JOURNAL OF INFORMATION SCIENCE AND ENGINEERING 33, 1399-1416 (2017)
DOI: 10.6688/JISE.2017.33.6.1

Effective Personality Preferences of Software Programmer: A Systematic Review

ABDUL REHMAN GILAL[1], JAFREEZAL JAAFAR[2], AHSANULLAH ABRO[3], MAZNI OMAR[4], SHUIB BASRI[5] AND MUHAMMAD QAISER SALEEM[6]
[1,2,3,5]*Department of Computer and Information Sciences*
Universiti Teknologi Petronas
Perak, 32610 Malaysia
[1,3]*Department of Computer Science*
Sukkur Institute of Business Administration University
Sukkur, 65200 Pakistan
[4]*School of Computing*
Universiti Utara Malaysia
Kedah, 06010 Malaysia
[6]*Collage of Computer Science and Information Technology*
Al-Baha University
Albaha, 65527 Saudi Arabia
E-mail: {a-rehman[1]; ahsanullah.abro[3]}@iba-suk.edu.pk;
{jafreez[2]; shuib_basri[5]}@utp.edu.my; mazni@uum.edu.my[4]; qsaleem@bu.edu.sa[6]

A plethora of research has been carried out to explore the key importance of team roles and personality types in software development. What types of personality are handy and beneficial for an ideal and effective teamwork is still a question for the researchers and practitioners. This study has combined the past claims of personality preferences for programmer role so that researchers and practitioners can easily access the literature. In order to achieve the study objective, Kitchenham guidelines were followed to design and implement the review protocol. The whole review focused to find the effective personality preferences of programmer role from different experimental settings: individuals-and-teams and academic-and-industry. Additionally, only those studies were selected that used Myers-Briggs type indicator (MBTI) personality test. The results of this study were divided into three categories based on the obtained personality preferences: strongly appeared, weakly appeared, and disappeared. For example, it was strongly observed in the results that combination of intuitive (N) and feeling (F) traits is not a suitable personality choice for programmer role. The conclusion of this study can be drawn with the statement that personality based software development research needs serious attention to fill the wide gaps. There are numerous ambiguities for practitioners if they intend to put these studies into use.

Keywords: software development, programmer, systematic review, MBTI, personality

1. INTRODUCTION

Software are developed for people by people [1]. This statement which is commonly used to indicate that software development and usage is a human-centered activity. Hence, the success of software projects is also attributed to human aspects [2, 3]. Personality types of team members is one of the important human aspects to ensure the

Received November 12, 2016; revised January 2, 2017; accepted January 26, 2017.
Communicated by Basit Shahzad.

quality of software development projects [4-10]. Personality is defined as a set of internal factors that differentiate a person's behavior for particular situations [11]. Personality forms actions, feelings, thoughts and consistence. It varies from person to person in which each every one maintain different attitude and temper. In addition, it has also been confirmed that a technical sound individual cannot perform satisfactorily in a team environment unless he collaborates with well-formed team based on human aspects: personality types, which is effective way to form software development teams [12]. A plethora of research has been carried out in the past to explore the key importance of team roles and personality types in the software engineering, but what personality types are handy and beneficial for an ideal and effective teamwork is still a question for the researchers and practitioners [2, 13-15]. Numerous models for an effective teamwork have also been suggested, yet they have been disapproved by the researchers and organizations for having ineffectiveness in yielding positive results. The ambiguity of the problem exists in the team composition models where different researchers accentuate on different individual types for an effective teamwork without considering their suitable and effective role in the teamwork [16, 17]. For example, Gorla and Lam [18] found E (Extrovert) trait preference is suitable for programmer role whereas Capretz and Ahmed [19] mentioned I (introvert).

Keeping the importance of personality in view, this study is conducted to explore the literature to know the current focus of the researchers within this domain. In order to discuss the literature on personality aspect, this study has focused the literature of MBTI instrument. The MBTI has been used as a source for identification of personality preferences of an individual. This personality type indicator is used for making theories of Jung applicable and useful in everyday life [20]. Moreover, only programmer role is highlighted throughout the study as it is one of the main software development roles. This study can contribute within the domain of knowledge by several ways: firstly, this study has brought several past and present claims on personality preference together which can reduce the ambiguities. Secondly, practitioners will have clear edge to employ the results for composing software teams with programmers. Lastly, this study has also left certain future directions for researchers interested in software development.

2. RELATED WORK

Software development literature is lacking to provide a handsome amount of review studies on the study topic. Despite of it, certain authors have participated in this domain. For instance, the recent study of Cruz, *et al.*, [21] was based on a systematic mapping review in which software engineering research and personality were focused. This study collected forty years of research, from 1970 to 2010, conducted on personality in software engineering from several publishing platforms. The authors claim that MBTI is the most frequent personality test among software engineering domain. Furthermore, they found that pair programming is the most recurring topic in software engineering. At the end, author also warned the alarming situation, as notified in this study, that there are many contradictories in the past studies. Practitioners and researchers should be well known to those issues before they decide to use them. The authors related these contradictories to different context and methods.

In the same vein, review conducted by McDonald and Edwards [22] also highlights that these issues occurred when an inappropriate personality test is used that definitely lead to weak outcomes. They further identify the problem by adding a claim that user of personality theories sometimes misunderstand them. Authors have recommended that a personality test should be conducted when the following questions are answered: What test is to be used; Is it a recognized and validated test; Are the testers fully trained and qualified to administer the process; How will the process be administered? It shows that contradictions could be caused due to misuse of psychometric test. This study also acknowledges that MBTI test is one of the mostly used personality tests in personality based software development research.

Pocius [23] conducted a review in 1991 for finding the relationship between personality and human-computer interaction. The author divided review into three main topics: programming aptitude and achievement, the programmer personality, and computer-assisted instruction (CAI). Generally, author claimed that introvert (I) preferred programmers are, commonly, effective than extrovert (E). Additionally, the ISTJ, INTJ, and INTP personality types were highlighted effective for programmer role. In the same vein, a review performed by Balijepally *et al.*, [24] also claimed that MBTI is a popular test in software engineering. They also found the effectiveness of Five Factor Model (FFM) among agile developers. Authors also recommend the personality of team members can bring the collaboration and effectiveness in project development. They further maintain that problem solving abilities are influenced by the personality of team members.

According to the best of authors knowledge, there is no single study stated the personality preferences together with programmer role. Therefore, this study has combined the past claims of personality preferences for programmer role. This study has also narrow down the personality preferences claims to bring common personality traits and types from the past studies so that researchers and practitioners can easily access them.

3. METHODOLOGY

In order to meet the major objective of the study, this systematic literature review followed the guidelines of Kitchenham, *et al.*, [25]. A recent review, "Forty years of research on personality in software engineering: A mapping study", conducted by Cruz, *et al*. [21] also followed the same guidelines. Therefore, this study also set these steps as the foundation guidelines to get the better outputs from this review. The steps are:

1. Research questions
2. Inclusion and exclusion criteria
3. Search sources and strategies
4. Study selection
5. Data extraction
6. Synthesis of results

These steps are found common in different fields other than software engineering. For instance, review conducted by Grimshaw, *et al.*, [26], to measure the effects of clinical guidelines on medical practices, also followed these steps.

3.1 Research Questions

In order to contribute to the literature of software development, this study has set following questions to be answered:

Q1. What effective MBTI personality preferences are identified for programmer role in software development research?
  Q1.a. Is there any difference in programmer personality preferences between studies conducted on teams and studies conducted on individuals?
  Q1.b. Is there any difference in programmer personality preferences between studies conducted on students and studies conducted on professionals?
Q2. To what extent the gender is explored in the past studies?

Basically, the first question is kept to see that what personality types and traits are frequently found by past researchers for programmer role. It should be noted that in this study the term personality types and traits are always based on MBTI. Moreover, the parts of first question are designed to get the clear edge to see whether or not the impact of students or professionals and individual or teams on the preferences of personality. The last question is consider in the review after reading the statement of Whipkey (1984) [27] in which he mentions that previous studies have found significant difference between the personality of male and female programmers. Therefore, the last question can contribute, in terms, to avoid "threats to validity" and for future works too.

3.2 Inclusion and Exclusion Criteria

This study, basically, covers two main dimensions of software engineering research: Programmer role and MBTI based personality preferences. Therefore, following criteria were, primarily, consider for inclusion and exclusion after focusing the dimensions.

All studies must include:
(a) Software development/ Engineering studies that highlight personality preferences based on MBTI.
(b) Any personality based studies that focus personality traits/types against programmer's role.
(c) Empirical, theoretical, and Literature studies published in journal and conferences only.

All studies must exclude:
(a) Studies other than English language.
(b) Studies which are not available online (automatic search).
(c) Incomplete, abstract, keynote lectures, reports, dissertations, and books are excluded.
(d) Any studies of software engineering which include personality in general (means which do not focus personality traits/types with programmer role).
(e) Any personality research which does not include software engineering as major.
(f) Studies which were not published online during years January-2000 to December 2014.

3.3 Search Sources and Strategies

The process to collect the studies for the review, this study divided the process into two episodes: Search from Digital Databases/Libraries and Search from References. Hence, the following four digital databases were selected as primary sources:

(a) IEEE (http://ieeexplore.ieee.org/Xplore/home.jsp)
(b) ACM Digital library (http://dl.acm.org/)
(c) ScienceDirect (www.sciencedirect.com) and
(d) Springers (https://www.springer.com/)

Only digital libraries were used to select primary studies for this review in which journal articles and conference papers were focused from year January-2000 to December-2014. Moreover, as the main objective of this study was to find personality preferences for software programmer, therefore, keywords in the following table (Table 1) were finalized to search from the digital libraries:

Table 1. Keywords for search.

Keyword-ID	Keyword	Keyword Alternate
K1	Software development	Software engineering
K2	Programmer	Developer, software engineer, software professional
K3	Myers-Briggs type indicator	MBTI, personality types, traits

With the help of these keywords, year, and paper type (journal article or conference) filters, the mentioned libraries were explored to find the appropriate studies. Moreover, once the studies were selected from "study selection process" then the second phase, Search from References, was performed on the selected studies. The "search from references" process was performed manually and, in which, digital libraries limits were ignored.

Based on the keywords search, the IEEE digital library (http://ieeexplore.ieee.org/) returned almost 1285 journal and conference papers within mentioned years. In the same vein, search from ACM digital library (http://dl.acm.org/) returned around 1090 publications and, whereas, 1113 publications were found in search results on Science Direct (http://www.sciencedirect.com/science/search). Lastly, Springer (https://www.springer.com/) digital library was also searched with same keywords and 1390 publications were returned in the results. Moreover, the process of selecting primary studies was then performed to filter the most related studies based on the research objectives.

3.4 Study Selection

After getting search returns, the study selection process was applied into two different processes: Pre-selection and Selection, based on the Kitchenham and Charters [25] guidelines. The pre-selection process, generally, was applied to filter the studies based on the titles, abstracts, and conclusions. This process helped to shortlist the more relevant studies for the review. Whereas, the selection process was then applied on the pre-selected studies based on the inclusion and exclusion criteria. The whole process of study

selection was performed by two different reviewers simultaneously and the third reviewer was also kept on standby if the difference of agreement occurred. Consequently, no difference of agreement was found by both reviewers. Moreover, the validation on study selection was also performed by selecting and reviewing papers. For that purpose, five selected papers, from each reviewers, were randomly picked and evaluated based on the inclusion and exclusion criteria by the third reviewer. Fig. 1 shows the overall selection process.

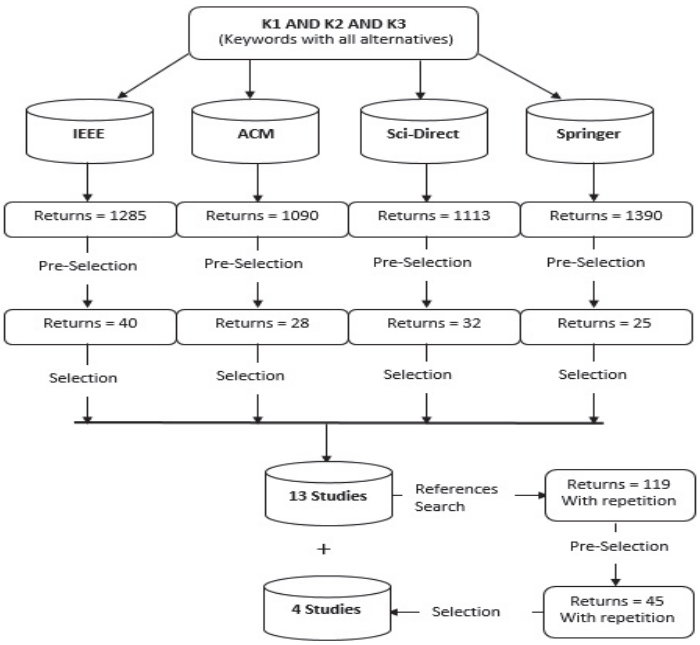


Fig. 1. The study selection process.

It was observed that around 90% of the returns' results were eliminated during pre-selection process. It may be because of the very precise and narrow scope of the study in which only studies were shortlisted those discussed the programmer role with MBTI personality test. Therefore, pre-selection process returned 40 studies from IEEE search, 28 studies from ACM, 32 studies from Science-Direct, and 25 studies from Springer. The selection process was then taken based on inclusion and exclusion criteria on 125 pre-selected studies. Additionally, introduction, methodology, results and discussion portions were also read during selection process. Finally, only 13 studies could fulfill the demand of the study.

The second part of the study selection process was totally based on the final results of the primary search. Therefore, 13 selected studies' references were then explored based on the title of the references without the database and year restrictions. Total 119 references were found related to this study and, of course, with some repetitions. The pre-selection and selection techniques were applied in the same vein as applied during the first part of the study selection. In the end, 4 studies were found from reference search and the size of the dataset grew to 17 studies.

3.5 Data Extraction

The same reviewers worked independently in the data extraction section as performed in the study selection process. It means, two reviewers individually extracted data from selected study dataset and, whereas, the third reviewer performed validation and difference of agreement tasks. Moreover, the data extraction themes were made from the study questions. The data from this process was logically divided into two categories: about basics and about contents. The about basics term referred to study titles, authors, publishers, and years. Whereas, the second category, about contents, extracted data related to study objectives, effective personalities, methods, populations, and study settings. The following table shows all fields which were used to extract data from studies:

Table 2. Data fields for data extraction process.

FieldID	Data field	Type of data
F1	Study Title	Title of study: "Use of MBTI in software engineering course"
F2	Authors	Main author and co-authors: "Abdul Rehman Gilal, Muhammad Yahya".
F3	Year of publication	Year of publication: "2010".
F4	Publisher	Published by: "IEEE".
F5	Study objective	The main objective of the study: "to find the effectiveness of MBTI in software engineering course".
F6	Effective Personality traits or types	The personality traits and types that study have highlighted to be efficient for programmer role either empirically or from literature: "ISTJ was found suitable personality type for programming task".
F7	Method	How did the setup of study was arranged. And which data analysis techniques were used to extract study patterns: "8 quantitative measures were used to identify success in the first programming course and Linear regression was used to model".
F8	Population	Study population: "25 Students or 50 professionals"
F9	Population arrangement	How population was arranged for the study: "teams or individual"
F10	Gender involved	To check whether or not gender involved.

In Table 2, first four fields are for basic information extraction from the dataset. Software Mendeley was used to automatically extract these fields' data. Moreover, fields F6, F8, F9, and F10 were used to find the answer for the questions of this study. In last, field F7 was formulated for data extraction that had helped to extract whether the study is empirical or theoretical and, also, to see the variations in results based on the method of studies.

3.6 Synthesis of Results

In order to find the answer of first question, it was important to synthesis the results of the primary studies. Descriptive synthesis was carried out to tabulate the traits and types of MBTI. The traits and types were tabulated separately, because, some studies

discussed outcomes based on traits and some studies based on types. Therefore, to cop the maximum claims from the studies both sides of MBTI were considered. Moreover, synthesis results were presented in tables and graphs. The basic descriptive analysis was performed using SPSS and Excel software.

Table 3. The types of personality in MBTI.

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ

The description of the synthesis results was based on MBTI, as it was the main objective of the study. The four pairs of MBTI personality traits: Introvert-Extrovert (IE), Sensing-iNtuiting (SN), Thinking-Feeling, and Judging-Perceiving (JP) could make 16 personality types (Table 3).

4. ANSWER TO THE RESEARCH QUESTIONS

In this section of the study, each question is separately answered. All questions' answers are totally based on the results and claims observed from extractions and synthesis.

4.1 Q1: What effective MBTI personality preferences are identified for programmer role in software development research?

In this question, the term "effective" refers to the results and claims suggested for programmer role for composing effective teams in the primary studies. It could also be said that which traits and types have been suggested in the past studies for programmer role to make team effective. Moreover, as mentioned above, this question was designed to answer the ambiguities to researchers and practitioners for programmer's personality.

In order to answer this questions, two objectives were formed to find the appropriate answer. The first objective was to compare programmer personality preferences between studies conducted on teams and studies conducted on individuals. It was, basically, considered to see the difference between the study settings because group project programmers' preferences cannot be generalized with individual programmers. Moreover, it was observed that some studies just used questionnaires for programmers to know the preferences [S3]. Whereas, some studies setup the simulations by assigning projects in teams to know the preferences [S8]. Therefore, the first objective was designed to see whether or not the difference of settings impact the personality preferences for programmer role.

Moreover, the second objective was to compare the personality preferences between academic and industrial programmers. This objective was designed after reading the claim of psychology that personality gets changed by time. Additionally, it is also said that many factors develop the personality preferences: experiences and age. Therefore, in order to verify whether or not the personality preferences of industrial or academic programmers vary from each other.

4.1.1 Team programmers and individual programmers

Firstly, the dataset was categorized based on the type of experiments: study population involved as teams or individuals. In this categorization, it was found that experiments on teams were conducted by 7 studies (*i.e.*, S1, S7, S10, S11, S13, S16, and S17) whereas remaining all 10 studies were conducted by focusing individual programmers. Secondly, all claims were tabulated against traits and types of MBTI. For instance, Martínez *et al.*, [3] claimed that ISTP personality preference is suitable for programmer role. Therefore, from this study, ISTP is extracted as personality type and I, S, T, and P separately were counted in traits table (as mentioned above). In the same vein, all studies were carefully read to bring all claims in one table. Fig. 2 below shows the overall extraction of data from studies in percentage against MBTI traits.

Thirdly, in order to confirm, whether or not, the significant difference exists between these two groups, *t*-test was applied on the groups. The traditional benchmark $P < 0.05$ was considered to accept or reject the difference hypothesis. In this case, it was accepted because the difference value 0.028161 (or $P = 0.028161$) was obtained. Therefore, one cannot generalize the personality preferences for programmer role if the experiment setup was based on individuals or on teams.

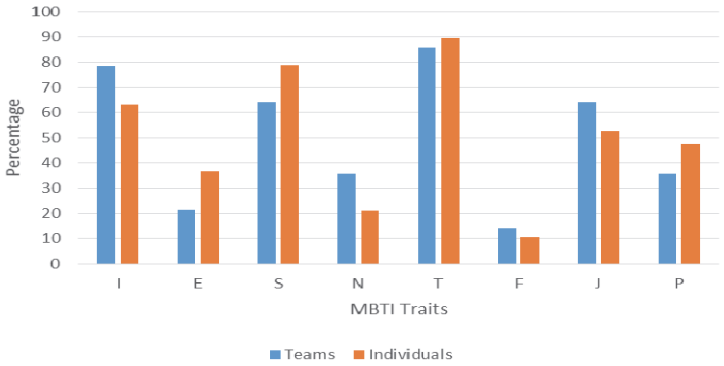


Fig. 2. Programmer MBTI traits' appearance based on teams and individuals.

Lastly, to know the exact differences, each trait was compared one by one from each groups. Based on this review, first major difference occurred in the J-P pair of MBTI. The studies which were conducted on teams, majorly claim the judging (J) trait of personality for programmer. On another hand, in this pair, the both traits of personality were preferred for programmer by studies conducted on individual programmers. It is, may be, because of team experiments are mostly based on a given task in which members tend to remain organized (reflects J trait) [28]. Moreover, the second highest difference was found in I-E pair, in which only two studies [S7][S16] performed on teams, claim that E trait programmers outperformed in their studies. Whereas, the remaining studies from the group highlighted I trait preferences for programmer. On another side, although the cumulative number of I trait for programmer was higher in the studies conducted on individual programmers but, at the same time, 6 out of 10 studies also mentioned the E trait preference for programmer. Therefore, it shows an ambiguity here to decide whether the personality preference for programmer should be I or E trait.

4.1.2 Programmers from industrial and academic settings

This part of the study answers the first question's second objective, in which effective personality preferences were extracted from selected studies by grouping industrial and academic settings. Because, it is said that personality preferences can vary from setting to setting. For example, professional people from software industries are considered more mature than students. Therefore, the second objective was designed to find whether, or not, the differences of personality preferences exist between students and professionals.

The first objective method was used in the second objective to find the answer of the question. In which, firstly, the studies were grouped based on settings: Academic, Industrial, both (academic and industrial). Additionally, two studies, S12 and S15, were non-empirical. For example, study S12, by Capretz and Ahmed (2010), performed by collecting job requirements from newspaper, magazines, and online and then mapped with personality traits of MBTI. In the same vein, study S15 collected personality preferences from reviews based on IS/IT related jobs and hypothesis were made based on unfolding model of LEE and MITCHELL. Therefore, these both studies were eliminated from this part of the study as they do not involve any, either students or professional, programmers. Moreover, two studies, S1 and S6, involved both settings for finding the results. Studies S3, S4, S7, S16, and S17 involved industrial settings and, whereas, remaining 8 studies out of 17 involved academic population. Fig. 3 illustrates the distribution of the studies based settings.

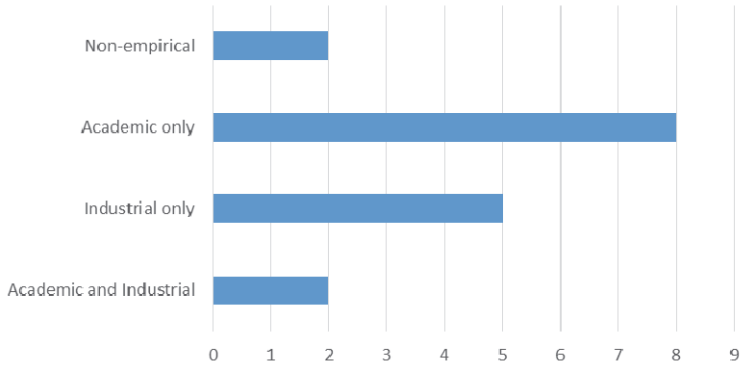


Fig. 3. Studies grouping based on the population settings.

Secondly, the studies data were extracted to trait table for further investigations. For instance, 14 traits claims were extracted from academic groups and 13 claims were extracted from industrial groups. Only two claims were extracted from both studies which use academic and industrial settings: INTJ and ISTP. Based on these two studies, I and T traits were found common and N trait observed with J whereas S trait with P. Keeping in view, third step of applying statistic method to find the significant difference the T-Test was performed on both groups. Following the same benchmark as in first objective (*i.e.*, $P < 0.05$), the significant difference was not found because 0.338343 value of difference was obtained from test. It is, therefore, based on these results, the results from academic settings are generalizable with industrial settings or other way around.

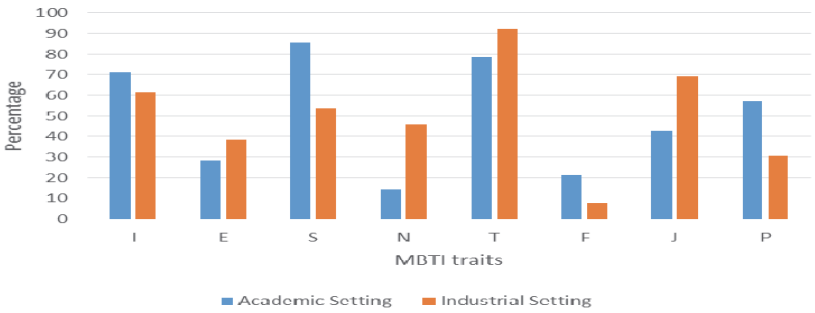
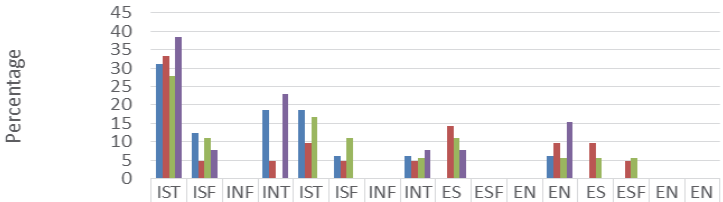


Fig. 4. Academic and industrial settings against MBTI traits.

Even the difference was not significant, however, the JP pair again showed the clear variance in settings. For instance, as shown in Fig. 4 above, programmers from academic settings preferred P trait whereas industrial programmers highly preferred the J trait. Once again, it could be because of the nature of responsibility, as students are generally considered spontaneous (P trait) and job holders are mostly well organized (J trait) [28].

4.1.3 Summary of the first question's answer

Based on the data extraction, three different classes of effective personality types were formed: strongly appeared, weakly appeared, and disappeared. The term strongly appeared states that this class includes all personality types which appeared in all four categories of settings (*i.e.*, teams, individuals, students, and professionals). In the same vein, weakly appeared refers to the personality types' class in which particular personality types appeared in different settings but not in all. Whereas, disappeared class contains all those personality types which were never appeared in any of the primary studies. Fig. 5 summarizes the overall findings of primary studies based on personality types.



	ISTJ	ISFJ	INFJ	INTJ	ISTP	ISFP	INFP	INTP	ESTP	ESFP	ENFP	ENTP	ESTJ	ESFJ	ENFJ	ENTJ
Teams	31	13	0	19	19	6.3	0	6.3	0	0	0	6.3	0	0	0	0
Individuals	33	4.8	0	4.8	9.5	4.8	0	4.8	14	0	0	9.5	9.5	4.8	0	0
Students	28	11	0	0	17	11	0	5.6	11	0	0	5.6	5.6	5.6	0	0
Professionals	38	7.7	0	23	0	0	0	7.7	7.7	0	0	15	0	0	0	0

Fig. 5. Summary of studies based on personality types.

Only four personality types appeared in the strongly appeared class such as ISTJ, ISFJ, INTP, and ENTP. It means, these personality types' findings are common from all the four settings of this study. In the same vein, Varona *et al.*, [S14] also found the ISTJ

is the most frequent personality type for programmers. So based on these personality types, programmer who are less talkative (I) and make decision based on policies and deadlines (T) are frequent and successful in programming jobs [S1]. Moreover, six personality types were never appeared effective by any of the primary studies in this review: INFJ, INFP, ESFP, ENFP, ENFJ, and ENTJ. It could further be investigated that why these six personality types are completely out from the programmer role. In other words, one can conduct the mapping study to find the positive and negative relationship between programmer jobs and these personality types. But, based on these facts, one claim can be made from this study that N and F is not a suitable personality combination for programmer role. Furthermore, remaining six personality types appeared in three or two settings of the studies (not in all). For instance, INTJ, ISTP, ISFP, and ESTP appeared in three settings whereas ESTJ and ESFJ appeared only in two settings (Fig. 5).

It was also observed that professional participant studies have repeated certain personality types: ISTJ (38.46%), INTJ (23.08%), ENTP (15.38%), ISFJ (7.69%), INTP (7.69%), and ESTP (7.69%). In the same vein, seven personality types ISTJ (31.25%), INTJ (18.75%), ISTP (18.75%), ISFP (12.50%), ISFP (6.25%), INTP (6.25%), and ENTP (6.25%) appeared in team settings. Whereas, Individuals and Students settings repeated almost the same personality types except INTJ did not appear in students setting.

4.2 Q2: To what extent the gender is explored in the past studies?

The personality is known as a characteristic of human behavior in psychology. It is also believed in psychology that gender male's characteristics can never be generalized with gender female [29]. In the same vein, as mentioned above, there is a significant difference between the personalities of gender male and female. Even though, it is also mentioned that MBTI calculates the score of T-F pair differently based on the gender type [S2] Therefore, in this study, this question was designed to see, precisely, that how is gender explored by researchers in the past studies. The main intention of this question was to find the gap and future recommendations.

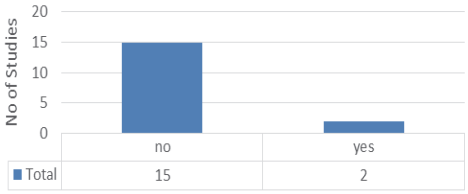


Fig. 6. Gender appearance in the primary studies.

In order to find the answer of this short question, all studies were grouped based on the involvement of gender variable. Only two studies out of seventeen included the gender variable whereas remaining all just discussed personality in general. For instance, study S2 and S14 worked on personality and also discussed the differences of personality based on gender. Moreover, in the study S2 no conclusions were warranted on gender differences and, whereas, study S14 found the higher significant difference in the S-N

and T-F pairs between male and female developers. Only two studies discussed gender and both produced different claims. Therefore, based on these two studies one cannot make a general claim for (either or not) using the different traits of personality for programmer.

5. FUTURE WORK AND RECOMMENDATIONS

This study suggests certain recommendations based on the review performed which can pay betterment in the soft side of software development research. The following recommendations are suggested:

1. Gender is ignored in personality based software development research. The future work can be carried out to find the appropriate personality preferences based on gender.
2. No previous study was found that worked on personality balancing. It means that the past studies only included software development roles and personality preferences. Basically, the personality preferences balancing work should be carried out in this domain to avoid implementation issues.
3. Programmer is not cross validated with other roles of software developments: Team lead, Analyst, Designer, or Tester. Software development jobs are quite often interactive. It was found that, mostly, past studies just either highlighted one role or roles totally independent. The future work should be carried out to validate the programmer personality preferences after cross checking with other roles which frequently communicate with programmer.
4. Only few studies are found on culture diversity. Definitely, personality preferences may vary based on the culture settings. Therefore, cultural diversity must take place in this domain to make the decision clear for practitioners.
5. This study did not find any implication and difference of methodology on results. The future research can also be performed to show the implication of methodological settings on results.

6. CONCLUSION

The conclusion of this study can be drawn with the statement that personality based software development research needs serious attention to fill the wide gaps. The claims from past studies either are suitable for particular settings or for particular geographical areas. There are numerous threats to validity for practitioners if they intend to put these studies into use. For instance, differences in settings can change the preferences of personality. Thus, this study has proposed certain future recommendations to be carried out to bring the maturity in this domain. Based on the conducted survey, 17 primary studies were obtained from search engines and search references. This review intend to answer two basic questions in which the first question was to see the personality preferences among the past studies. Whereas, the second question was to highlight the gender gap among the past studies. Moreover, the first question was divided into two sub questions to see the differences in claims based on the settings: academic vs industrial and indi-

vidual vs teams. Additionally, based on the descriptive synthesis of results, ISTJ, ISFJ, INTP, and ENTP personality types were found effective and most frequent in all the settings. In the same vein, INFJ, INFP, ESFP, ENFP, ENFJ, and ENTJ were less frequent in the past studies. Moreover, it was strongly observed in the results that combination of N and F traits is not a suitable personality choice for programmer role. Finally, from second question's answer, this study recommended the involvement of gender in personality based research in software development for to achieve the better results.

REFERENCES

1. L. F. Capretz, "Bringing the human factor to software engineering," *IEEE Software*, Vol. 31, 2014, p. 102-104.
2. T. Dingsøyr, S. Nerur, V. Balijepally, and N. B. Moe, "A decade of agile methodologies: Towards explaining agile software development," *Journal of Systems and Software*, Vol. 85, 2012, pp. 1213-1221.
3. L. G. Martínez, G. Licea, A. Rodríguez-Díaz, and J. R. Castro, "Experiences in software engineering courses using psychometrics with RAMSET," in *Proceedings of the 15th Annual Conference on Innovation and Technology in Computer Science Education*, 2010, p. 244.
4. S. T. Acuña, M. Gómez, and N. Juristo, "How do personality, team processes and task characteristics relate to job satisfaction and software quality?," *Information and Software Technology*, Vol. 51, 2009, pp. 627-639.
5. A. D. D. Cunha and D. Greathead, "Does personality matter?: an analysis of code-review ability," *Communications of the ACM*, Vol. 50, 2007, pp. 109-112.
6. K. Koroutchev, S. T. Acuña, and M. N. Gómez, "The social environment as a determinant for the impact of the big five personality factors and the group's performance," *International Journal of Human Capital and Information Technology Professionals*, Vol. 4, 2013, pp. 1-8.
7. A. R. Gilal, J. Jaafar, M. Omar, and M. Z. Tunio, "Impact of personality and gender diversity on software development teams' performance," in *Proceedings of IEEE International Conference on Computer*, *Communication*, *and Control Technology*, 2014, pp. 261-265.
8. B. Shahzad and S. A. Safvi, "Effective risk mitigation: a user prospective," *International Journal of Mathematics and Computers in Simulation*, Vol. 2, 2008, pp. 70-80.
9. A. R. Gilal, J. Jaafar, M. Omar, S. Basri, and I. Din, "Balancing the personality of programmer: Software development team composition," *Malaysian Journal of Computer Science*, Vol. 29, 2016, pp. 145-155.
10. A. R. Gilal, J. Jaafar, M. Omar, S. Basri, and A. Waqas, "A rule-based model for software development team composition: Team leader role with personality types and gender classification," *Information and Software Technology*, Vol. 74, 2016, pp. 105-113.
11. I. L. Child, "Personality in culture," E. F. Borgatta and W. W. Lambert, ed., *Personality Theory and Research*, Rand McNally, Chicago, 1968, pp. 82-145.

12. Ç. M. Karapiçak and O. Demirörs, "A case study on the need to consider personality types for software team formation," in *Software Process Improvement and Capability Determination*, Springer, 2013, pp. 120-129.
13. F. Q. B. da Silva, A. C. C. França, M. Suassuna, L. M. R. de S. Mariz, I. Rossiley, R. C. G. de Miranda, T. B. Gouveia, C. V. F. Monteiro, E. Lucena, E. S. F. Cardozo, *et al.*, "Team building criteria in software projects: A mix-method replicated study," *Information and Software Technology*, Vol. 55, 2013, pp. 1316-1340.
14. B. Shahzad, I. Ullah, and N. Khan, "Software risk identification and mitigation in incremental model," in *Proceedings of International Conference on Information and Multimedia Technology*, 2009, pp. 366-370.
15. H. I. Mathkour, B. Shahzad, and S. Al-Wakeel, "Software risk management and avoidance strategy," in *Proceedings of International Conference on Machine Learning and Computing*, 2011, Vol. 3, pp. 477-481.
16. A. R. Gilal, M. Omar, and K. I. Sharif, "A rule-based approach for discovering effective software team composition," *Journal of Information and Communication Technology*, Vol. 13, 2014, pp. 1-20.
17. J. Gulla, "Seven reasons why information technology projects fail," *IBM Corp. August*, Vol. 11, 2011.
18. N. Gorla and Y. W. Lam, "Who should work with whom?" *Communications of the ACM*, Vol. 47, 2004, pp. 79-82.
19. L. F. Capretz and F. Ahmed, "Making sense of software development and personality types," *IT Professional*, Vol. 12, 2010, pp. 6-13.
20. R. Sach, M. Petre, and H. Sharp, "The use of MBTI in software engineering," in *Proceedings of the 22nd Annual Psychology of Programming Interest Group*, Universidad Carlos III de Madrid, 2010, pp. 19-22.
21. S. Cruz, F. Q. B. da Silva, and L. F. Capretz, "Forty years of research on personality in software engineering: A mapping study," *Computers in Human Behavior*, Vol. 46, 2015, pp. 94-113.
22. S. McDonald and H. M. Edwards, "Who should test whom?" *Communications of the ACM*, Vol. 50, 2007, pp. 66-71.
23. K. E. Pocius, "Personality factors in human-computer interaction: A review of the literature," *Computers in Human Behavior*, Vol. 7, 1991, pp. 103-135.
24. V. Balijepally, R. Mahapatra, and S. P. Nerur, "Assessing personality profiles of software developers in agile development teams," *Communications of the Association for Information Systems*, Vol. 18, 2006, p. 4.
25. S. Keele, "Guidelines for performing systematic literature reviews in software engineering," in Technical Report, Ver. 2.3, EBSE, 2007.
26. J. M. Grimshaw and I. T. Russell, "Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations," *Lancet*, Vol. 342, 1993, pp. 1317-1322.
27. K. L. Whipkey and J. T. Stephens, "Identifying predicators of programming skill," *ACM SIGCSE Bulletin*, 1984, pp. 36-42.
28. L. F. Capretz, "Personality types in software engineering," *International Journal of Human-Computer Studies*, Vol. 58, 2003, pp. 207-214.
29. E. M. Bennett and L. R. Cohen, "Men and women: Personality patterns and contrasts.," *Genetic Psychology Monographs*, Vol. 59, 1959, pp. 101-155.

APPENDIX – Selected Papers

[S1] P. Barnes, "Programmer paranoia revisited," in *Proceedings of the 13th Annual SIGCPR Conference*, 1975, pp. 114-131.

[S2] K. L. Whipkey and J. T. Stephens, "Identifying predicators of programming skill," *ACM SIGCSE Bulletin*, 1984, pp. 36-42.

[S3] K. Ketler and R. D. Smith, "Placement, performance and turnover of information systems professionals: implications for HRIS," in *Proceedings of SIG Conference on Computer Personnel Research*, 1993, pp. 131-138.

[S4] J. Teague, "Personality type, career preference and implications for computer science recruitment and teaching," Joy Teague School of Management Information Systems Waurn Ponds Campus Deakin University, 3217, School of Management and Information Systems, 1998, pp. 155-164.

[S5] L. F. Capretz, "Are software engineers really engineers?" *World Transactions on Engineering and Technology Education*, Vol. 1, 2002, pp. 2-4.

[S6] L. F. Capretz, "Personality types in software engineering," *International Journal of Human-Computer Studies*, Vol. 58, 2003, pp. 207-214.

[S7] N. Gorla and Y. W. Lam, "Who should work with whom?" *Communications of the ACM*, Vol. 47, 2004, pp. 79-82.

[S8] A. D. D. Cunha and D. Greathead, "Does personality matter? an analysis of code-review ability," *Communications of the ACM*, Vol. 50, 2007, pp. 109-112.

[S9] L. F. Capretz, "Psychological types of Brazilian software engineering students," *Journal of Psychological Type*, Vol. 68, 2008, pp. 37-42.

[S10] L. G. Martínez, G. Licea, A. Rodríguez-Díaz, and J. R. Castro, "Experiences in software engineering courses using psychometrics with RAMSET," in *Proceedings of the 15th Annual Conference on Innovation and Technology in Computer Science Education*, 2010, p. 244.

[S11] M. Omar and S.-L. Syed-Abdullah, "Identifying effective software engineering (SE) team personality types composition using rough set approach," in *Proceedings of IEEE International Symposium on Information Technology*, 2010, pp. 1499-1503.

[S12] L. F. Capretz and F. Ahmed, "Making sense of software development and personality types," *IT Professional*, Vol. 12, 2010, pp. 6-13.

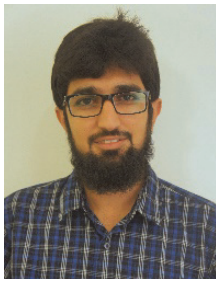
[S13] L. G. Martinez, J. R. Castro, G. Licea, and A. Rodríguez-Díaz, "Towards a fuzzy model for RAMSET: Role assignment methodology for software engineering," *Soft Computing for Intelligent Control and Mobile Robotics*, Vol. 318, 2015, pp. 23-41.

[S14] D. Varona, L. F. Capretz, and Y. Piñero, "Personality types of Cuban software developers," *Global Journal of Engineering Education*, Vol. 13, 2011, pp. 77-81.

[S15] G. Mourmant and M. Gallivan, "How personality type influences decision paths in the unfolding model of voluntary job turnover: An application to IS professionals," *Business*, 2007, pp. 134-143.

[S16] C. M. Bush and L. L. Schkade, "In search of the perfect programmer," *Datamation*, Vol. 31, 1985, pp. 128-132.

[S17] E. A. Buie, "Psychological type and job satisfaction in scientific computer professionals," *Journal of Psychological Type*, Vol. 15, 1988, pp. 50-53.

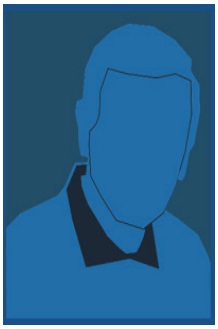


Abdul Rehman Gilal is currently pursuing Ph.D. (IT) from Universiti Teknologi Petronas (UTP), Malaysia. He holds a degree of MSc (IT) from Universiti Utara Malaysia, 2013. His areas of interest are human aspect in software development, complex networks, databases and data mining, programming and cloud computing.

Jafreezal Jaafar is an Associate Professor and former Head of Computer and Information Sciences Department at Universiti Teknologi Petronas, Malaysia. He holds a Ph.D. degree from University of Edinburgh, UK, 2009. He did MAppSc in IT from RMIT University, Australia, 2002 and bachelor's degree in Computer Science from Universiti Teknologi Malaysia, 1998. His main research areas include big data analytics, soft computing and software engineering. He has managed to secure several number of research projects from industry and government agencies. Based on his publication tract record, he had been appointed as a Chief Editor and reviewer for several journals. He also possess a great experience for organizing and participating as a technical chair or member for several international conferences. He was appointed as an Executive Committee member for IEEE Computer Society, Malaysia Chapter in year 2016 and 2017.

Ahsanullah Abro has received his Bachelor degree in Computer Science from Shah Abdul Latif University Khairpur Mir's, Sindh, Pakistan, 2006; MSc IT (by research) from Universiti Teknologi Petronas (UTP), Malaysia, 2011. Ahsanullah Abro is currently pursuing his Ph.D. studies in IT at UTP, Malaysia. Previously, He has worked as Research Associate and Assistant Professor in Public Institutes of higher learning and participated in various academic activities and research projects. He teaches various engineering and ICT courses to undergraduate students. His research interest includes design science, development of engineering and computer science applications, and User Experience (UX) evaluation of systems, products and services.

Mazni Omar graduated with honours degree in Information Technology from Universiti Utara Malaysia in 2000. She received MSc degree in Software Engineering from Universiti Teknologi Malaysia in 2002. In 2012, she received the Ph.D. degree from Universiti Teknologi MARA, Malaysia for a thesis on the empirical studies of agile methodology in humanistic aspects. She began her career as a tutor in School of Information Technology, UUM in 2000. After getting her Master degree, she was appointed as a Lecturer at the same school in 2002. Then, after getting her PhD, she is appointed as Senior Lecturer at School of Computing. Her field of expertise is in software engineering that focuses on human aspects, as well as on data mining and knowledge management. Her field of interest covers across a multi-disciplinary field of computing and social sciences applications to the human aspects of software engineering education.



Shuib Basri was born in Kedah, Malaysia, in 1972. He received the Bachelor degree in IT with Hons from university Utara Malaysia, the MSSE from Melbourne University, Australia in 2001, and Ph.D. degree in Software Engineering from the Dublin City University, Republic of Ireland in 2010. In 2000, he joined the Department of Computer and Information Sciences, University Teknologi Petronas, as a tutor and aster obtain his Master he work as a Lecturer, until now. His current research interests include software quality, software matrix, software process improvement and also research related to big data such as data synchronization and categorization. Shuib Basri is a member of IEEE Malaysia and IEEE computer Society Malaysia and works closely with several industry *e.g.* Microsoft, Malaysia Testing Board and Malaysia Quality Board.

Muhammad Qaiser Saleem is currently working as an Assistant Professor in Collage of Computer Science and Information Technology, Al Baha University, Al Baha, Saudi Arabia Since August 2013. He has completed his Ph.D. (Information Technology) from Universiti Teknologi Petronas (UTP), Malaysia in the year 2013. He has earned his MS in Computer Sciences from Malardalen University, Vasteras, Sweden in the year 2006. He has also obtained an MS degree in Computer Science from International Islamic University, Islamabad, Pakistan, in 1998. He has obtained his BSc in Mathematics and Physics from Punjab University, Lahore, Pakistan, in 1995. During his professional career, he remained involved in academia as well as IT industry in various development projects related to databases and data warehousing environment. Currently, his main research interest is modelling of security requirement during business process modelling in SOA application.