Role of Human Aspects on the process of Software Requirement Elicitation

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Abstract: Requirement elicitation(RE) process requires collaboration with people of different backgrounds and expertise. Collaboration between diverse teams such as developers, testers, designers, requirement engineers, and stakeholders makes requirement elicitation process highly human dependent. The main goal of this research is to find out the role and importance of "human aspects" such as domain knowledge, motivation, communication skills, gender, age personality, attitude, geographical distribution, emotions, and cultural diversity in requirement elicitation activities. The purpose of this study is to identify the industrial perspectives of key human aspects that will help organizations to carry out RE-related activities more effectively. To fulfill that purpose, we surveyed 165 software practitioners and elicited the industrial perspective through their responses. Practitioner's data revealed that requirement elicitation activities are highly human-dependent, 90% of practitioners were of the view that the success of requirement engineering activities depends on the individuals engaged in those activities. Software practitioner's data revealed that domain knowledge (84%), motivation (68%), communication skills (61%), and personality (41%) are the highly important aspect for the individual engaged in requirement engineering activities. Furthermore, the data revealed that the correctness (73%) of identified requirements is a highly important factor in measuring the performance of the person involved in the RE process. Simultaneously, the clarity (78%) and the completeness (75%) of identified requirements are also important. Our results suggest that the individual engaged in the requirement engineering process should have the social and collaborative (89%), enthusiastic (94%), altruistic (kind, generous, trustworthy, and helpful) (67%) qualities to be able to carry out RE activities effectively. Our survey suggests that the practitioners may consider the findings of this research appropriately when forming, managing teams, and conducting software requirement elicitation activities.

Index Terms: Requirement Engineering, Requirement elicitation, Business analyst, Human aspects, Requirement gathering.

1. Introduction

The process of requirement engineering is one of the important phases in the software development lifecycle. It is the first major activity in software development that involves understanding the domain of a problem, determining a solution, defining a solution that is testable, comprehensible, sustainable, and that meets the project quantitative guidelines [1]. The requirement engineering activities consist of eliciting, collecting, documenting, validating, maintaining, and communicating the software requirements [2]. The quality of requirements plays an important role in the success of any software [3]. The error produced during the requirement gathering stage can be very costly if it remained undetected until later stages [4]. Nowadays, requirement elicitation is considered an iterative process where tasks need to be interleaved with other software engineering tasks [5]. According to research carried out by Wick, the software does not develop itself, it should be developed systematically with the help of necessary software development skills, the right tools, and effective team collaboration. In general, software development requires collaboration between software developers, testers, requirement engineers, and stakeholders who come from different backgrounds [6].

Cognitive biases gained popularity in the software development process; it is one of the sources of project failure. Requirement elicitation teams make biased decisions while eliciting requirements, which can sometimes lead to catastrophic consequences [7]. In the software elicitation process, human aspects play an important role that can build and break the entire software [8]. Most of the research carried out in the past, whether was academic-based or focused on a few human aspects.

Hence, in this research, we are focusing on human aspects such as gender, culture, emotions, personality, motivation, communication skills, domain knowledge, and attitude and trying to find out the effects of these human aspects on RE activities. We are also going to look at the effects of an individual's gender, culture, emotions, personality, motivation, communication, behavior, and other human aspects on the process of requirement elicitation. Our findings may help the practitioner in forming the team for the software requirement elicitation process. The main objective of this research is to address the following questions, which are outlined below:

Q1. What human aspects affect the performance of people involved in RE activities?
Q2. What characteristics should an individual and his team have to perform RE activities more efficiently?
Q3. What are the key factors in measuring the performance of people involved in RE activities?

2. Background

Nowadays, Human aspects play a crucial role in the requirement elicitation process. The human aspects of an individual can build and break the entire software product. Requirement elicitation is one of the fundamental activities in the software development lifecycle. The quality of software products largely depends on the quality of requirement, the failure of many software system can be traced back to human error in requirement elicitation activity [9, 10]. Many of the researchers have studied the impact of each of the aspects such as personality [11], emotions [12], culture, gender, team climate, etc. in detail on software requirement engineering process. Most of the research is being conducted based on academia, with only a handful of research based on industry perspectives. To gain an understanding of the industry perspective, the study should be carried out to get the role of human aspects on requirement elicitation while being in the real world. One of the researchers has studied cognitive philosophy to understand how people gain and attend information, to improve the requirement elicitation process [13]. This study was conducted to understand human behavior which plays important role in requirement elicitation. Since the software development lifecycle aims to improve the software quality day by day, all the steps of the lifecycle have to be done correctly so that the new software is less risky. The process of requirement elicitation is considered the first step to acquiring basic knowledge of the system that has to be developed. RE process requires the involvement of each stakeholder who is the user of the system.

We see that the culture of the industry also impacts the requirement engineering process of any software project. The process of collecting requirements has been part of culture and plays important role in gathering the right information. Both national and organizational culture impacts the behavior of any individual and his work practices, and it can also deeply impact RE activities [14]. The study also suggests a framework that not only helps identify cultural influences at the national level but also extends it to the organizational level in order to provide a more important perspective. Individuals with diverse backgrounds and diverse skills contribute to the requirement elicitation process, which makes the process highly humane. Any failure in the RE process can cause systematic failures in the software that has to be developed [15]. In previous studies, the think tank of researchers was focused on how the requirement elicitation process can be improved and what are the main characteristics of gathering the requirements. Some researchers have independently tried to improve the elicitation process in specific domain systems [16]. Thus, further studies should be conducted regarding human factors and their deep involvement in requirement engineering process as it plays important role in overall software requirement engineering processes.

3. Related Work

The human aspects play a vital role in the interaction between software development team and different stakeholders during requirement gathering process. RE itself is one of the human-centered activities that require continuous interaction and effective communication between diverse people including RE engineers, development team, and project stakeholders [17]. In a study [18], a researcher focused on one of the human aspects which is communication, as a success factor in requirement elicitation. Apparently, that research was limited to global software development and marked communication as an important factor in gathering the requirements. They further found out that geographical presence, different time zone, cultures, and physical aspects were the causes that lead to miscommunication in the requirement elicitation process. The success of any software project cannot be accomplished without accurate implementation of all its requirements. According to a systematic literature review conducted by Yaseen [19], lack of coordination, collaboration, communication, domain knowledge, and awareness between teams are critical challenges and barriers in the path of RE activities. An SLR and survey-based study were carried out to investigate motivation factors for the requirement change management (RCM) activities in global software

development (GSD) [20]. They extracted 25 motivators and developed 6 taxonomies to help practitioners consider the most relevant categories based on the challenges faced during the RCM process.

Various researches carried out in the context of software engineering to find out the impact of human aspects such as gender [21], personality [11], communication issues [22], soft skills, team performance, human values, and human cognitive biases [7] on software engineering processes and since each broader term consists of multiple disciplines, it can create an impact on downstream branches. Requirement elicitation is one of the processes in software engineering that has the most involvement with users, participants, and a group of individuals. Fuentes-Fernández et al. [23] proposed a framework that was based on socio-psychological activity and analysis of human context, they used a case study to illustrate the application and impact on a new system in the organization. Their framework provides the complete requirement specifications in the context of the influence of human behavior and helps to perform RE activities. This framework can save efforts in requirement elicitation process as compared to other techniques. Askarinejadamiri [24] Studied and focused on effective personality in the field of web development during requirement elicitation. They proposed that web development has some relationship of human personality with RE and there is more that can be identified as other human aspects in RE process. Another study was carried out by Aihnoa Aldave et al. [25] and they found that agile development is another field that influences human creativity during requirement elicitation. They proposed that creativity can play important role in requirement elicitation in agile software development. Creativity can improve overall Software Engineering processes and bring innovation to have a better lifecycle of software development. Human error is another aspect that we can keep an eye on in requirement elicitation. Human error can create problems in the process but that depends on the percentage of occurring of an error. Requirement elicitation processes are prone to error; thus, research was conducted on human error taxonomy [26] and they tried to study human error that is caused by cognitive psychology. They found that sometimes requirement engineers carelessly take notes during the interview while eliciting requirements. To get more understanding, there is a need for more research that can help improve the requirement elicitation process. Creativity, personality, emotions, team climate, culture, etc., are important human aspects that have now attracted researchers to conduct research to improve requirement engineering processes. Human behavior is very natural, and it is very difficult to analyze. It could be a challenging task when relating to requirement elicitation process because each participant will have different behavior, but researcher can summarize the views of the participants and can identify the areas which need improvements.

Very few systematic and empirical studies based on the human factors are conducted in the context of requirement engineering. Most human-based studies are conducted on contextual software engineering and primarily on the global software development cycle. It is inferred from some previous research that human behavior has become an emerging area for requirement engineering as well as for its process requirement elicitation. To help out the research community in the future-focused on RE, the studies should think beyond the current requirement engineering practices and engage with people from different departments. Researchers need to identify new methods for understanding human behavior in RE to improve the overall requirement engineering process.

4. Methodology

To find out the role of human aspects on requirement elicitation process, we conducted survey research to find out the experiences and opinions of practitioners in the field. The questionnaire was designed on google form for the employees who were working for different software development firms worldwide. To know the perspective of the broader population, we approached our target respondents online through social media platforms (WhatsApp, Twitter, Reddit, LinkedIn, and Facebook) and collected data through an online Google Forms survey. Participation in the survey was voluntary and they were asked to complete the set of questions. To achieve the objective of the research, we have adopted a questionnaire from one of the similar research projects and modified it according to our research. The questionnaire was designed in such a way to provide an in-depth analysis of practitioners in a relevant field.

The questionnaire consisted of 21 closed and open-ended questions and the questions were divided into four sections. The first section consists of personal information like age, gender, country, and educational background. The second section consists of employment information like current job title, software development methodologies, job responsibilities, and job experience. The third section consists of the question regarding the practitioner's performance in requirement engineering. This section is designed in such a way to identify the aspect that motivates a practitioner to effectively perform RE activities. The fourth section is designed to elicit impact of human aspects on the RE process through the experience of practitioners or their team members.

In the questionnaire, we used different pictorial presentations for the close-ended questions to identify the importance of human behavior and its impact on requirement elicitation activities. The Likert scale was used for closed-ended questions and the scale included five possible answers ranging from "Not at all important" to "Very Important". As the survey was online, different practitioners around the globe voluntarily participated in the survey and we received responses from multiple countries. The questionnaire was designed in a way to extract quantitative data and Microsoft Excel was used to organize and investigate the respondents data. For the data visualization, we have used pie charts, bar charts, and scatter charts. Extracted practitioners responses revealed important elements of the human aspect which can affect the software requirement elicitation process.

4.1. Practitioner Profile Analysis

In total 165 people participated in the survey and since the survey was online the participants were from multiple countries. Majority of the participants were from Pakistan (67%), India (14%), and the rest of them were from Australia, UAE, Canada, Philippines, Estonia, and Germany.
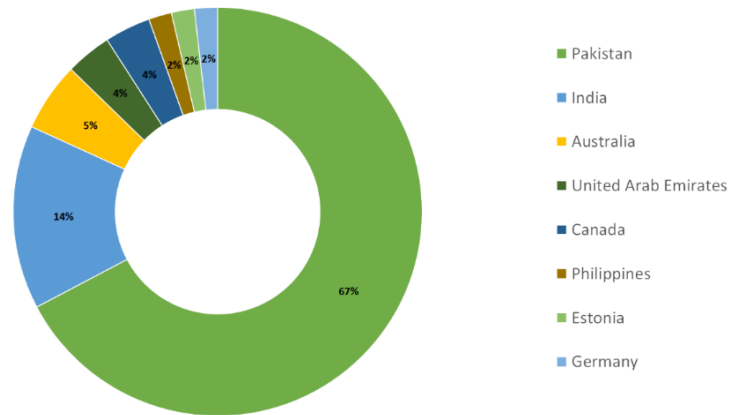

Fig.1. Countries of Respondents

Majority of the practitioner who participated in the survey were males (68%) compared to females (32%). The age of the respondents was between 23 to 39.
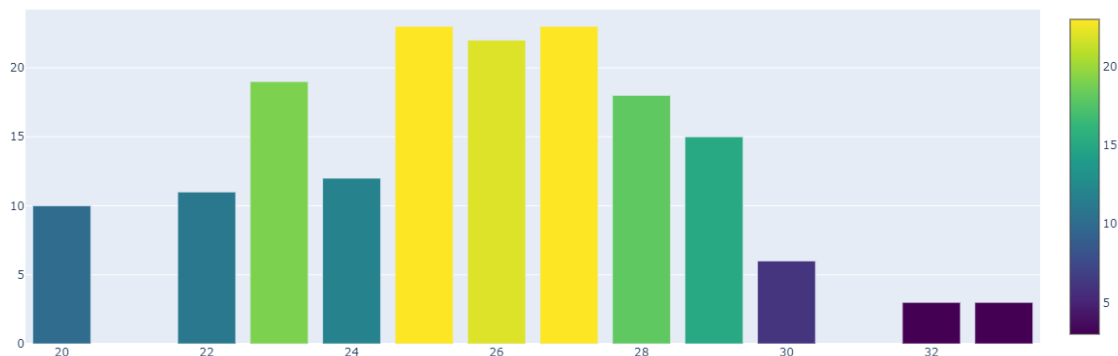
Fig.2. Age Distribution of Respondents

A high number of respondents have a university degree in computer science (77%) while some of them have a university degree in other IT fields.
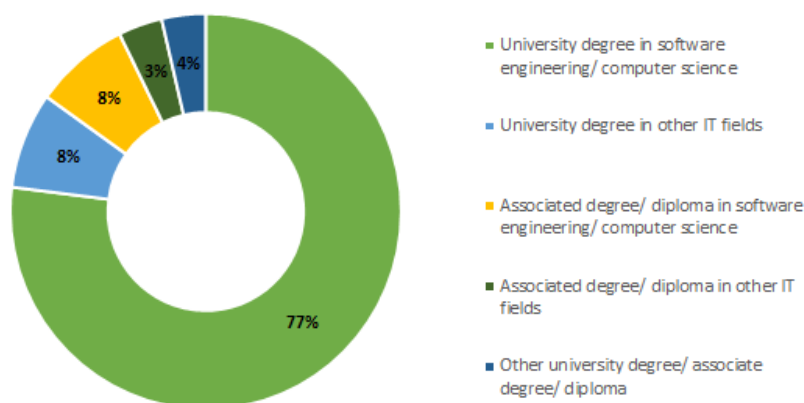
Fig.3. Educational Information of the Participants

The job title of most of the respondents was software engineer, business analyst, SQA engineer, and software developer while some participants belong to project management, Data scientist, game development, and other departments.
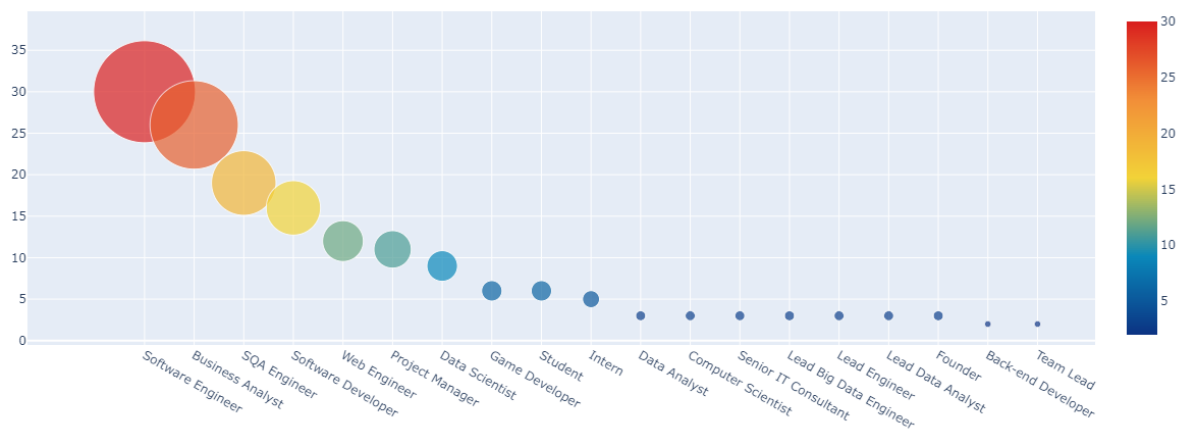

Fig.4. Current Job Title Distribution of Respondents

The majority of respondents have between 1 and 5 years (63%) of work experience in the software industry, some participants have less than 1 year (16%) and between 6 and 10 years (13%) of work experience while the rest of the participants have no experience.
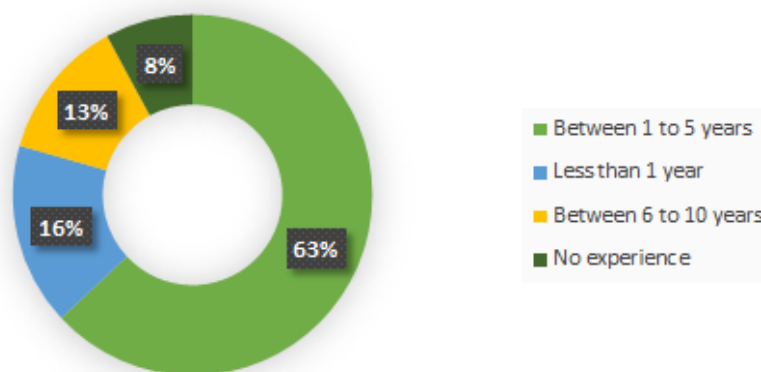

Fig.5. Job Experience Distribution of Practitioners

Most of the participants use Agile software development methodology (50%), and some participants use both traditional waterfall and agile methodology (24%). While others use the DevOps, Scrum, and Kanban approaches to software development.
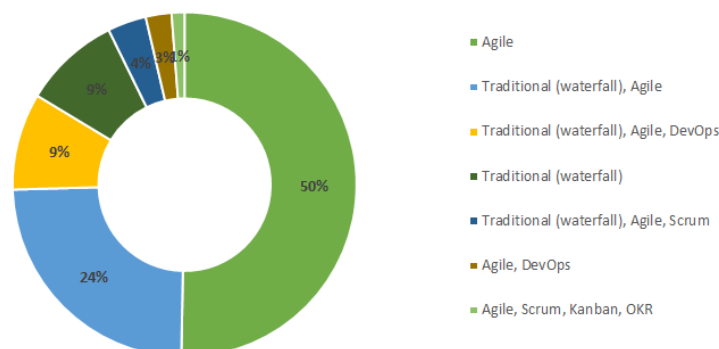

Fig.6. Software Development Methodology Distribution

We elicited from the data obtained through our survey and it was found that the majority of the participants are usually involved in requirement management activities. In this regard, Fig 7 shows complete participants' responses; it is evident that 61% of participants, in a combined manner, were either always or often involved in requirement management activities whereas 11% were sometimes and 28% never or rarely involved in requirement management activities. Survey further shows that 74% of the participants actively collaborate with stakeholders during RE activities while 11% sometimes, 8% rarely, and 7% never participate in RE activities. 71% of the participants were found to be highly involved in SRS documentation, whereas 16% of the participants sometimes and 13% of the participants, in a combined manner, rarely or never involved in SRS documentation. It was also noticed that 58% of the participants were actively while 13% sometimes and 29% rarely or never involved in requirement prioritization activities. Furthermore, 57% of the participants were noticed to play a leading role in requirements analysis and verification activities, while 22% sometimes, and 21% rarely or never participate in those activities.
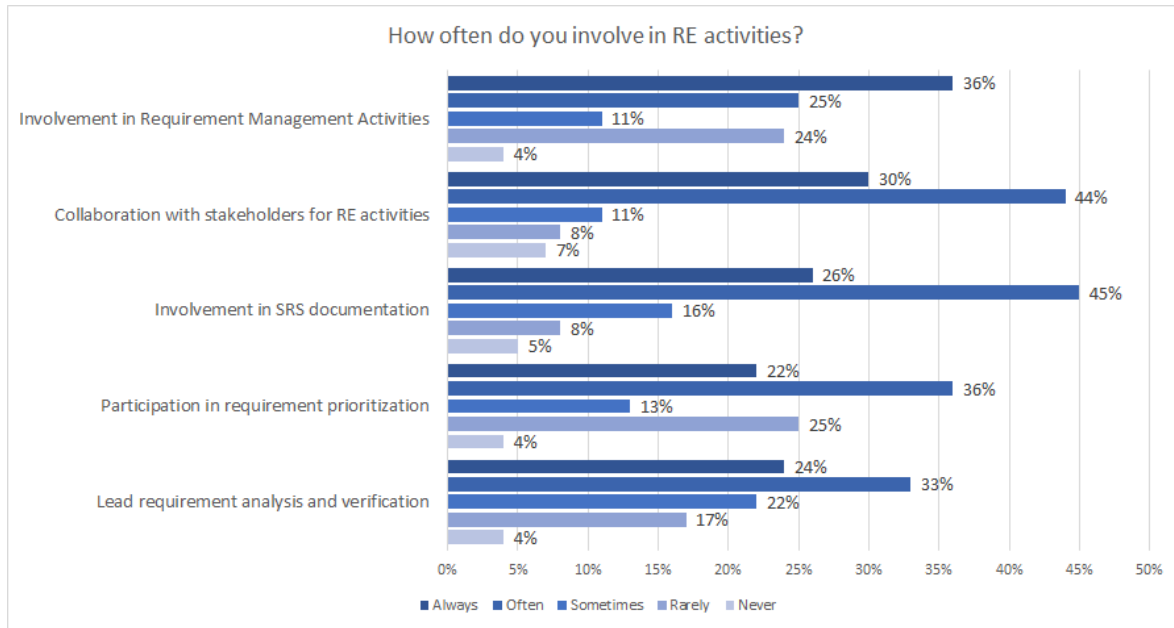

Fig.7. Practitioner Involvement in RE Activities.

5. Findings

We approached multiple professionals online through various social media groups and gathered practitioner's data through an online survey. Our survey analysis identified some potential human aspects that could affect requirement engineering activities. *Fig 8* shows the practitioners perspective on the success of RE whereas 90% of practitioners agreed that the success of requirement elicitation process is highly dependent on the people involved in those activities. When asked about the differences in human characteristics such as behaviors, people's skills, and habits affect RE-activities, 39% strongly agreed to it, while 48% agreed, 11% somewhat agreed and 2% neither agreed nor disagreed with that statement.
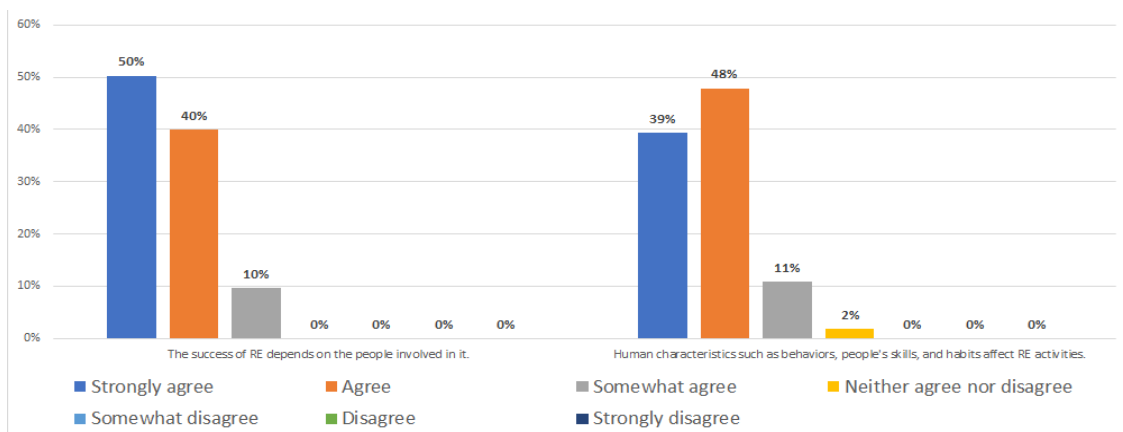

Fig.8. Success of RE depends on People involved in it

Q1. What human aspects affect the performance of people involved in RE activities?

We elicited industrial perspective through our survey, and we identified some important human aspects. As shown in *Fig 9*, the majority of the practitioners agreed that Domain knowledge (84%) is one of the most important attributes that can affect the performance of an individual while eliciting requirements. Motivation (68%) and communication skills (61%) are other important human aspects mentioned by practitioners. Personality (41%) of individuals is also an important aspect, while age, gender, emotions, cultural diversity, and attitude are the least important human aspects for individuals involved in RE activities.
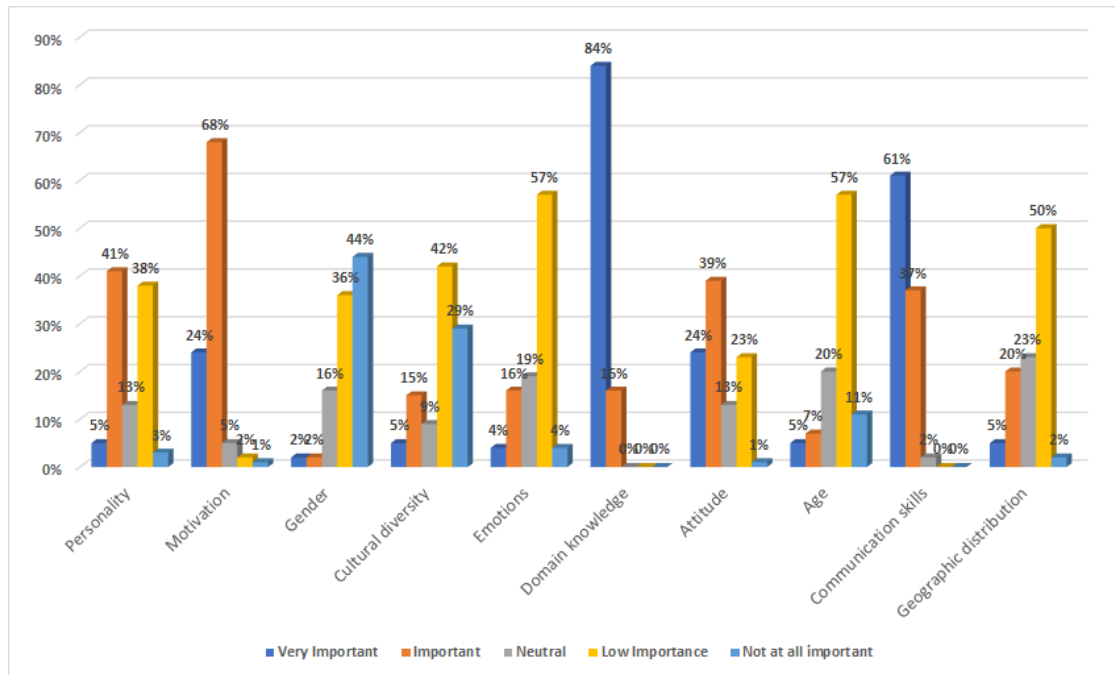

Fig.9. Influence of Practitioner Human Aspects on RE Activities.

Software development team geographic distribution is also mentioned as the least important aspect by practitioners. However Jo Hanisch et al [27] case study sheds light on the challenges and complexities that arise when teams are based on widely distributed geographical locations. They stated that the societal and cultural behavioral aspects need to be considered as there are many risks and challenges in global software development, especially in RE-related activities.

Q2. What characteristics should an individual and their team have to perform RE activities more efficiently?
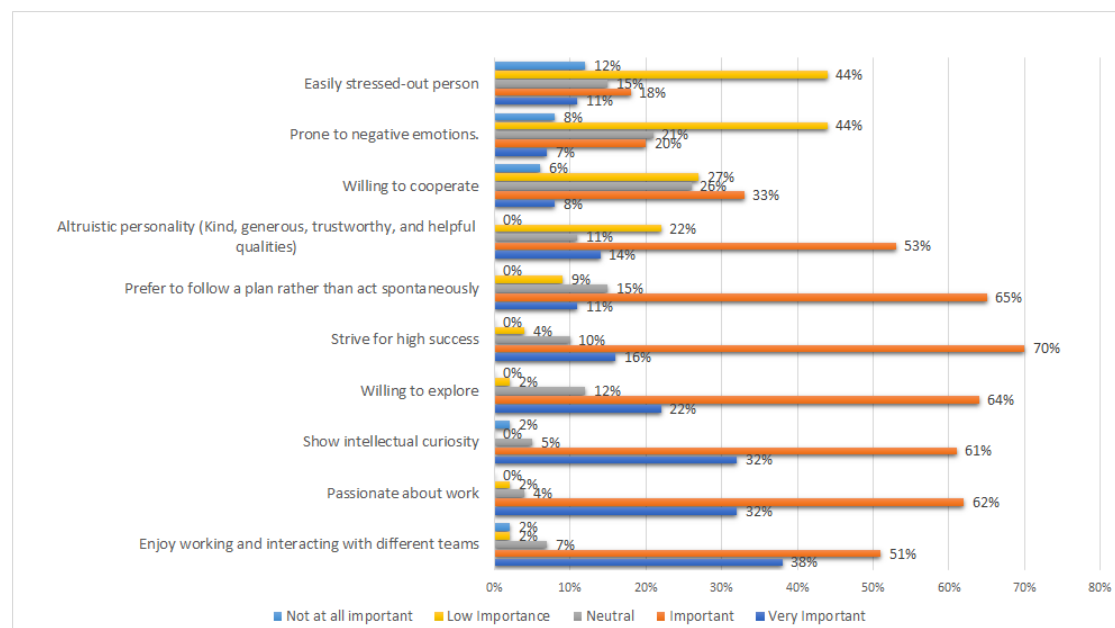

Fig.10. Important characteristics for an individual to perform RE-activities effectively

We have identified some of the key human characteristics through the online survey that should be present in an individual to perform RE-related activities effectively. We found that '*enjoy working and interacting with different teams*' is one of the very important human characteristics for an individual to effectively perform RE activities. '*Passionate about work*', '*show intellectual curiosity*', '*willing to explore*', '*strive for high success*', and '*altruistic personality*' are other important characteristics for an individual involved in RE activities. While '*easily stressed-out person*' and '*prone to negative emotions*' are mentioned as not at all important by practitioners. Majority of participants agreed that '*prefer to follow a plan rather than act spontaneously*' is another important human characteristic for an individual to perform RE-related activities more efficiently.

Q3. What are the key factors in measuring the performance of people involved in RE activities?

Preciseness and the quality of the requirement greatly influence the software system. Requirement engineering activities are the foundation from which the software quality is measured. Previous research by Khalid al-Imam et al. [28], has listed many key common factors to determine the performance of people involved in requirement elicitation activities. As shown in *Fig 11*, most of the contributors agreed that the *correctness* (73%), *completeness (75%), and clarity (78%)* of identified requirements are highly important factors in measuring the performance of a person. While other factors like the *capability to deal with others involved in RE (35%), capability to deal with software team feedbacks (46%), capability to deal with requirement changes (42%), capability to deal with customer feedback (41%)* were also mentioned as very important factors in measuring the performance of an individual.
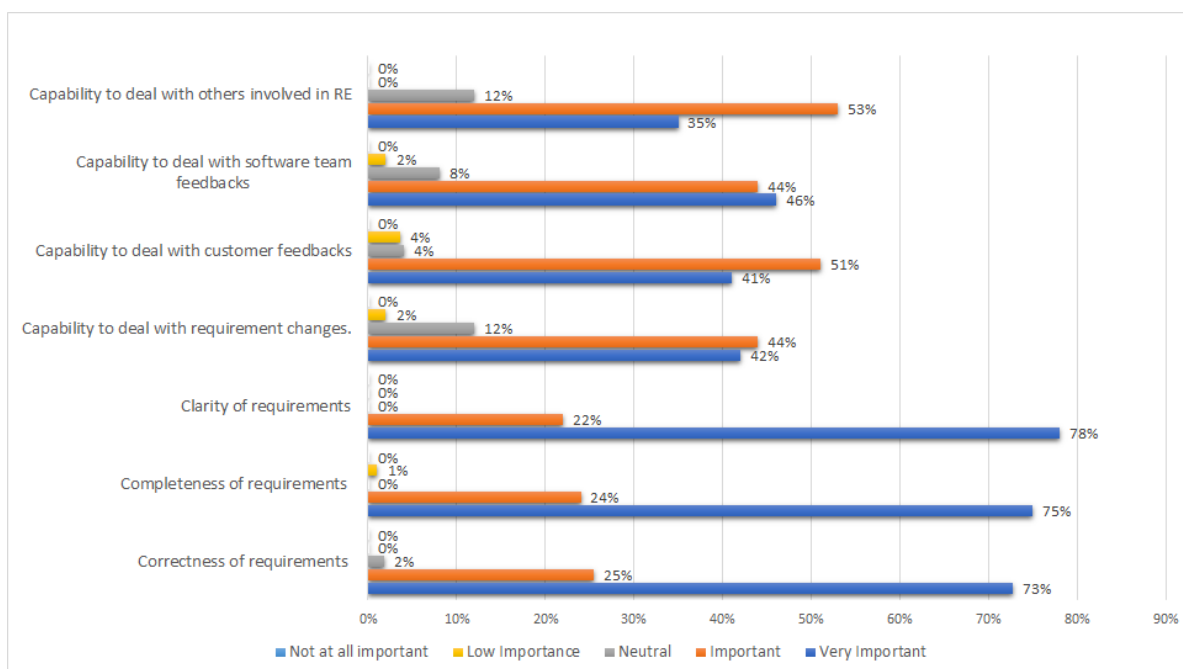

Fig.11. Key factors in measuring the performance of individuals involved in RE activities

We have asked the practitioner through the open-ended question to provide his or her view on what makes people ineffective when involved in requirement elicitation activities. Some respondents mentioned in the open-ended question that lack of communication, lack of knowledge, less collaboration among the team, negative emotions, and imposition of their opinion on the client make the RE process biased and ineffective.

6. Conclusion and Future Work

The process of requirement engineering requires continuous collaboration among people with different backgrounds and diverse areas of expertise. This continuous collaboration makes requirement engineering activities highly human dependent. In this study, we examined the impact of human aspects on requirement elicitation activities and the online questionnaire helped to asses the practitioners industrial view on the role of human aspects in requirement elicitation activities. Practitioners data revealed that requirement elicitation activities are highly human-dependent, and the success of requirement engineering activities strongly depends on the people involved in the process. The majority of respondents agreed that domain knowledge (84%), motivation (68%), communication skills (61%), and personality (41%) are the highly important human aspect. Geographical distribution, emotions, attitude, and cultural diversity are considered less significant human aspects. Whereas gender and age are mentioned as 'not at all important' human aspects for the person who is engaged in requirement elicitation activities.

It is also identified that the correctness (73%) of identified requirements is a highly important factor in measuring the performance of the person involved in the RE process. Simultaneously, the clarity (78%) and the completeness (75%) of identified requirements are also important. By analyzing open-ended questions, we identified that lack of communication, lack of knowledge, less collaboration among the team, negative emotions, and imposition of opinion on the client make the requirement elicitation process ineffective. We have also identified that in order to perform requirement elicitation activities effectively, an individual must enjoy working and interacting with different teams, shows intellectual curiosity, and is willing to try new things.

This research will help the organization to get an idea of what qualities a practitioner should possess to carry out RE activities effectively. The practitioners may consider the finding of this research appropriately when forming, managing teams, and conducting requirement elicitation activities. Our findings will help researchers understand the industrial perspective of how an individual human aspect can influence the requirement elicitation during the software development process. Our research is limited to the requirement elicitation phase only, and further studies are needed to determine the impact of human aspects on other areas of software development.

Future work includes:

- Continue collecting practitioners' views on the impact of human aspects on the requirement engineering and other software development process.
- The validation of identified human aspects will be investigated and a framework will be proposed in further studies for the effective software requirement engineering practices.

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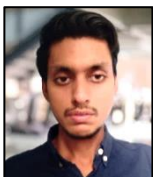
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