical concepts and categories. We grouped similar codes to define various concepts and then identified and grouped these concepts into categories. Figure 2 shows an example of the STGT qualitative data analysis conducted in this study. We used STGT to obtain an exploratory understanding of the potential impacts of personality on RE. As part of it, while following the open coding, we wrote *memos* that were helpful in recording key insights in identifying potential influences of personality-related characteristics on RE-related activities and practices in the team. An anonymous example of our codebook and a memo can be seen in our repository[6]

Quantitative data was collected through the personality test, and analysis was carried out using the standard personality test analysis method specified in IPIP-NEO 120 personality test (**IPIP**)[7]. Microsoft Excel was used to analyze the data, and the personality trait and facet scores were presented as percentages. The personality test scores of each individual were then categorized into "low", "average", and "high" for each factor and facet, based on whether the score was approximately in the lowest 30%, middle 40%, or highest 30% of the scores. This categorization assisted in identifying the level of each personality trait of an individual. The results obtained from the analysis of the participant personality profiles are discussed in section 4.2, and an anonymous example of a personality profile can be seen in our repository[8]. The personality test was conducted as a self-assessment separate from our observations and interviews and was analysed at last. It was used to obtain insights into the team members' personalities. It served to corroborate our qualitative findings by helping us map the researcher-defined concepts and categories identified via STGT data analysis with the personality traits and/or facets defined by the personality test. We illustrate the integration of the different data sources – observations, interviews, and personality tests – in section 4.3.

[6]https://zenodo.org/records/10565707 (Appendix E)
[7]https://ipip.ori.org/
[8]https://zenodo.org/records/10565707 (Appendix D)

4 FINDINGS

4.1 Demographics of the Participants

Table 1 summarizes the demographic information of all eleven team members. The majority (n=9) of the team members were men. The age and experience distribution within the team was diverse, with six members falling within the age range of 31-40 years and having over a decade of experience in the software industry. Notably, two team members, specifically P1 (Lead Business Analyst) and P7 (Senior Analyst), possessed over 25 years of industry experience, with more than two decades dedicated to RE. Almost all team members (n=10) reported daily involvement in RE-related activities, including requirement elicitation, analysis, prioritization, and management, as part of their job roles. Only P5 (a quality engineer) indicated that he was *very rarely* involved in RE-related activities. Among these, the lead business analyst (P1), senior analyst (P7), business analysts (P2, P6), and software engineer (P10) indicated that they *always* or *very often* collaborated with stakeholders to elicit requirements and were involved in requirements analysis, prioritization and managing requirements throughout the project. The other team members, such as the iteration manager (P3), software engineer (P4), and quality engineer (P5), indicated that they were sometimes or *rarely* involved in these activities, whereas the senior

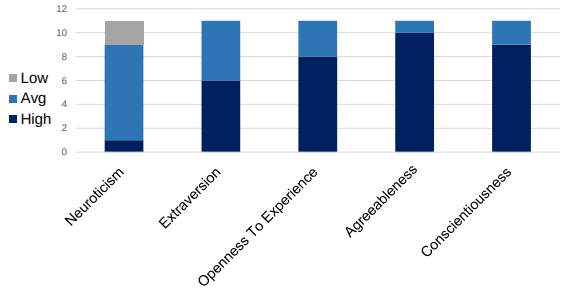

Figure 3: Summary of personality profiles of team members

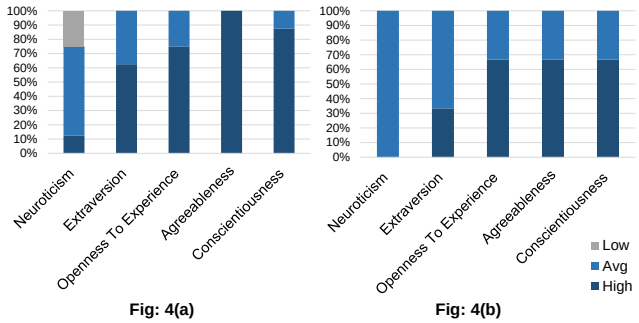

Figure 4: Personality profiles vs involvement of RE-related activities:(a): The team members always/ very often involved in all sorts of RE-related activities; (b): The team members sometimes/ rarely involved)

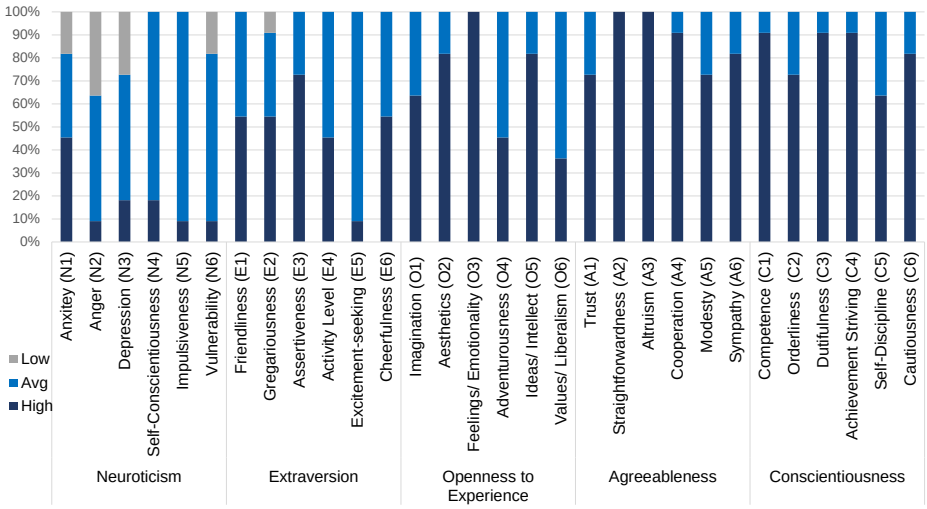

Figure 5: Variation of the facets of the Personality traits/dimensions of the participants

integration developer (P8), senior automation engineer (P9) and senior quality assurance engineer (P11) indicated that although they *rarely* collaborated with stakeholders, they were *always* involved in analysis, prioritization and managing the requirements throughout the project. This indicates that the majority of the team members were involved in RE-related activities, and their involvement varied throughout the project.

4.2 Personality Profiles of the Participants

Figure 3 summarises the personality profiles of the team members that were collected via the IPIP-NEO 120 personality test. Even though the personality test results were analysed last, we present the results first here as it provides relevant personality vocabulary such as the traits (e.g. *agreeableness*, *conscientiousness*) and facets (e.g. *friendliness, cheerfulness*) and helps make sense of the integrated qualitative and quantitative findings described next.

A majority of the participants (90.9%) obtained high scores for the personality traits of *agreeableness*, *conscientiousness* (81.8%) and *openness to experience* (72.7%), whereas only 54.5% (n=6) obtained high scores for the *extraversion* trait. Referring to the *neuroticism* trait, the majority (72.7%) obtained an average score, whereas 18.1% (n=2) obtained low scores. *Neuroticism* is the only trait where the participants obtained a low score. Among these, the team members who are always or very often involved in all sorts of RE-related activities (e.g. requirements elicitation to management) tend to have the highest scores in *agreeableness* and *conscientiousness* traits. As shown in Figure 4, all of them obtained high scores in agreeableness followed by conscientiousness and openness to experience (Figure 4(a)). Others who are sometimes or rarely involved in RE-related activities tended to have lower scores (Figure 4(b)). Each personality trait has six additional *facets* that can be used to describe each of the five personality traits in detail. Hence, an individual's personality can be described with five personality traits and thirty facets. Figure 5 shows the detailed analysis of the personality profiles of 11 team members, taking both personality traits and respective facets into account. The facets related to *agreeableness*, *conscientiousness* and *openness to experience* were found to be significantly high among all team members, whereas two facets that describe the *agreeableness* trait, straightforwardness (A2) and altruism (A3), and feelings/emotionality (O3) in the *openness to experience* trait, had high scores for all team members. 90.9% of the team members (n=10) had a high score in cooperation (A4) facet within the *agreeableness* trait, and competency (C1), dutifulness (C3), and achievement-striving (C4) facets within *conscientiousness* trait.

In contrast, facets related to *extraversion* had a more mixed set of high and average scores. For example, for facets such as friendliness (E1), gregariousness (E2), activity level (E4), and cheerfulness (E6), nearly half of the team members (54.4%) had a high score, and the rest had an average score. Only assertiveness (E3) and excitement-seeking (E5) had a huge difference, where the majority (72.7%) scored high for assertiveness and average (90.9%) for excitement-seeking. Referring to the *neuroticism* trait, the majority of the facets had average scores, and for facets such as anxiety (N1), anger (N2), depression (N3) and vulnerability (N6), some of the team members had low scores (e.g., P9 and P10). The majority of the team members (n=9 and n=10 respectively) had an average score for self-conscientiousness (N4) and impulsiveness (N5) facets in the *neuroticism* trait. None of the facets of *extraversion* and *neuroticism* reached the level of scores of the facets under *agreeableness*, *conscientiousness* and *openness to experience*. Specifically, among the team members who collaborated with stakeholders to elicit requirements (e.g., Lead business analyst (P1), senior analyst (P7), and business analyst (P6, P2)), the majority (three out of four of them) were identified to have a high score in *agreeableness*, *conscientiousness* and *openness to experience* and the average score in *extraversion*.

4.3 Impact of Personality on RE-related Activities

Through six weeks of regular observation of team meetings and in-depth follow-up interviews with team members, we identified

five areas in which diverse personalities within the team might positively impact RE and task completion. We illustrate these impacts with original quotes from the observed meetings and interviews. When we compare these categories with measured personality traits/facets, we can observe that they align with the personality traits/facets we mapped post the inductive STGT data analysis.

4.3.1 Collaborative nature in managing requirements changes. Collaboration plays a key role in any teamwork, and from the observed meetings, we identified that team members' *collaborative nature* and their willingness to work together *cooperatively* impact positively on managing requirement changes. For example, at one of the observed story walk-through meetings, the team discussed a few change requests from the stakeholders. P10 (software engineer) agreed to work on the change and discussions were focused on when to start working on the changes with his current work in the sprint. The senior integration developer (P8) expressed his willingness to work together to finish the changes within the same sprint: *"P8 - Let's begin the preparation for the X feature as well (to P10); what do you say? I'm also working on the automation piece in the background; I can work on it with you. P10 - Yep, then we can have a look at it definitely and see how it goes. I think we can work on it"* This suggests that cooperative behaviour impacts managing the requirements of the project. This characteristic can be directly referred to as the compliance/cooperation facet of the **agreeableness** trait. From their respective personality profiles, both team members scored high (90%) for the cooperation facet (A4) in their personality profiles. Apart from these, there were diverse scenarios where both P8 and P10 expressed their willingness to work collaboratively on various tasks, especially when they needed clarity of an allocated task (e.g., P9 - software engineer) or testing a completed task (P5 - quality engineer), either in daily stand-ups or story walk-through sessions. Compared to P8 and P10, team members who obtained lower scores for the cooperation facet seemed to wait until other team members offered their preference to work collaboratively on their allocated tasks in the aforementioned meetings rather than initiating a collaboration.

4.3.2 Organized & responsible nature on validating and managing requirements. From the observed meetings, we identified that the organized nature of the team members was helpful in managing requirements in a sprint. The organized nature of the team members was also seen to vary from one to another. For example, P7, the senior analyst in the team, seems to be well prepared to plan the sprint with detailed information about the workload and the time frame of the project: *"(talking to P1, the lead business analyst), I would like to add X task into the next sprint, we know what works to be done in the next couple of days and how much work there is, and how long it will take, so we can plan it ahead" - P7 at the story walk-through meeting.*

This is also supported in the follow-up interview we conducted with P7 (INT06), as he explained that his nature of wanting to work for a plan is helpful in managing the requirements in each sprint and working on grooming stories for the upcoming sprints. Further, the responsible nature of team members is also helpful in validating and managing the requirements in the sprints. For example, when there is an unclear requirement, the lead takes the responsibility of making it correct, irrespective of the extra work that has to be done to implement the correct function: *".. then keep it for now, I will talk to X further about this, I'm fine even to move it to the next sprint because we have to make the accurate function" - P1 (Lead business analyst at a daily stand-up meeting).* These characteristics are directly related to self-discipline (C5) and dutifulness (C3) facets, respectively, in the **conscientiousness** trait. From their personality profiles, the majority of the team members (including the above-mentioned two individuals) have obtained a high score in these two facets. Referring to self-discipline facet (C5) P1 and P7 obtained 95% and 90% scores respectively. For the dutifulness facet (C3), they obtained 95% and 100% scores.

4.3.3 Open-to-discuss & change nature on requirements prioritization. The team members who are open to discussing and making changes appeared to have a positive influence on prioritizing requirements. This was mainly observed in the story walk-through meetings where the senior analyst (P7), senior integration developer (P8), and senior quality engineer (P11) had open discussions with the lead business analyst (P1) on grooming of the stories, including missing requirements and prioritizing them by bringing them to the next sprint based on the amount of work to be completed for a particular user story: *"P11 - with the discussion we had yesterday, I've started working on X task to assess the integration job; I've created a card for it, so are you okay if we bring that to the next sprint?" "P8 - just following up with that, it's pretty much been de-prioritized now, but going forward, it's going to be big.."*
Further, their flexibility to change the prioritized tasks and work on something new impacts prioritizing the important requirements in each sprint: *"I think we can definitely talk about this with X, and if yes, this can be incorporated into the next sprint. Probably we have to look at the priority in a different manner. With this approach, we can add them as one of the action items for features" - P1 (Lead business analyst).* These kinds of open discussions and their willingness to change positively impacted prioritizing the requirements. These characteristics can be directly mapped into the ideas/ intellect facet (O5) and actions/ adventurousness facet (O4) in **openness to experience** trait. Referring to their personality profiles, P7 obtained the highest score (100%) for ideas/ intellect facet (O5) and 90% for the actions/ adventurousness facet (O4) while the other two members also (P8 and P11) obtained high scores (around 80%) for the above-mentioned facets among the team members.

4.3.4 Interactive vs reserved nature on clarifying allocated tasks (requirements). A key observation was around more interactive team members in meetings and those who were more reserved when they needed some clarification on their allocated tasks. For example, during story walk-through meetings, business analyst (P2), software engineers (P4 and P10), senior integration developer (P8) and senior quality engineer (P11) seemed to be more interactive about getting clarifications of their allocated tasks by having discussions with the team compared to other team members: *" P2 - (talking to P8) I think there is a missing element in the X response, maybe it's a minor thing, but that would help to improve the integration, what do you think P8?" "P8 - I agree, and we can have a quick chat and sort it out"*. That they tended to solve problems in the moment by interacting with each other was explained by P2 (INT02) in his follow-up interview: *" If there is anything I need to understand and work on, I prefer talking to them and solving that issue. It can*

be with the team members or our external parties". This interactive nature can be related to the assertiveness facet (E3) in **extraversion** trait, where individuals prefer to speak out directly with others. From their personality profiles, it is identified that all the above-mentioned team members have a high score in the assertiveness facet as well as in the *extraversion* trait.

4.3.5 Hard-working nature and competence in successful task completion. From the observed meetings and follow-up interviews, it was identified that a team members' perception of *hard-working nature* and *competence* are helpful in completing their allocated tasks prior to the scheduled time and in reducing delays that can occur due to task dependencies: 🗨*"I already wrote these two stories, and if everything is good, we can move it to the next sprint; even in this sprint, we have three more days. I can even start it in this sprint. What do you think? (asking from P1 -lead)" - P2 (Business analyst at the story walk-through meeting).* In follow-up interviews, he elaborated that due to his hard-working nature, he tends to complete his allocated tasks beforehand and utilise the rest of the time collaborating with other team members to work on the requirement changes: 🗨*"I'd like to work, I'll give my 110% to work and make sure it completes beforehand because I don't want to make anything delayed because of my work, so I think that nature really helps me in the team, especially as a newbie" - P2/INT02 (Business analyst)*

Along with a hard-working nature, the competency of the team members is also helpful in not causing delays that can occur due to task dependencies, as they know how to get things done and complete tasks successfully. For example, it was identified that P8 (senior integration developer), P10 (software engineer) and P11 (senior quality engineer) have already completed their tasks and submitted them to review without any delays: 🗨*"These two, I have done these and submitted them to review. So once P07 and everyone else review it, we can close them off. I think I will be picking up the XXXX, which I'm about to move into this sprint" - P8 (Senior integration developer at the daily stand-ups).*

This competence of the team members and hard-working nature appear to directly relate to the two facets, competence (C1) and achievement-striving (C4), in the **conscientiousness** trait. Indeed, all of these above-mentioned team members have a high score related to these two facets and the conscientiousness trait in their personality profiles. This suggests that these personality characteristics have a positive influence on successful task completion.

4.4 Strategies used to overcome challenges related to diverse personalities

Along with the positive influences outlined above, we also identified several strategies the team members (specifically the leads) followed to try and overcome RE-related challenges that seemed to occur due to personality differences in the team (practices the team uses).

4.4.1 Enhancing collaboration. There were a few instances where we observed differences in team members' preferences for working collaboratively. This may be due to their personality differences. For example, there was a situation where a team member wanted to collaborate with another team member to complete an allocated task, whereas the latter preferred working on it separately and then discussing it later. The lead business analyst (P1) and iteration manager (P3) were involved in the situation, and they assigned another team member who preferred to work collaboratively, to work on the same task to avoid any delays in completing the task: 🗨*"P3 - Well, (talking to P8), do you mind if I request you to work with P4 (software engineer) on this one today to sort this out?" (at a daily stand-up meeting).* P1 and P3 elaborated in their interviews that they wanted to increase the collaboration among team members to complete their tasks on time, yet also respect different team members' work preferences, characteristics and 'vibes' to avoid causing conflict in collaborations: 🗨*"I'd have to think about the team. I know, at least I have some idea of what will work and what not. Sometimes, when I see that with two of them, it's not going to work, I ask someone else to look at it, or sometimes I put all BAs, QAs together to let them find a way" - P1/INT01 (Lead business analyst).*

The majority of the team obtained high scores (above 75%) for the cooperation (A4) facet, whereas only one team member obtained an average score (60%), and interestingly they were the one who preferred to work on the allocated task separately. They obtained average scores for most of the facets in the **extraversion** trait, such as friendliness (E1), activity level (E4) or positive emotions/ cheerfulness (E6), whereas the one who was later included to complete the task (P8) obtained high scores (90%) for the cooperation facet (A4) as well as for the friendliness (E1) and activity level (E4) facets.

4.4.2 Conduct detailed discussions. Detailed discussions with the team members might be helpful in addressing challenges that may be caused by the personality differences of the team members.This strategy is closely related to the enhancing collaboration strategy as well. These discussions can be in any form, such as formal meetings (e.g., sprint retrospectives, story walk-throughs), informal catch-ups (e.g., casual catch-ups with colleagues), open discussions (with all the team members) or individual discussions (e.g., with the respective team member) and the preference on these discussions vary based on team members' personality differences. For example, some of the team members are comfortable discussing their concerns openly in the meetings (e.g., in story walk-throughs or sprint retrospectives), whereas some tend to be more reluctant to share them with the whole team. Rather, they prefer to discuss it with the relevant person in the team: 🗨*"I had some concerns, and I needed to understand some points. So, I had a discussion with P1 (lead business analyst) yesterday, and now I'm working on it" - P9 (Senior automation engineer at the daily stand-up meeting)*

We also identified that both detailed open and individual/separate discussions could be helpful in prioritizing requirements, focusing on missing requirements, enhancing collaboration, and avoiding delays in task completion. In our interviews, both P2 (business analyst) and P7 (senior analyst) described that detailed discussions at the story walk-through sessions are helpful in bringing everyone to the same page and getting a clear idea of user stories and allocated tasks, whereas P1 (lead business analyst) explained that having individual discussions with team members is important to assist them in completing their tasks: 🗨*"there can be missing elements, unclear user stories, and then we'll end up having long conversations at the story grooming sessions [story walk-through meetings] to get it clear, and then everyone knows what to do in the next sprint" - P2/INT02 (Business analyst)* The team members' preference to have

open, detailed discussions to clarify requirements could be related to their interactive and open-to-discuss nature under **extraversion** trait. When relating this to their personality profiles, it showed that P2, P8 and P11, who prefer to speak out and discuss in the story-walkthrough meetings, obtained high scores (around 80-90%) for the assertiveness facet (E3). P9, who prefers to have individual discussions, obtained an average score (65%) for the assertiveness facet, indicating the importance of both open and individual discussions relating to their personality differences.

4.4.3 Ask for external support. Asking for external support could be another strategy to overcome the challenges that may occur due to diverse personalities. This external support can be from high-level authorities of the organization or other teams (e.g., IT support), whom the practitioners require support to solve issues with stakeholders. In their follow-up interviews, both the lead business analyst (P1/INT01) and the iteration manager (P3/INT03) elaborated that there are some instances where the team has conflicts with stakeholders as they have to deal with a diverse set of stakeholders for that particular project: *"As this project is XXX-wide, we have various people to interact with and meetings to attend [all are stakeholders], so sometimes I know there are conflicts the team is not happy with. There, I talk to the team as well as with all the higher levels to make it easy for all of them" - P1/INT01 (Lead business analyst).*

Further, it was identified that these conflicts could result in delays in getting more information about a particular requirement or validating it, making it difficult to complete the task on time. As elaborated by the iteration manager (P3/INT03) in the interview, to overcome this, they try to obtain the required information from the IT support teams who have experience working in similar contexts: *"Sometimes, we don't get a proper reply from the XXX, then we have to contact IT support or HR to get some additional details, or maybe we just want to get the confirmation of something" - P3/INT03 (Iteration manager).* However, team members should speak up when having these difficulties, and the leads should communicate them to the necessary external parties at the correct time.

This can be related to the personality differences of the team members, where some are more proactive at asking/offering for help or communicating requirements-related issues to the lead, while some are reluctant to ask for help. In team meetings, it was been observed that P2 (business analyst), P7 (senior analyst), P8 (senior integration developer) and P10 (software engineer) were more proactive in communicating the issues to the lead or asking/offering their support to the team members (including the lead) to solve requirements-related issues with stakeholders. *"P2 - I'll contact XXX [one of the stakeholders] to clarify this. (to P9) then you can work on XXX with P10". "P1 - Yeah, we can discuss all these XXX in the next XXX meeting [stakeholder meeting]. Then we can get a clear picture. (to P9) are there any other issues?"* (at a daily stand-up meeting). When referring to their personality profiles, all the above-mentioned team members and P1 (lead business analyst) obtained high scores (above 90%) for the altruism facet (A3) and cooperation facet (A4) in the **agreeableness** trait and more than 80% for the assertiveness facet (E3) in the **extraversion** trait.

4.4.4 Balancing team member and external stakeholder needs. Having a balance between the team and the external stakeholders is a strategy highlighted by the business analysts (P1, P2, P6 and P7) in their follow-up interviews. They elaborated that it is important to handle the requirement changes without making it too difficult for the developers while giving importance to the stakeholder requests. This might be due to some developers in the team not agreeing to do instant changes and requiring more time to do the changes as they prefer working on a plan.: *"they won't always agree to make the changes; it takes time, and we should make them do what they are comfortable with. So, what I do is, give more time to complete their ongoing work and explore more about the new request" - P1/INT01 (Lead business analyst).* This was observed in a sprint retrospective meeting, where one team member highlighted their concern about having changes after every [stakeholder] meeting. When referring to their personality profiles, it is identified that their obtained high scores in the **conscientiousness** trait, specifically in the orderliness (C2) facet (100%), which describes a person's preference for work for a plan/ schedule in a well-organized manner.

5 DISCUSSION

Below we share possible implications for software practitioners and researchers arising from our analysis. The purpose of these implications is not to try and 'fix' personality traits but rather to become more aware of them and work with people to achieve better balance and collaboration across the team as they perform RE activities. Since individual personalities are a sensitive matter, these implications need to be considered holistically and applied with due care for software team members' preferences, strengths, and weaknesses in consultation with relevant individuals, as personality traits are often seen to balance each other [9] [55].

5.1 Implications for Practitioners

Software practitioners' response to requirement changes depends on their diverse personalities: The findings of our study suggest that team members' personality traits, such as *agreeableness*, *conscientiousness* and *openness to experience*, can be helpful in managing requirement changes. The team members scoring higher on facets indicating cooperative, organized and responsible nature and willingness to change seem to be comfortable making many requirement changes. Respective of their personality profiles, these team members in our study had high scores for all the related facets indicating these personality traits. However, among these, team members who prefer working on plans and schedule activities (self-discipline facet in conscientiousness trait) seem to be taking more time to explore and work on the changes than others. This highlights the importance of considering the impact of personality on software development as practitioners' reactions to the requirement changes depend on their diverse personality characteristics. Similarly, studies such as [29] [54] showed the importance of considering diverse personalities of practitioners as it impacts the software development process, including RE.

Detailed discussions in story walk-through meetings are helpful to gain clarity of requirements: From the observed meetings, we identified that detailed discussions in story walk-through meetings are helpful in obtaining clear requirements, identifying missing elements from the user stories, prioritizing requirements and grooming the user stories for the next sprint. However,

it was also found that not everyone in the team is closely involved in detailed discussions in these meetings. Rather, they prefer to get clarifications by having individual discussions with respective team members (e.g., leads, BAs or QAs). Hence, it is important to identify who in the team is comfortable with expressing their opinions openly and who needs separate discussions to make the task clear to the team members and have everyone on the same page during the sprint. For example, it was observed that P9 (senior automation engineer) prefers to discuss requirements-related issues via individual meetings with the lead, whereas P8 (senior integration developer) always openly discuss the issues during the daily stand-ups/ story-walkthrough meetings. Referring to their personality profiles, P8 obtained higher scores for agreeableness (90%) and extraversion (75.8%) traits than P9 (80% and 70%, respectively). Therefore, alternative ways for team members who are less comfortable expressing their views in such meetings, such as team members who obtained average/ low scores on assertiveness, ideas/ intellect, actions/ adventurousness or cooperation facets in extraversion, openness to experience and agreeableness traits are important. The team leads should employ complementary techniques to include them better, such as pre-meeting and post-meeting offline comments, structured turn-taking in meetings, or informal catch-ups.

Collaboration is the key to successful RE-related task completion: To work on RE-related tasks and successfully complete the allocated task, collaboration among team members was identified as a key. Enhancing collaboration while keeping personality differences in mind was identified as one strategy. To do that, it is important to identify who is comfortable working with others and who prefers to work individually, which depends on their personalities, and this will benefit successful task completion in the end. It was observed that some team members always expressed their willingness to work together on tasks and seemed to complete their tasks before time (e.g. P8 and P10). At the same time, some team members seemed to prefer working on their own and only reaching out to others when needed, such as to get more clarity on a task (e.g. P4 and P9). Even in situations where they have been offered to work with others, they prefer to work on their own and discuss it later. When relating these to their personality profiles, both P8 and P10 obtained high scores (90%) for the cooperation (A4) facet compared to P4 and P9 (60% and 80% respectively) in the *agreeableness* trait that can be used to describe a person's collaborative nature. Hence, as mentioned by P1 (lead business analyst) in his interview, having some idea of team members' comfort in working with others would be helpful in successful task completion without any conflicts.

Assertiveness is helpful in managing stakeholder demands: From the observed meetings and the follow-up interviews, we identified that the assertive nature of the team members is helpful in managing stakeholders' change requests during the sprint. As the observed team has numerous stakeholders, from top management to HR, it was observed that they received various change requests after their meetings with different stakeholders. The team members' clear communication on what can be done within a sprint and what changes required more time and planning helped the team manage stakeholder demands without having any major conflicts. For example, P2, P7, P8 and P11 were more expressive and clear on this and in his follow-up interview, P1, the lead business analyst, mentioned that due to their clear communication, it was much easier for him to plan the sprint and manage the change requests. *" (mentioning names), they always make it clear what they can do, sometimes I have to talk to XXX [stakeholder] and get some extra time, but it was all smooth because we talked about XXX [change request] in our meetings" - P1/INT01 (lead business analyst).*
When relating to the personality profiles, all of the above-mentioned team members obtained high scores (above 80%) for assertiveness (E3) facet in extraversion trait.

5.2 Implications for Researchers

Conducting case studies in different contexts: further case studies are needed across different teams, software organizations, domains and working environment (e.g. physical, hybrid or completely remote) worldwide to enhance our understanding of how software team members' diverse personalities impact RE-related activities. A number of other factors may impact team performance or mitigate or accentuate personality differences. These include different organizational cultures, team member demographics and personalities, and team size and team personality combinations. Our mixed methods approach allowed us to corroborate and triangulate findings across the standard personality test, observations, and interviews. A similar approach is recommended for researchers considering studying similar human aspects. This is in line with [55], who found that personality has a strong impact on SE and suggested that certain phases, such as RE, has both positive and negative effects, where future research on these would be particularly rewarding.

Consideration of other human aspects along with personality influence: Along with personality, we also suggest carrying out more studies considering other human aspects, such as culture and gender [3] [36], as the impact of individuals' personalities may differ based on the influence of these (and other) human aspects as well. For example, the culture of a particular country can have a major impact on people's personalities [3]. Hence, it is important to identify the relationship between personality and culture by conducting similar studies with global software development teams where we can observe the influence of diverse cultures and personalities on RE/ SE activities.

Further investigation of the application of strategies: The identified strategies used by our observed team (specifically the leads) were formulated in part to overcome challenges that occurred due to personality differences in the team. Some of these identified strategies are in line with the set of strategies identified in previous studies [16] [19] [34]. However, we also identified differences in some of the strategies, such as balancing team members and stakeholders. The exact impact of these strategies also needs further investigation. Hence, we suggest carrying out more research studies to investigate the application of these strategies and to identify further strategies that are applied by practitioners in different situations or contexts.

Involving external stakeholders/end users: Our study does not focus on observing software developer meetings with external stakeholders, nor did we have any involvement with them. We suggest conducting more empirical studies involving external stakeholders / end users to identify how the personality of software

practitioners may influence their RE-related activities (e.g., when eliciting and validating requirements) with their stakeholders/end users. Further, it would be interesting to understand how stakeholders'/ end users' personalities impact RE-related activities that they partake in, as they play a huge part in the successful completion of RE-related activities and overall project outcome.

6 LIMITATIONS AND THREATS TO VALIDITY

The context of this study is limited to a software development team following an agile approach in developing an in-house application for a large public organization in the education domain. Hence, the findings of our study are limited to the context represented, limiting the generalization to the entire SE community, such as in [6]. We believe that our study can be replicated in similar or other contexts to extend the findings, with more than one software development team. Another main limitation of our study is that we could not observe all team meetings in person. The team worked in a hybrid situation where some team members worked from home and some from the office. Consequently, all meetings were held online, and we could not observe how the entire team worked face-to-face in their organizational environment.

Our observation data is limited to 28 meetings for a period of six weeks. Observing the team for a longer period would have provided more data to analyse. In practice, it would be difficult to conduct regular observations for a very long period of time, including considerations of obtaining participants' consent to conduct such a study. Further, we could not observe any interactions of the software team with their clients/external stakeholders as we did not get their consent to do the observations. We acknowledge that observing these interactions could be a relevant part of RE and suggest conducting more empirical studies involving external stakeholders (section 5.2).

We analysed personality test results after analysing the observed meetings and follow-up interviews to reduce any potential bias of observing participants based on their personality profiles and while conducting the qualitative data analysis.

Among various personality assessment theories that have been used in the SE domain [20], FFM was considered the dominant, most suitable one, referring to its validity and reliability. We chose to use the IPIP-NEO 120 test in our study, developed based on the FFM, due to its acceptable reliability and practicality compared to other IPIP-NEO personality tests. We provided standard instructions for the personality test, including definitions of personality, to participants before its administration. We explained personality-related terminologies during interviews with the participants. However, participants' understanding of personality can vary, and the experiences they share during the interviews may differ. The impacts of personality that we identified may depend on team members' interpretation and understanding of personality. The strategies we have proposed to deal with the challenges associated with personality differences may depend on how these impact such situations. These may also depend on particular contexts they are involved in, their organizational context, and other individual and social differences, e.g. age, gender, experience, culture, etc.

All the observed meetings and interviews were recorded and shared with the research team during the data collection period, and several discussion rounds took place related to the observation notes, meeting records, and transcriptions to reduce any potential data collection biases. We could not interview all the team members as only 6 out of 11 team members provided their consent to participate in follow-up interviews. Following the STGT for qualitative data analysis, we generated concepts and categories based on the coding of interview and observation data. Our primary focus was on employing STGT for data analysis rather than delving into advanced theory development that requires theoretical saturation. Given the strength and adequacy of the emerging concepts and categories obtained, as well as the number of meetings we got to observe, we did not aim for data saturation (a crucial step in theory development in STGT). However, we acknowledge that advanced theory development remains a possibility for future research, involving multiple team observations for longer periods with more follow-up interviews. After the first author conducted the initial coding and analysis, it was shared with all the other authors to discuss and resolve any different opinions. All these codes, concepts and categories were collaboratively discussed and finalized by all the authors to try and overcome any potential coding biases.

7 CONCLUSION

The findings of our study contribute to understanding the potential impact of the personality of software team members on how they carry out RE-related activities. Most team members exhibit high *agreeableness*, *conscientiousness* and *openness to experience* traits, and average in *extraversion* and *neuroticism* traits. Through six weeks of observations and six follow-up interviews, we identified how various personality characteristics appear to impact their RE-related activities. We identified that software team members' personality characteristics related to *agreeableness*, *conscientiousness*, and *openness to experience* appear to positively influence successful conduct of requirements validation, prioritization, managing requirement changes, obtaining clarity of requirements and completing the allocated tasks on time. However, some team members' reluctance to speak out or wanting to work alone, which can be identified as opposites of *extraversion* and *agreeableness*, seems to create challenges in the completion of the allocated tasks. We identified a set of strategies followed by the team members to overcome perceived challenges that occurred due to the personality differences. This research study provides guidance to software practitioners on improving RE-related activities considering the influence of diverse personalities of the team members and strategies to overcome the difficulties faced due to diverse personalities as they carry out everyday tasks.

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