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THE IMPACT OF DARK PERSONALITY TRAITS ON SOFTWARE PROFESSIONALS' PERFORMANCE

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Abstract

The personality of an employee has shown a great impact on workplace outcomes. The dark side as well as the bright side of individuals' personalities play a major role in their job performances. In research mostly the positive traits or bright side of the employees' personalities have been addressed in general workplaces. However, limited work has been done on the personality dysfunctionalities or dark side of employees' personalities. The aim of this research is to assess the personality disorders of software professionals by using a dark personality traits-based model. This assessment is carried out with the help of an instrument that has been designed to study the personality variables of software professionals. The instrument items are based on the Big Five personality traits model to assess overall personality and the Dark Triad traits scale (Jones and Paulhus 2014) to examine personality dysfunctionalities. The results show that 'narcissism' among Dark Triad traits, and 'agreeableness' and 'conscientiousness' from Big Five contain a significant positive relationship with Software Team Performance (STP), whereas the 'extraversion' from Big Five and 'psychopathy' construct of Dark Triad traits were found individually in a negative relationship with STP. The 'extraversion' construct showed an approximately more significant score than 'psychopathy'. In general, the results of this study will be helpful in exploring personality disorders among software professionals and identifying their impacts on their work performance and productivity in the domain of software engineering.

Introduction

The human personality has been under study for a long time and its relationship with work performance in various domains also has been a topic of research. The normal or bright side of the human personality mainly remains the topic of interest for researchers. The big five personality model (Goldberg 1990) has helped psychologists and researchers to perceive the personality dimensions including *extraversion*, *emotional stability*, *agreeableness*, *conscientiousness*, and *openness to experience*, in routine and work life. Consequently, the need of expanding this perception was also raised by several studies in which the big five personality model reported having limitations, as it only covers the normal range of human personality characteristics. The big five personality model or five-factor model (FFM) does not include ambiguous or undefinable terms, for instance, evil, or worthy. In psychological research, the Dark Personality Traits have not been well described within the five-factor framework. The big five personality model or FFM is considered deficient in defining the dark personality traits (S M Spain, Harms, and Lebreton 2014). The absence of these or negative valences has made FFM limited in measuring the personality disorders and dark side of personality (Durrett and Trull 2005).

Personality disorders which are also referred to as dysfunctional dispositions are not related to mental health issues. These are characteristics of human personality and are related to their daily work life behaviors. It is more than a decade since the dark personality traits within the employees of an organization have become one of the popular research areas (Seth M Spain, Harms, and LeBreton 2014). The dysfunctionality of personality or personality disorder has an association with poor occupational performance (R. Hogan and Hogan 2001). The studies conducted to find the impact of dark personality traits within the employees on their work behavior and attitudes have mostly focused on Dark Triad traits including Machiavellianism, Narcissism, and Psychopathy (Paulhus and Williams 2002) and DSM-IV Axis II disorders (R. Hogan and Hogan 2001) which is a taxonomy of clinical disorders.

The Human factor plays an important role in software engineering and for two decades researchers have been investigating various aspects of human involvement in the whole software life cycle (Angelis 2019). In the domain of software engineering, most of the studies were conducted on the positive personality traits of individuals and their relationship with their performance and work environment. Software development is a team-based process and depends upon interactions among the team members. The individual differences among the team members may cause poor interpersonal abilities and can be the reason for project failure as well as poor team performance (Akarsu et al. 2019). To observe the individual differences among software professionals, most of the researchers used a five factor model (FFM) and Myers-Briggs Type Indicator (MBTI) to assess human personalities and their relationship with performance (Soomro, Salleh, and Nordin 2016). Dark Traits in Software Engineering in relationship with performance have not been addressed in any study particularly.

This study aims at exploring the dark personality traits of software professionals and their relationship with their performance. Following are the objectives which are addressed in this research.

- To measure the Dark and Big Five Personality Traits or FFM in software engineering professionals.
- To find the relationship between Dark along with Big Five Personality Traits of software professionals with Software Team Performance.

The remainder of the paper is organized as follows. Section 2 of the paper discussed the background of the study, the research design is elaborated in Section 3, Section 4 describes the instrument used in this research to measure the constructs of the study, model testing and results are reported in Section 5, and the last Section 6 is about the conclusion of the study and discussion.

Background

Software engineering has evolved into the industry and marked its 50th anniversary. The whole software development process heavily relies on humans, the diversity of these humans includes software experts, customers, and other stakeholders. To get things done in a more successful manner with good results, it is important to make interpersonal communication clear among all the relevant personnel.

For the past two decades, Personality and Software Engineering have been studied by researchers and have been a topic of discussion. The software engineering processes are mainly based on software development teams. To get fruitful results from these software teams, it has been studied that the team members' personalities have a strong relationship with their performance. To get a clear perception of their assigned tasks and to observe the progress in those tasks, mutual and frequent interaction among team members is considered mandatory. It has been evident from the literature that many studies agreed upon the fact that software professionals who were previously perceived as programmers only are introverts. Capretz (2003), conducted a study on a sample of 100 software engineers with a ratio of 80% male and 20% female. The aim of the study was to locate the best personality compositions for software professionals. The study used Myers-Briggs Type Indicator as a tool to investigate the software professionals' personalities, which resulted in that they are most probably STs (Sensing plus Thinking) or TJs (Thinking and Judging), or NTs (Intuitive and Thinking). The study also reported that more software professionals were found introverts than extroverts. It has been affirmed by a general study that personality traits have a strong influence on human behavior while working in teams (Martínez-Miranda and Pavón 2010). Studies on team building and teamwork in software engineering also emphasized personality factors, for example, a study on software team development mentioned that the personality of a team leader has an impact on the success of a team (J. M. Hogan and Thomas 2005). In another study by Whitworth (2008), the focus was stressed on the socio-psychological environment for best team performances in agile teams. The author mentioned that the involvement of team members in discussions with each other on a daily basis can raise the productivity of the team.

Personality and performance in software engineering have been tested in a study by Feldt et al. (2010) by using the IPIP 50-item scale based on FFM and performance by considering the theory of the Blumberg and Pringle model (i.e., capacity, willingness, and opportunity). In this research, the results of a total 47 respondents from 10 different companies, stated that personality has a strong association with performance. It is also strongly recommended by the authors to focus on personality psychology in the software engineering research domain to produce knowledge, helpful for managers in team building.

The literature on personality and team performance was found scarce in the software engineering domain. In a study conducted by Ferreira and Langerman (2014), to assess a relationship between individual performance and personality type, MBTI is used to map the personality type and Belbin's theory of team roles for finding suitable roles in requirement analysis and development phases. The results presented that the individuals can be varied according to their unique characteristics and certain personality compositions are suitable for specific task assignments. The way individuals perceive the information and apply the knowledge may differ from one personality type to another. This helps in understanding each person's role in a team and task assignment as per their capability.

Most of the personality studies were carried out with an aim of finding the best personality composition for an individual to fit in a team or lead a team and eventually improve individual or group performance. From the literature, it can be found that the intense or negative aspects of personality were covered in limited studies and

dysfunctional traits were mostly overlooked by researchers in the domain of software engineering.

Kosti, Feldt, and Angelis (2014) conducted a study on intense personality by taking software engineering (SE) students as subjects. They classified the personalities of SE students into "Intense" and "Moderate", this classification has been done by using the Five Factors Model (FFM) scores. The authors also include emotional intelligence and self-compassion as constructs and associated them with work preferences. To measure these personality traits, they have used TEIQue and Self-compassion tests respectively. Their results emphasized that emotional psychometric tests can be helpful in analyzing work preferences in software engineering. In another research by Agrawal et al. (2015), conducted on pair programming teams, the positive and negative aspects of programmers' personalities were discussed in relationship with team performance and team composition. Instead of addressing the negative side exclusively or measuring it with a specific psychometric instrument, the authors performed a general analysis by including three constructs to measure the negative aspects of personality namely *Alexithymia*, *Insomnia*, and *Obsessionality*. Whereas the traits like Discrete, Gregarious and Exuberant were taken as positive personality traits.

For a long, the FFM has been considered a unified framework to assess the normal and abnormal dimensions of an individual personality. Instead, the common structural basis among the normal and abnormal personality traits, the industrial-organizational psychology grew on a number of personality models e.g., DSM-IV and V to measure maladaptive behaviour in the workplace (Wille and Fruyt 2014), Dark Triad traits to measure counterproductive work behaviors (CWB) (Cohen 2016), Hogan Development Survey (HDS) for the dark side of personality and negative/positive organizational attitudes (Palaiou, Zarola, and Furnham 2016), Psychological contracting for offender personality disorder (OPD) (Harvey and Ramsden 2017), the honesty-humility dimension of HEXACO model considered as an opposite pole of dark personality (Templer 2018), Short Dark Triad personality test to find relationship among dark personality and motivation at work (Prusik and Szulawski 2019), Dirty Dozen scale to measure dark triad traits at wider scale covering forty nine countries (Jonason et al. 2020). Moreover, in a study (Grover and Furnham 2021) on situational differences, the authors measure the dark triad traits exclusively by using three various scales for each of the traits, e.g. The Levenson Self-Report Psychopathy (LRSP), Narcissistic Personality Inventory (NPI), MPS for Machiavellianism. In another detailed study (Truhan et al. 2021) on dark triads, multiple scales have been used which include Short Dark Triad and Dirty Dozen, FFNI–Short Form and NPI for narcissism, MACH-IV to assess Machiavellianism and SRP-4 to measure Psychopathy.

Among all, the dark triad concept has been repeated in many research works. Paulhus and Williams (2002) proposed the concept of the Dark Triad, which includes three socially undesirable yet subclinical personality traits Machiavellianism, Narcissism, and Psychopathy. Individuals possessing these traits are often associated with manipulative and harmful behaviors, leading to problematic interpersonal relationships. Machiavellianism describes individuals who show little empathy and frequently manipulate others to achieve personal goals. Narcissism is defined by a strong desire for admiration and recognition, with individuals often displaying a sense of superiority in their interactions. Psychopathy is characterized by impulsiveness, self-interest, and emotional detachment, often resulting in antisocial tendencies and disruptive social behavior. The summary of workplace literature covering the measurement of the dark side of personality by using various scales is listed in Table 1.

Table 1: *Summary Of Studies With Dark Traits Measurements*

Studies	Constructs	Psychometric instrument
(Wille and Fruyt 2014)	Maladaptiveness	DSM IV and V
(Cohen 2016)	Counterproductive Work Behavior	Dark Triad traits
(Palaiou, Zarola, and Furnham 2016)	Personality Dark Side	HDS
(Harvey and Ramsden 2017)	Offender Personality Disorder	Psychological contracting
(Templer 2018)	Honesty-Humility dimension	HEXACO
(Prusik and Szulawski 2019)	Dark Triad traits, Motivation	Short Dark Triad
(Jonason et al. 2020)	Dark Triad traits	Dirty Dozen Scale
(Grover and Furnham 2021)	Dark Triad traits	LRSP, NPI-16 and MPS
(Nguyen, Pascart, and Borteyrou 2021)	Dark Triad traits	Short Dark Triad
(Truhan et al. 2021)	Dark Triad traits	SD3 and DD, FFNI-SF and NPI, MACH-IV, and SRP-4

Research Design

This research has followed an exploratory approach to address the research objectives. This research has used purposive sampling which is a form of non-probability sampling technique. In total, the subjects of this study are fifty-one (51) software professionals affiliated with software houses situated in various countries. It is more challenging to conduct research on subjects belonging to a certain industry which is why the studies with software professionals as subjects of study possess a small sample size, e.g., 47 (Feldt et al. 2010). Therefore, the majority studies are conducted in an academic setup with student subjects.

In this study, most of the professionals reached for data collection, are working in software houses located in Pakistan i.e., 41.67% of the total. The rest of the distribution belongs to the Middle East (12.5%), India (10.42%), Europe (10.41%), USA and Canada (14.58%), Malaysia (8.33%), and Korea (2.08%).

Most of the professionals are male (82.35%), qualification-wise most of them are with master's degrees (52.94%). The role-wise distribution shows that 70.83% are Project Managers (Table 2). The roles of these software professionals are classified as *Project Managers*, *Domain Representatives*, and *Stakeholders* (Henderson and Lee 1992). The brief descriptions for each of these roles were placed in the questionnaire to help the respondents in choosing the correct one. The role definition of a *Project manager* is a focal person who can be an expert in any of the areas of an information system or information technology e.g., in system design or development, programming, etc. The *Domain Representatives* are experts in defining the business functions and customers' needs. The *Stakeholders* are individuals who are not the main part of software projects but have an impact on team performance (Henderson and Lee 1992).

Table 2: *Demographic Statistics*

Variable	Values	Response Rates
Gender	Male	82.35%
	Female	17.65%
Age	< 30 years	35.29%

	30-35	54.90%
	36-40	7.84%
	> 40	1.96%
Academic Level	Diploma	5.88%
	Undergraduate Degree	37.25%
	Master's degree	52.94%
	PhD Degree	3.92%
Work experience in teams	< 2 years	18.75%
	2 – 4 years	39.58%
	5 – 8 years	31.25%
	> 9 years	10.42%
Project Size	Small (<30 functionalities)	13.73%
	Medium (between 30 and 100)	37.25%
	Large (>100 functionalities)	49.02%
Experience in designing and implementing software?	< 2 years	14.58%
	2 – 4 years	25.00%
	5 – 8 years	35.82%
	> 9 years	25.00%
Role	Domain Representatives	25.00%
	Project Manager	70.83%
	Stakeholders	04.17%

Instrument

A research questionnaire has been designed to investigate the main constructs of this study namely, Machiavellianism (M), Narcissism (N), and Psychopathy (P), and their impacts on software team performance (STP). To measure these constructs, this study adopted a Dark Triad scale (Jones and Paulhus 2014). This research also administered the IPIP items to measure general personality traits namely Extraversion (E), Agreeableness (A), Conscientiousness (C), Emotional Stability (ES), and Intellect (I), and their effects on STP (Figure 1). To keep the responses unbiased the items from Dark Triad and IPIP scales were randomized in their order. The software team performance is measured by using the scale by Guinan, Cooprider, and Faraj (1998).

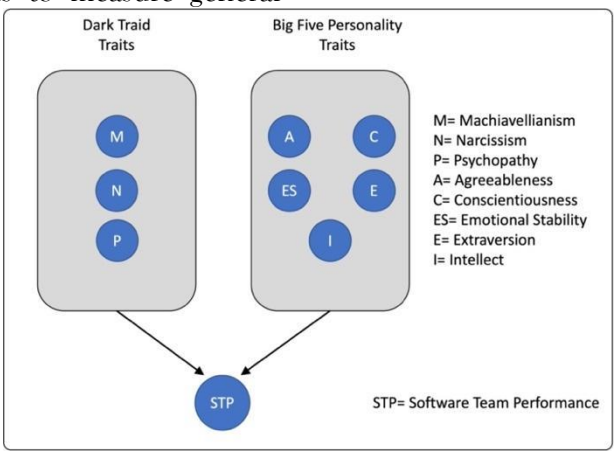

Figure 1. Research Model

In the original version of the Dark Triad scale, the constructs *Machiavellianism* and *Narcissism* contained 13 items each, and 15 items in *Psychopathy* construct. In this study, the number of

selected items for *Machiavellianism* and *Narcissism* is 8 in each of the constructs, and 6 items in *Psychopathy* construct. The main idea of choosing limited items for the mentioned factors is that there are some items having reversal scales and direct phrases, which may cause bias in respondents' responses. However, the language of the items is unchanged. The list of the chosen items is as follows:

1. Machiavellianism Measure

M1. It is unwise to share your secrets with others.
M2. Most successful people in the world live ethically sound lives.
M3. In general, people tend not to work hard unless it is necessary.
M4. You should do whatever is needed to gain the support of influential individuals.
M5. It is better to avoid direct conflicts, as others may be beneficial to you later.
M6. It is smart to remember information that could be used against others in the future.
M7. Certain things should be concealed from others to maintain your reputation.
M8. You should wait for the appropriate moment to take revenge on others.

2. Narcissism Measures

N1. Others perceive me as someone who naturally takes the lead.
N2. I feel uninterested when spending time with average people.
N3. Group activities often feel unexciting without my presence.
N4. Individuals with talent and attractiveness should display them openly.
N5. I enjoy building connections with influential people.
N6. I demand the level of respect I believe I deserve.
N7. I have been likened to well-known personalities.
N8. I tend to show off when given the opportunity.

3. Psychopathy Measures

P1. I enjoy taking revenge on authority figures.
P2. I seek out exciting and risky experiences.
P3. Others often describe me as lacking self-control.
P4. It is important to seize opportunities whenever they arise.
P5. Those who provoke me usually end up regretting it.
P6. I am willing to say anything to achieve my goals.

This research also incorporated the measurement of the Big Five Personality traits of software professionals, the five personality traits are namely *Extraversion*, *Agreeableness*, *Conscientiousness*, *Emotional Stability*, and *Intellect*. To measure these personality traits, this study particularly used the selected items from the 50-item IPIP version of the Big Five markers. This inventory was chosen due to its flexibility in item order arrangement and public availability. It is also allowed to edit the language or wording of items, mixing of these items with non-IPIP items, shorten the existing IPIP scales or combine with longer scales. Each construct contained 6-items and to keep the consistency, all the items of the questionnaire were measured by using a 7-point Likert scale. The selected items are listed below:

1. Extraversion

E1. I am often the most lively person at social gatherings.
E2. I feel at ease when I am around others.
E3. I usually initiate conversations.
E4. At parties, I interact with many different people.
E5. I am comfortable being the focus of attention.
E6. I tend to be reserved when I am with unfamiliar people (reverse-key item).

2. Conscientiousness

C1. I am consistently well-prepared.
C2. I focus carefully on details.
C3. I complete tasks without delay.
C4. I prefer organization and structure.
C5. I adhere to a planned schedule.
C6. I am precise and thorough in my work.

3. Intellect

I1. I possess a broad vocabulary.

I2. I have a strong and imaginative mind.
I3. I grasp concepts quickly.
I4. I tend to use complex words.
I5. I often spend time thinking deeply about things.
I6. I generate many ideas.

4. **Agreeableness**

A1. I show genuine interest in others.
A2. I empathize with how others feel.
A3. I am kind-hearted and compassionate.
A4. I make time to support others.
A5. I am sensitive to others' emotions.
A6. I help others feel comfortable around me.

5. **Emotional Stability**

ES1. I remain calm most of the time.
ES2. My mood tends to fluctuate frequently.
ES3. I rarely feel sad or down.
ES4. I am not easily upset by situations.
ES5. I seldom become angry.
ES6. I rarely feel annoyed or irritated.

The main aim of this study is to measure the impact of software professionals' personality traits on software team performance. There are several scales developed to measure team performance based on objective measures (Sawyer 2001) and perceptual measures (Henderson and Lee 1992; Guinan, Cooprider, and Faraj 1998). This study has used the perceptual measures, the Team-Rated performance (Guinan, Cooprider, and Faraj 1998). The items for Software Team Performance measures are listed below.

STP1. The number of new ideas or innovations produced by the design team.
STP2. Our effectiveness in coordinating with each other.
STP3. Our standing for delivering high-quality work.
STP4. Our capability to achieve project objectives.

Analysis and Results

The results were gathered in two parts, the first was for Dark Triad and the second for Personality Traits IPIP items.

Dark Triad Traits

The three Dark Triad constructs Machiavellianism (M), Narcissism (N), and Psychopathy (P), and their relationship with software team performance (STP) were measured by PLS-SEM with the help of SmartPLS software. The PLS algorithm for path analysis was set to 1000 iterations with stop criterion 7. In the first run the factor loadings for the Dark Triad constructs were weak, after dropping some poor indicators in the third run, the loadings improved. With an intention to keep at least 3 indicators per construct, the loadings were retained. Table 3 illustrates the factor loadings for Dark Triad traits.

Table 3: Factor Loadings (Dark Triad traits)

Constructs	M	N	P	STP
M2	0.707			
M3	0.658			
M4	0.400			
M7	0.433			
N1		0.599		
N4		0.780		
N5		0.681		
N6		0.542		
P1			0.844	
P2			-0.423	
P4			-0.483	
STP1				0.754
STP2				0.873
STP3				0.908

STP4	0.914

In total eleven (11) items were dropped out of twenty-two items of Dark Triad traits. The Machiavellianism, and Narcissism constructs lost four (04) items each, whereas the Psychopathy construct retained three (03) items after dropping out three (03) with weak loadings (Table 4).

After the execution of the PLS algorithm, eleven (11) items have been dropped out of twenty-two (22) items of Dark Triad traits due to weak loadings. So, Machiavellianism and Narcissism constructs were retained with four teams each, whereas the Psychopathy construct was retained with three items. The dropped-out items are listed below, with the item number followed by the item statement.

To measure the internal consistency in scale the construct reliability and validity for Dark Triad traits have been established. The computed results of Cronbach's alpha show poor value for the construct *Psychopathy* (0.010) and low for *Machiavellianism* (0.395) i.e., < 0.5. Therefore, the composite reliability was considered which also yielded poor results for *Psychopathy* (0.002) but acceptable for *Machiavellianism, Narcissism*, and *Software Team Performance* constructs. Nevertheless, the average variance extracts (AVEs) are not good for any of the Dark Triad constructs. Table 4 shows the results of construct reliability and validity of Dark Triad traits.

Table 4: ***Construct Reliability and Validity (Dark Triad traits)***

Construct	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance
M	0.395	0.315	0.639	0.320
N	0.543	0.577	0.739	0.420
P	0.010	0.126	0.002	0.375
STP	0.886	0.900	0.922	0.748

The final check has been done by considering the discriminant validity in terms of the Fornell-Locker Criterion that shows good values for squares of AVE which is higher than any of the inter-factor correlations. Similarly, the Heterotrait-Monotrait Ratio was good for all constructs except the Psychopathy construct, which must be beneath 1 (see Table 5).

Table 5: ***Discriminant Validity***

Validity Methods	Constructs	M	N	P	STP
Fornell-Larcker Criterion	**M**	0.565	0.32	-0.164	0.373
	N		0.648	-0.387	0.567
	P			0.612	-0.468
	STP				0.865
Heterotrait-Monotrait Ratio	**M**		0.769	1.148	0.491
	N			0.955	0.78
	P				0.654

The path measurements for the Dark Triad traits and their individual impacts on software team performance (STP) construct were not found much significant except for the Narcissism trait because of its p-value < 0.01. Machiavellianism possessed a positive but not significant relationship with the STP construct, whereas the Psychopathy trait result shows a negative relationship with software team performance. To affirm the significance of the results, PLS Bootstrapping was executed which produced t-statistics instead path weights, which are required to be greater than 1.96 at a 95% confidence level. The results show that the Narcissism traits significantly possess a much higher value i.e., 3.035 than Machiavellianism (1.351) and Psychopathy (0.934) traits (see Table 6).

Table 6: *Path Coefficients (Dark Triad traits)*

Constructs	Path Values	t-statistics	p values
M→ STP	0.200	1.351	0.177
N→ STP	0.393	3.035	0.002
P→ STP	-0.283	0.934	0.351

Big Five Personality Traits

The questionnaire contained the items for Big Five Personality traits to assess *Extraversion* (E), *Agreeableness* (A), *Conscientiousness* (C), *Emotional Stability* (ES), and *Intellect* (I) constructs in software professionals' personalities. The factor loadings for these traits show better results than Dark Triad Traits except few items with weak factor loading, which were dropped out to refine the results. Table 7 illustrates the factor loadings for Big Five Personality traits.

Table 7: *Factor Loadings (Big Five Personality traits)*

Constructs	A	C	ES	E	I	STP
A1	0.568					
A2	0.790					
A3	0.668					
A4	0.535					
A5	0.804					
A6	0.764					
C1		0.734				
C2		0.838				
C3		0.640				
C5		0.770				
C6		0.690				
ES4			0.655			
ES5			0.635			
ES1			0.810			
ES2			0.641			
E1				0.584		
E2				0.770		
E3				0.661		
E4				0.618		
E5				0.753		
I2					0.780	
I3					0.784	
I5					0.679	
I6					0.707	
STP1						0.755
STP2						0.874
STP3						0.907
STP4						0.913

After the execution of the PLS algorithm on Big Five personality traits, there are six times that have been dropped out of thirty items due to weak loadings, which is less than 0.5. From Conscientiousness and Extraversion traits one item for each has been dropped and from

Emotional Stability and Intellect traits, two items for each have been dropped.

The construct reliability and validity for Big Five personality traits resulted are good, i.e. Cronbach's alpha for all constructs is higher than 0.5. The composite reliability is higher than 0.8 for all Big Five traits except emotional stability i.e. 0.781 as shown in Table 8. The average variance extracts (AVEs) values for Conscientiousness and Intellect traits meet the required value i.e. > 0.5, whereas the Agreeableness, Emotional Stability, and Extraversion possessed AVEs of approximately 0.5.

Table 8: ***Construct Reliability and Validity (Big Five Personality traits)***

Constructs	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance
A	0.786	0.812	0.847	0.455
C	0.791	0.812	0.855	0.544
ES	0.659	0.731	0.781	0.474
E	0.741	0.652	0.811	0.464
I	0.727	0.746	0.827	0.546
STP	0.886	0.898	0.922	0.748

The discriminant validity of Big Five Personality traits similarly to Dark Triad traits has been computed in terms of the Fornell-Larcker Criterion that shows good values for squares of AVE which is higher than any of the inter-factor correlations. Similarly, the Heterotrait-Monotrait Ratio is good for all constructs as no construct has possessed an HTMT higher than 1(see Table 9).

Table 9: ***Discriminant Validity (Big Five Personality traits)***

Validity Methods	Constructs	A	C	ES	E	I
Fornell-Larcker Criterion	A	0.696				
	C	0.625	0.738			
	ES	0.398	0.308	0.689		
	E	0.564	0.632	0.306	0.681	
	I	0.699	0.666	0.462	0.453	0.739
	STP	0.691	0.734	0.440	0.396	0.694
Heterotrait-Monotrait Ratio HTMT	A					
	C	0.785				
	ES	0.621	0.461			
	E	0.677	0.769	0.371		
	I	0.898	0.836	0.592	0.541	
	STP	0.772	0.847	0.512	0.406	0.838

The path analysis for the Big Five personality traits towards software team performance (STP) construct is not found significant Conscientiousness with a 0.537 path value, 3.923 t-statistic, and p < 0.01. This is followed by Agreeableness with path value 0.331 and t-statistics value 2.392 but the p-value is found slightly higher than 0.01 i.e., 0.017. The emotional stability and intellect constructs have shown not many significant impacts on software team performance whereas the Extraversion result shows a weak and negative relationship with STP construct having path value -0.242, t-statistic value 1.759, and p-value 0.079 which is much higher than 0.01 (see Table 10).

Table 10: ***Path coefficients (Big Five Personality traits)***

Constructs	Path Values	t-statistics	p values
Agreeableness → STP	0.331	2.392	0.017

Conscientiousness → STP	0.537	3.923	0.000
Emotional Stability → STP	0.149	1.452	0.147
Extraversion → STP	-0.242	1.759	0.079
Intellect → STP	0.146	0.876	0.381

Discussion And Conclusions

Human personality has remained a topic of discussion for a long time and its relationship with workplaces and the environment also has been investigated by many researchers. In the domain of software engineering, personality and its relationship with the workgroup environment are also being investigated in several ways. In this study, the software professionals' personality was measured in terms of dysfunctionality and for this Dark Triad traits *Machiavellianism*, *Narcissism*, and *Psychopathy* were measured by using Jones and Paulus scale (Jones and Paulhus 2014). Software engineering and development heavily rely on teamwork and collaboration, therefore this study also aimed to check the effects of these dark personality traits on software team performance. To keep the responses unbiased and undoubtful the Dark Triad traits items were shuffled and mixed with the IPIP measures for the Big Five personality traits Agreeableness, Conscientiousness, Emotional Stability, Extraversion, and Intellect. After response collections, the items were reorganized and categorized construct-wise. The subjects of this research were software professionals affiliated with different software houses situated in various countries. The sampling of these professionals is done by using a non-probability-based technique namely purposive sampling. It was used as the subjects of this study were reached by using personal contacts and further snowballing technique has been incorporated to reach other professionals in their acquaintances.

The sample size could not reach more than fifty-one responses. It has been observed that it's hard to target professionals as a subject of study and make them spare their time in the process of data collection. The testing of models is initiated by checking the construct reliability and validity as this may give poor results in case of a problematic sample size. The Cronbach alpha for Dark Triad traits was found above 0.5 for Narcissism i.e., 0.543, therefore the composite reliability has been considered to continue with model testing which shows better values for Machiavellianism, and Narcissism but a very low value for Psychopathy i.e., 0.002. The results for the Psychopathy construct were found poor in discriminant validity criteria, the HTMT was higher than 1 i.e., 1.148. In path modeling, the effect of the Psychopathy construct was found different from the other two traits on software team performance which was negative and weak i.e., -0.283, and its t-statistics 0.934. This infers that either the items for these constructs are required to be revised or restructured. The factor loadings for this construct showed more weak items in comparison to the other two constructs. Out of six items, only one item with the statement "I like to get revenge on authorities." has shown higher factor loading i.e., 0.844. To retain at least 3 items per construct the two more items were kept with weak loadings which were approximately near 0.5. In other words, the construct of psychopathy due to its loading was nearly about to drop out. Which shows that it has no significant relevance to STP.

To examine the combined effect of all independent constructs of Dark Triad traits on software team performance construct (STP) R2 is observed. R2 shows the value of the proportion of independent variables related to variance in all independent variables, in our study this value was found 0.430 which implies that Dark triad traits explain 43% of the variation in STP Figure 2.

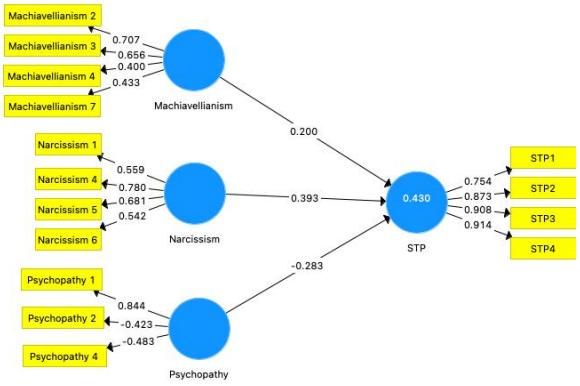

Figure 2. Path Analysis (Dark Triad traits)

The Big Five traits showed much better and more acceptable outer loadings than Dark Triad traits. The Agreeableness constructs retained all its six (06) items with acceptable factor loadings i.e., > 0.5. The constructs also showed stability and dropped a single or two items by retaining other items with cutoff values > 0.5. The construct reliability and validity of Big Five personality traits were impressive and Cronbach's alpha was found greater than 0.7 for all constructs except for Emotional Stability which was 0.659, which is still above 0.5 i.e., required. The computed values for composite reliability were also good and AVE values were also found acceptable except for Emotional Stability and Extraversion which were approximately 0.5. The construct reliability and validity, along with discriminant validity show good scores for the Big Five personality traits. Whereas the path analysis results were significant in terms of t-statistics for Agreeableness and Conscientiousness with p values of 0.017 and 0.000 respectively in a positive relationship with STP. The Emotional Stability and Intellect constructs showed positive but weaker relationships with STP, consecutively with p values 0.147 and 0.079. The Extraversion resulted in a negative path value of -0.242, and a t-statistic value of 1.759 which is lower than 1.96 and cannot be considered significant but approximately near to it. The combined effect for all the five constructs on STP was found much higher than the R2 for the dark triad model i.e., 0.694, which explains that the Big Five personality traits define a 69.4% proportion of variance in STP Figure 3.

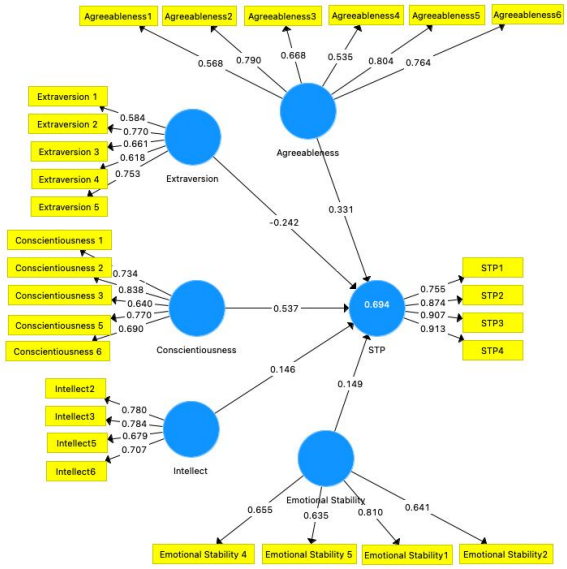

Figure 3. Path Analysis (Big Five Personality traits)

It can be summarized from both models that the personalities with Narcissism in the dark spectrum and Agreeableness along with Conscientiousness have a strong impact on software team performance. The software team performance construct showed stability by keeping the high factor loadings in both models and in retaining all its items.

This research will drive the attention of researchers to explore the software professionals' personalities in terms of dysfunctionality and to investigate the dark side of human psychology in the domain of software engineering. The findings of this research would be helpful for software project managers when making the decision to select the right team members to compose software development teams with the aim to increase team productivity and performance.

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