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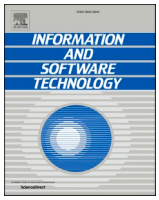

The impact of stressors on the relationship between personality traits, knowledge collection behaviour and programmer creativity intention in software engineering

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ABSTRACT

Context: Individual and contextual factors have a profound impact on an individual's creativity. In the first part of this research, we concluded that, for a programmer's creativity intention, individual factors including big 5 personality traits and knowledge collection behaviour play a key role. However, it is important to bring contextual factors into the model to provide a holistic understanding.
Objectives: Hence, the objective of the present research is to expand the earlier work by (i) identifying the software engineering occupational stressors relevant to programmers, and (ii) examining their impact as moderators for the relationship between individual factors (i.e., big five personality traits and knowledge collection behaviour) and the creativity intention of the programmer.
Methods: To analyse the moderating impact of 6 stressors, the survey questionnaire was used to collect data from 294 programmers working in software companies in Pakistan. The data were analysed using the Structural Equation Modelling (SEM) – Partial Least Square (PLS) technique.
Results: The findings revealed that in the presence of a moderate level of stress, the relationship between knowledge collection behaviour and creativity intention was strengthened. Furthermore, stressors interacted differently with different personality traits. An overarching statement could be that most of the stressors positively moderated the relationships between different personality traits and creativity intentions. However, contrary to the prior research, the majority of the stressors negatively affected the impact of the openness to experience trait on creativity intention.
Conclusion: The research significantly contributes to the body of knowledge of behavioural software engineering. The findings of this research are novel and intriguing in many aspects and will benefit software organizations to increase innovation, by increasing programmers' creativity through mitigating stress. The study is also one of the few studies which have attempted to understand the interaction between individual and contextual factors with a programmer's creativity.

Abbreviations: CTC, Componential Theory of Creativity; KCB, Knowledge Collection Behaviour; BF, Big Five; BFI, Big Five Inventory; GSD, Global Software Development; TPB, Theory of Planned Behaviour; FOO, Fear of Obsolescence; JC, Job Complexity; QD, Quantitative Demands; MRC, Missing Requirements from Clients; PSS, Poor Supervisory Support; BPR, Bad Peer Relations / Poor Co-worker support; AVE, Average Variance Extracted; VIF, Variance Inflation Factor; BSE, Behavioural Software Engineering.

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1. Introduction

Creativity, a fundamental driver of development and growth across many disciplines, holds increasing importance in today's knowledge-centric, globally competitive and dynamic workplace [1,2]. Consequently, there is a growing demand within the research community to explore creativity [3], including its importance in software engineering where it holds a pivotal place along with human knowledge and collaboration [4–6]. It has been argued that the ability of software developers to come up with solutions which are creative is critical for software companies [7,8]. The advocates of agile methods, one of the prevalent techniques in software engineering, believe that the only way to solve complex development problems in software engineering is through creativity and not written rules [9,10]. Despite the significance of creativity in software engineering, according to Graziotin et al. [11], the topic has been largely neglected in previous research. It is evident that in order to understand creativity and to promote it in software organizations, it is important to study the underlying processes and antecedents.

According to the Componential Theory of Creativity (CTC) [12], the antecedents, which can stimulate or inhibit creativity, include individual as well as contextual factors. Individual factors refer to the factors that are intrinsic to an individual and the extrinsic factors includes all those factors which are *'outside'* an individual. In modern organizations, the interaction between these two types of factors is complex [13,14]. Therefore, it is essential to identify and investigate not only the individual and contextual factors that enhance or inhibit creativity but also the interaction between them [15]. Pirzade [16] believes it is equally important in the field of software engineering, where the research work on the recognition of individual and contextual antecedents of creativity is inadequate.

To fill this void, a conceptual framework for the individual and contextual antecedents of a programmer's creativity was proposed by Amin et al. [17], which included the Big Five (BF) personality traits and Knowledge Collection Behaviour (KCB) as individual factors, and occupational stressors as contextual moderators. Later, based on the proposition of this conceptual framework, Amin et al. [18] empirically validated and published the framework for the impact of individual factors alone, including the big five personality traits and KCB, on a programmer's creativity intention. The results of the study showed that KCB and the personality factors of openness to experience, conscientiousness, and extraversion positively predicted a programmer's creativity intention. However, the programmer's intention to be creative was unaffected by agreeableness, but it was adversely predicted by neuroticism. In addition, it was discovered that creativity intention positively and strongly predicts programmers' creative behaviour.

However, as mentioned earlier, apart from the individual factors, it is also essential to understand the impact of contextual factors as well as the interaction between individual and contextual factors. Favourable contextual factors increase the interest and excitement of employees towards the content of their employment [15,19] leading to an increase in creativity. Researchers, over the period of time, have identified contextual antecedents of creativity including the psychological and organisational ones [3,20,21], but there are still voids in this field of research [1]. Recent study shows that one such contextual factor is stress, which is inadequately studied antecedent of creativity [3]. It is believed that the existing research on the impact of stress on creativity is inconclusive [1], with scholars suggesting a negative [22], positive [20] and a curvilinear relationship between both constructs [1]. Therefore, greater attention must be paid to the function of stress as a precursor to creativity [23].

Stress is pertinent to software engineering. In contemporary software organisations, the high intellectual demand coupled with various types of pressures, including those introduced by Global Software Development (GSD), has resulted in increased stress for software engineers [24,25]. However, although highly relevant, stress is an understudied phenomenon in software engineering. According to Ostberg et al. [26], regardless of the significant quantity of research conducted on stress from psychosocial and medical perspectives, this knowledge has not been transferred to software engineering. Due to the lack of attention devoted to occupational stress in software engineering [27], research in this domain is scarce [26], and there is a dearth of knowledge and understanding of the phenomenon [28]. Same is the case with the relationship between stress and creativity in software engineering.

The present research aims to fill this important void in the previous research related to creativity in software engineering as it aims to holistically examine programmer's creativity by examining the interaction between individual and contextual factors. This will also add valuable knowledge to the body of knowledge pertaining to behavioural software engineering. In order to achieve this, the present research extends the previous research work, Amin et al. [18], by including software engineering occupational stressors in the framework. This will result in important insights and implications regarding the underlying process and interplay of personality traits and stressors. The research seeks to address the questions of (i) which stressors are particularly relevant to software engineers? And (ii) how these stressors interact with the big five personality traits and knowledge collection behaviour to impact the creativity intention of the programmers?

Based on the above research questions, the research attempts to achieve the following objectives:

- To identify those stressors which are peculiar to the software engineering occupation.
- To analyse the moderating impact of these stressors on the relationship of knowledge collection behaviour and BF personality traits with programmer's creativity intention.

The research aims to achieve these objectives by initially formulating suitable hypotheses derived from the existing literature. Subsequently, the proposed framework will be validated using the data collected through a survey questionnaire administered to the programmers employed in software companies in Pakistan.

The present research is novel in many ways. First of all, the research is one of the few which incorporates and examines the impact of individual as well as contextual factors and at the same time their interaction with respect to creativity. Moreover, the study examines the theory as well as the proposed constructs in the domain of software engineering. As highlighted earlier, there is a dearth of research work which attempts to understand creativity in software engineering, especially in phases other than requirement engineering. Furthermore, the study incorporates creativity intention in the framework. Prior studies as well as CTC relied upon intrinsic motivation as the factor between different individual / contextual variables and creativity. Lastly, the role of occupational stressors as moderating variables is novel in the context of software engineering.

The remainder of the paper's format is as follows: The literature is reviewed and the proposed framework and hypotheses are presented in Section 2. Following a concise explanation of the research methodology in Section 3, Results and Discussion will be presented in Section 4. In the concluding section, the conclusion, including the final framework, future work, and the contribution of the research, will be presented.

2. Literature review

2.1. Theoretical foundation

The present research is primarily based on the Componential Theory of Creativity (CTC) (Fig. 1). Coined in 1983, the CTC has gained a prominent status as one of the major theories of creativity for individuals as well as organizational settings [29]. It offers a holistic framework that outlines the various social and psychological factors that are required for an individual to generate creative outputs. The model

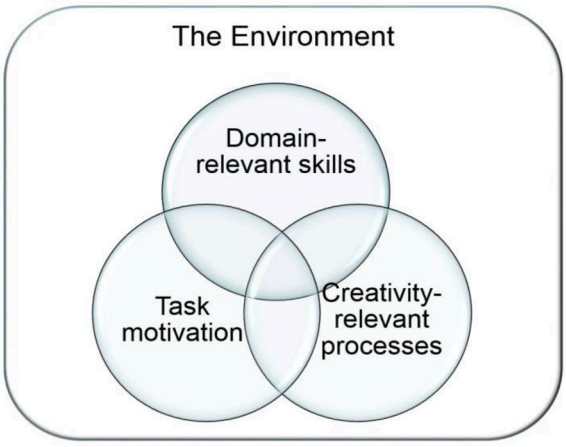

Fig. 1. The componential theory of creativity [29].

has been extensively tested and validated through empirical research and has served as a catalyst for the development of other intricate models that seek to explore the complexities of creativity [30,31]. The theory is based on two key assumptions as following:

i Creativity can be observed across a broad spectrum of levels, ranging from slight to extraordinary.
ii Individual's level of creativity within a particular domain is impacted by internal as well as external factors which are linked with creativity.
iii The internal factors can further be divided into creativity-relevant processes and domain-relevant skills which affect creativity through intrinsic motivation. The external factor is the work environment.
   a Knowledge, technical skills, expertise, and talent in the field in which the person is employed are examples of domain-relevant skills.
   b An individual's cognitive style and personality traits are examples of creativity relevant processes.
   c The external elements that can either foster or stifle creativity are included in the work environment component.

In the previous research by Amin et al. [18], we examined the impact of creativity relevant processes (through BF personality traits) and domain-relevant skills (through KCB on creativity intention (adapted from the Theory of Planned Behaviour (TPB)). The current study examines the moderating impact of the external component, namely the work environment (software engineering occupational stressors), on the impact of the creativity-relevant process (big 5 personality traits) and domain-relevant skills (knowledge collection behaviour) on creativity intention.

2.2. Contextual factors and creativity

Previously, studies in creativity literature have mainly attempted to understand creativity from an individual's perspective [32] by examining individual characteristics such as personality, intelligence, cognitive style and motivation [14,32,33]. However, according to Amabile [12], creativity is also affected by the external environment including all the extrinsic factors which can stimulate or inhibit an individual's creativity. With the ever-increasing emphasis on creativity in organizations, the attention of scholars shifted toward the contextual factors which can spur or hinder creativity and their interaction with individual characteristics [34,35]. Consequently, a more interactional approach to understanding creativity emerged [14]. According to the interactionist approach, creativity is a result of a complex interaction between individual and contextual factors [14]. Creativity-relevant contextual factors can be defined as *"dimensions of the work environment that potentially influence an employee's creativity but that are not part of the individual"* [15]. Concerning creativity, researchers have identified various contextual factors including factors such as job characteristics [19], relationship with supervisors [36], peers [34], organizational climate, leadership/supervisor's and co-worker's behaviour and characteristics [15]. However, according to Shalley et al. [15], there is a need to explore new contextual factors which can affect creativity.

2.3. Software engineering occupational stress

Stress, in general, can be defined in multiple ways such as a *"response to an inappropriate level of pressure"* [37] or *"a condition or situation that elicits a negative response such as anger or frustration or anxiety/tension"* [27]. In an organizational setting, it is also known as occupational, work or job stress [38] and has been studied in various occupations [39].

Software engineering is a profession characterized by high intellectual demand [25]. Moreover, aggressive schedules leading to overtime at work [40], varying working hours and dynamic culture and teams [25] are inherent to the software engineering profession. In addition to these inherent pressures, there are external pressures introduced by GSD i.e., ambiguity and communication problems [41] and technology i.e., rapid changes in technology, methods and tools leading to the need to continuously learn and update skills [24,25]. All of this has increased the level of stress for software engineers.

The aforementioned sources of stress can lead to errors in the engineering of software and can eventually put the quality of the software at risk [40]. However, despite the overwhelming impact and prevalence of stress in software engineering and its impact on the performance of software engineers and the quality of the software, there is still a lack of research work which addresses software engineering occupational stress [39]. According to Ostberg et al. [26], who reviewed the existing studies on software engineering occupational stress and highlighted their limitations, despite a substantial amount of work on stress from various perspectives, the knowledge has not been transferred to software engineering. Consequently, the stress in the software engineering profession is not well understood [42].

One of the objectives of the present research is to identify stressors which are highly relevant to the software engineering profession. Therefore, based on the existing literature as well as consultation with academicians and practitioners, the present study has identified 6 software engineering occupational stressors, which were perceived to be highly relevant by the software engineers. The following steps were undertaken to identify the stressors as suggested by Rajeswari and Anantharaman [27].

1 Firstly, five major studies were selected that proposed occupational stressors in different domains. Overall these five studies proposed a total of 44 stressors.
2 Secondly, a comparison of all 44 stressors was made under the closed guidance of three academicians from the software engineering discipline as well as three practitioners. With the suggestion of academicians and practitioners, the identical stressors were eliminated and a master list of 41 stressors was generated.
3 Lastly, the list was sent to 15 programmers. Based on their responses, the resulting list contained six stressors which were regarded as *'highly relevant'* by programmers. Stressors which were regarded as *'relevant', 'moderately relevant', 'irrelevant'* or *'highly irrelevant'* were not included in the final study.

Fig. 2 illustrates the software engineering occupational stressors, identified in the present research, which are pertinent to programmers. Table 1 presents the definitions of the stressors.

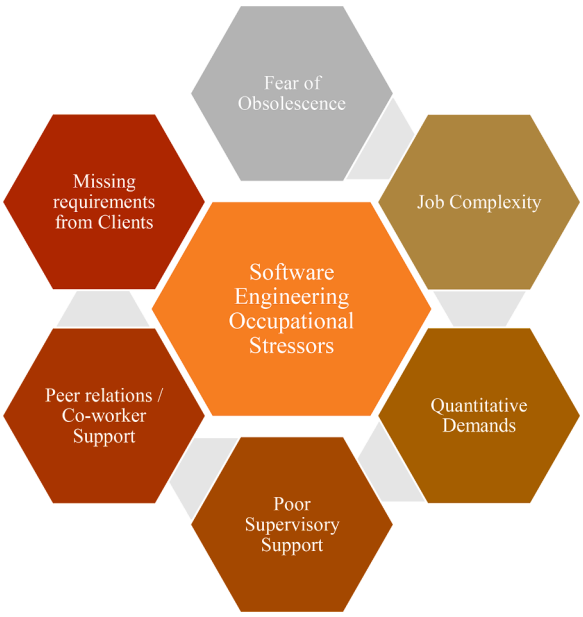

Fig. 2. The software engineering occupational stressors identified in the present work.

Table 1
Stressors and their definition.

Stressor	Definition
Fear of Obsolescence (FOO)	The fear of obsolescence is when, with time, one's skills are becoming obsolete and are no longer in compliance with the current technological demands [27].
Job Complexity (JC)	A job can be categorized as complex when the tasks of the job are complex. It becomes stressful when it is beyond an individual's skills and abilities or no training has been provided to perform the job [43].
Quantitative Demands (QD)	Quantitative demands include factors such as workload, overtime and general time pressure [27,44].
Poor Supervisory Support (SS)	Supervisory support refers to the accommodating and guiding behaviour of the supervisor which can be in the form of simple advice, training as well as empowerment and opportunities to enhance and develop skills [45].
Bad Peer Relations / Poor Co-worker support (BPR)	Bad relations with peers signify the nature of relations with peers whereas poor support from co-workers indicates the quality of support from the co-workers.
Missing Requirements from Clients (MRC)	The missing requirements can cause problems such as misunderstanding, errors and more work [46]. Furthermore, it can lead to incorrect designs, architectural drifts and hence defects in the final software [47–49].

2.4. Occupational stressors and creativity

As described at the outset of this paper, the relationship between stress and creativity needs further research and contemplation. Researchers have to dwell on answering the question of whether occupational stress is always detrimental to creativity or in some instances it can foster creative behaviour [50]. Scholars point towards a positive, negative as well as curvilinear relationship between both constructs.

There are various studies which suggest a positive relationship between stress and creativity (i.e., [51,52]). According to Sormaz and Tulgan, [53], stress can provoke an adrenaline rush, that can fuel work performance and mental focus which acts as a channel for creativity. Moreover, studies like Nicol and Long [54] and Anderson et al. [20] claim that stress augments arousal, which brings out creativity and encourages individuals to find creative solutions to problems. In short, the studies which suggest a positive relationship between stress and creativity base their argument on the premise that stress leads to cognitive and motivational stimulation as well as the need for creative solutions to problems which end up increasing the creativity of an individual [55].

As for the negative relationship between stress and creativity, the Theory of Distraction Arousal [56] posits that stress decreases an individual's creative performance. The rationale behind the assumption is that individuals have a limited cognitive capacity and in the presence of stress, this capacity further decreases as stress takes up a portion of it. As a result, the individual is left with fewer mental resources to come up with original and novel ideas and resolves to a narrower attention focus [22] as well as familiar and common ideas [57]. The overall analysis of the study conducted by Byron et al. [55] suggested that stressors can decrease creativity. Various studies have found a negative relationship between creativity and stressors such as time pressure [58], role ambiguity and conflict, job insecurity, organizational politics [50] and relationships with co-workers (Coelho et al., 2011).

Apart from the studies which propose a positive or negative relationship, many scholars have proposed a curvilinear or a u-form relationship between stress and creativity [1,59]. The theory of activation conforms to the notion that stress increases performance, however, the theory further adds that this positive impact is only to a certain point, beyond which if the stress becomes higher, performance, particularly of creativity-relevant tasks decreases [60]. A very high or very low-stress level causes cognitive meddling as well as a lack of engagement in the task, which can lead to low performance of tasks demanding cognition [55,58]. Hence, a moderate or intermediate level of stress is conducive to creativity as the task engagement will be high, resulting in increased positive effects and the best usage of cognitive resources [58,60].

From the literature, it is evident that the relationship between both variables is inconclusive. Moreover, the interaction effect of stress and personality traits on creativity is even more unclear. According to Amabile [12], workplace stress is a contextual factor and according to Tai [61], it can be considered a moderator because it is a significant contextual factor that can impede the daily work of individuals and teams. Hence, the present study proposes non-directional hypotheses as shown in Table 2.

Fig. 3 illustrates the proposed framework by incorporating the moderating impact of stressors. It is noteworthy that, in the present research, the moderating impact of each of the 6 stressors will be studied separately for the relationship between each of the BF personality traits, KCB and creativity intention. Furthermore, in Fig. 3, the results for the impact of individual factors validated by Amin et al. [18], have also been illustrated.

3. Methods

3.1. Research approach

The present research uses a mono-method quantitative approach and a survey technique to collect data from the programmers working in software companies in Pakistan. The research approach adopted in the study is appropriate to answer the research questions of the study. Moreover, the research in software engineering has mainly been following the deductive/quantitative approach [62] with the help of survey technique, particularly in the realm of human factors in software engineering [16].

3.2. Sampling

The primary respondents of the present research are programmers. Pakistan is known for its offshore software development projects [63], where the designers in one country create the design specifications and test plans, and then send them to programmers in another country to

Table 2
Proposed hypotheses.

Hypotheses No.		Hypotheses Statement
H1	(a)	Fear of obsolescence will moderate the relationship between the Big 5 personality traits and the programmer's creativity intention.
	(b)	Fear of obsolescence will moderate the relationship between knowledge collection behaviour and the programmer's creativity intention.
H2	(a)	Job complexity will moderate the relationship between the big 5 personality traits and the programmer's creativity intention.
	(b)	Job complexity will moderate the relationship between knowledge collection behaviour and the programmer's creativity intention.
H3	(a)	Quantitative demands will moderate the relationship between the big 5 personality traits and the programmer's creativity intention.
	(b)	Quantitative demands will moderate the relationship between knowledge collection behaviour and the programmer's creativity intention
H4	(a)	Poor supervisory support will moderate the relationship between the big 5 personality traits and the programmer's creativity intention.
	(b)	Poor supervisory support will moderate the relationship between knowledge collection behaviour and the programmer's creativity intention.
H5	(a)	Bad peer relations/co-worker support will moderate the relationship between the big 5 personality traits and the programmer's creativity intention.
	(b)	Bad peer relations/co-worker support will moderate the relationship between knowledge collection behaviour and the programmer's creativity intention.
H6	(a)	Missing requirements from clients will moderate the relationship between the big 5 programmer's personality traits and the programmer's creativity intention.
	(b)	Missing requirements from clients will moderate the relationship between knowledge collection behaviour and the programmer's creativity intention

implement [64]. According to the official website of the International Trade Administration of the United States [65], the overall size of Pakistan's software sector is $3 billion. The authorities are hopeful that the software and IT-related exports of Pakistan will reach $5 billion in the year 2023. Hence, due to a large number of programmers working on offshore projects in Pakistan, it becomes a suitable country to conduct research on programmer's creativity.

The software engineering organizations in Pakistan are primarily located in 8 major cities. Hence, to select a sample, at the first stage, a multistage cluster sampling technique was applied. In the first stage, out of the 8 major cities, 6 major cities were randomly selected which constituted 1105 software development companies. In the second stage, 379 GSD-based software development companies were selected from the population of the companies in the first stage. These 379 GSD organizations employed 1045 employees. To increase the response rate, all of the 1045 employees were approached to complete the survey.

The survey was administered using personally administered face-to-face and online surveys (through Google Forms) methods. Out of 1045 surveys sent to the respondents, 294 valid responses were received. Although the response rate was low, the required sample size was achieved. Table 3 illustrates the demographic details of the respondents as published in Amin et al. [18].

3.3. Measures

The items for the stressors were adapted from existing studies. Questionnaire items related to BF Personality Traits, also called as Big Five Inventory (BFI), was adopted from the work of John et al. [66], due to their robustness and ease to understand [67,68] as well as reliability and accuracy [69]. Items related to creativity were adopted from Tierney et al. [70] due to their high reliability and validity [71]. For creativity intention, items from Tierney et al. [70] were adapted by using the

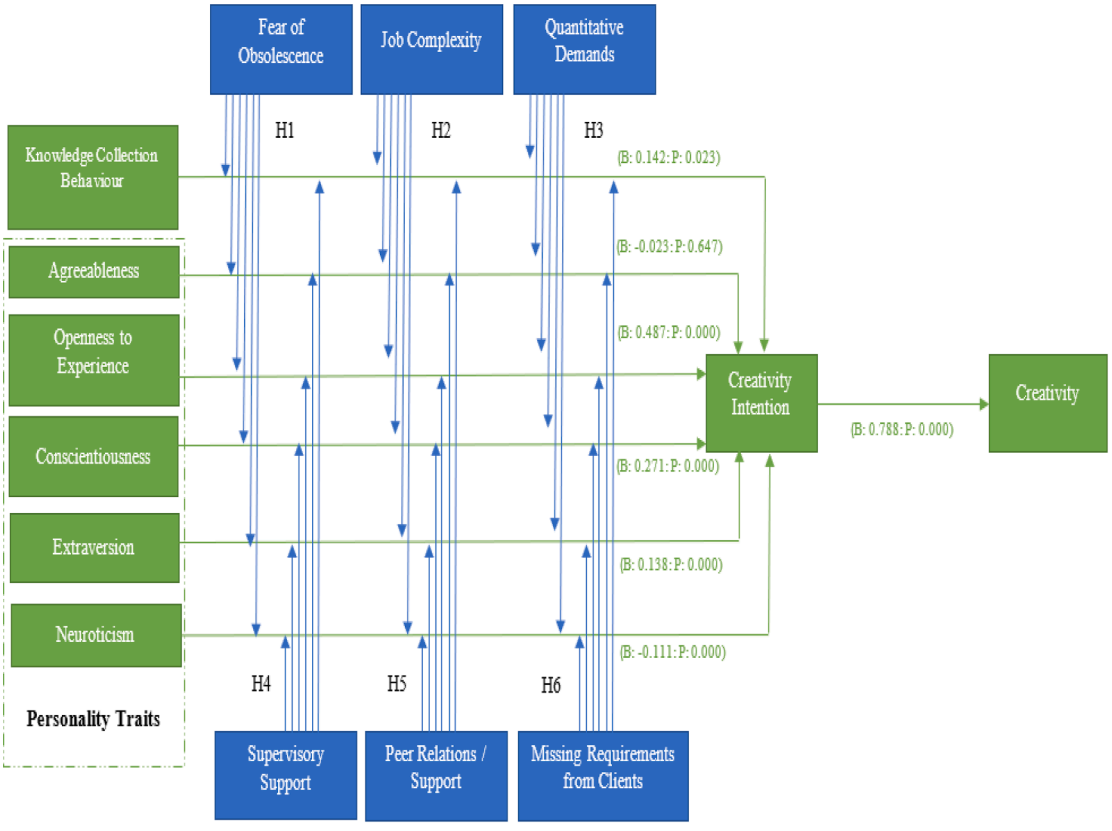

Fig. 3. Proposed framework.
Note: The green part of the framework was validated in [18]

Table 3
Demographic details [18].

	Number	Percentage
Gender		
Male	238	80.9%
Female	56	19.04%
Education Level		
Diploma/Certification	91	30.9%
Bachelors	167	56.8%
Masters	36	12.2%
Experience		
1–3 years	78	25.1%
4–7 years	113	38.4%
8–10 years	57	19.4%
More than 10 years	46	15.6%
Employment Status		
Full Time	218	74.2%
Part time	76	25.8%

word *'intend'* as suggested by numerous studies where the TPB was used [72,73]. Furthermore, the questionnaire items of knowledge collection behaviour were adopted from van den Hooff and Ridder [74] and Reychav and Weisberg [75].

To assess the validity and readability of the questionnaire, a panel of experts were consulted including two practitioners with 7 and 5 years of working experience in a GSD environment and a lecturer from a software engineering background. As a result, the items, which were considered redundant or duplicates, as well as the mistakes in words and sentences, were eliminated and changes were made to the overall layout of the questionnaire.

3.4. Analysis

The data were analysed using the Structural Equation Modelling (SEM) – Partial Least Square (PLS) technique with the help of the SmartPLS tool. Furthermore, SPSS was used for descriptive analysis.

4. Results and discussion

4.1. Measurement model analysis

The PLS results are presented in two stages [76]. In the first stage, the measurement model evaluation is presented, which includes the reliability and validity of the data. The demographic profile of the respondents can be accessed in our earlier publication i.e., Amin et al. [18].

According to the results presented in Tables 4 and 5, all the variables demonstrated a satisfactory Cronbach's alpha, composite reliability, and indicator reliability at 0.70 cut-off value (as suggested by [77]), multicollinearity at VIF<10 (as suggested by [78]) and the Average Variance Extracted (AVE) above the threshold value of 0.5 (as suggested by [79]). The results also showed that all the latent variables meet the Fornell-Larcker criterion for discriminant validity [80]. Moreover, the results also did not show any data normality issues. Table 4 also describes the mean values and standard deviation for each of the stressors. Moreover, the data normality was established using the skewness and kurtosis tests. Fig. 4 illustrates the measurement causal model.

4.2. Structural model for moderators

In this research work, all the moderators are separately analysed. According to Hair et al. [81], one should analyse one moderator at a time to maintain the interpretability of all results. The interaction terms were created with all the independent variables, and through the path coefficients and T-statistics, the impact and significance of the moderating impacts were tested. In the current section, apart from the results of all moderating variables, the discussion is also presented.

4.2.1. Fear of obsolescence (FOO)

Table 5 shows the moderating structural model results for the stressor *'Fear of Obsolescence (FOO)'*. It indicates that FOO significantly moderates the relationship of agreeableness, KCB and openness to experience with creativity intention. In contrast, for the remaining variables' relationship to creativity intention, FOO stress is not a significant moderator.

The results indicate that for the relationship between agreeableness and creativity intention, with the increase in the FOO stressor, the relationship becomes positive and significant. According to Chu et al. [82], an agreeable individual maintains a better social support system. Furthermore, individuals who maintain durable and generous relationships (high on agreeable traits) form entrepreneurial networks which enable them to benefit from individuals and gain access to a wide range of information [83]. Hence, it is plausible that an agreeable programmer, while facing FOO, can still make use of their social support system as well as the wide range of information to avoid obsolescence and to be creative at the same time.

Similarly, FOO positively moderated the relationship between KCB and creativity intention. According to Lazarus and Folkman [84], a stressful situation becomes positively challenging if it provides a chance for learning and personal growth and, according to Moran [85], to cope with the FOO, it is important to continuously learn and study. This entails that FOO can be a challenging stressor which might provoke an urgency for learning and development leading to augmented KCB. Moreover, when appraised as positive, a challenging situation positively and significantly affects creativity [86]. Appraisal of FOO is learning new skills, and according to Matzler and Mueller [87], knowledge sharing (including knowledge collection) is a prerequisite for learning.

Table 5
The result summary for the moderator: fear of obsolescence.

	Path Coefficient	Standard Deviation	T Statistics	P Values
FOOxKCB → CI	0.165	0.056	2.980	0.003**
FOOxAgree →CI	0.105	0.051	2.075	0.038**
FOOxOpen→CI	−0.183	0.061	3.008	0.003**
FOOxCons → CI	−0.049	0.064	0.758	0.449
FOOxExtra → CI	0.003	0.024	0.143	0.886
FOOxNeuro → CI	0.002	0.028	0.077	0.938

*** Significant at $p < 0.001$.
** Significant at $p < 0.05$
FOO: Fear of Obsolescence; KCB: Knowledge collection behaviour; Agree: Agreeableness; Open: Openness to Experience; Cons: Conscientiousness; Extra: Extraversion; Neuro: Neuroticism; CI: Creativity Intention.

Table 4
Reliability statistics for all variables.

Variable	Cronbach's Alpha	Composite Reliability	Multicollinearity	Mean	SD	AVE
Fear of Obsolescence (FOO)	0.809	0.865	1.874	3.39	0.75	0.562
Job Complexity (JC)	0.817	0.877	1.714	3.23	0.84	0.640
Quantitative Demand (QD)	0.890	0.920	1.922	3.12	0.93	0.743
Missing Requirements from Clients (MRC)	0.803	0.884	1.651	3.26	0.80	0.719
Supervisory Support (SS)	0.882	0.911	1.753	3.12	0.86	0.673
Bad Peer Relations (BPR)	0.790	0.862	1.448	3.40	0.78	0.611

Hence, it is plausible to argue that, to appraise the FOO stressor, programmers may engage themselves in learning, resulting in increased knowledge collection behaviour as well as creativity intention.

The results have also shown that the greater the FOO stressor, the weaker the relationship between the openness to experience trait and creativity intention. It is worth noting that the majority of the stressors have negatively affected the relationship between the openness to experience trait and creativity intention. In our opinion, the overall negative impact of stressors on programmers with the high openness trait is explained by the following:

(a) Such individuals tend to feel good and bad events more deeply [88]
(b) It is also suggested that such individuals can be creative only in the presence of a supportive work context [13,85].

Hence, it is possible that the programmers with the openness to experience trait feel more stressed in the presence of even a moderate level of stressors or if they do not have a supportive work context. Particularly in the case of fear of obsolescence, as mentioned earlier, it is important to continuously learn and study [85]. However, individuals with high openness-trait, are likely to engage in continuous learning only in the presence of intrinsic motivation, especially in professions similar to software engineering, such as system engineering [89]. Apart from agreeableness, openness to experience, and KCB, FOO does not significantly moderate the relationship between any other independent variable and creativity intention and hence the results are inconclusive. For the negative and insignificant relationship between conscientiousness and creativity intention, it is known that a highly conscientious individual is prone to rigidity and self-deception, which can restrain the acquisition of new skills and knowledge [90,91] which are imperative characteristics to appraise FOO. Hence, it is reasonable to assume that a conscientious programmer is likely to be negatively affected by the FOO stressor which can eventually negatively affect their intention to be creative at work. For the extraversion trait, the FOO stressor strengthens its relationship with creativity intention. As discussed earlier, FOO can be challenging and such situations provide a chance for learning and personal growth. Individuals with high extraversion traits consider stress to be a challenge and deal with it positively. Combined with an ambitious and inspiration-seeking attitude, it is plausible to assume that an extraverted programmer is likely to not only learn new skills to avoid obsolescence but also to intend to be creative. As for neuroticism and creativity intention, besides being non-significant, the overall effect of the FOO stressor is very small. The same was found by Silvia and Kimbrel [92], who found that anxiety and depression (which are facets of neuroticism) result in only a small variance in creativity.

4.2.2. Job complexity

The results, presented in Table 6, show that Job Complexity (JC) significantly moderates the relationship between three independent variables, extraversion, KCB and openness to experience, and creativity intention.

For the extraversion trait, the results show that the greater the JC stressor, the stronger the relationship between extraversion and creativity intention. As discussed in the literature review, about the JC stressor, it is argued that a complex and demanding job spurs creativity in contrast to simple and routine-based jobs, which hinder creativity [93]. Extroverts are active, ambitious, and assertive individuals who seek inspiration in an organization [94–96]. Moreover, extroverts have good self-efficacy [97]. In light of these attributes of extroverted programmers, it is plausible to state that a moderate level of job complexity will further spur creativity in extroverted programmers rather than dampen it. For KCB, the results indicate that the greater the JC stressor, the stronger the relationship between KCB and creativity intention. According to Shalley et al. [98], the complexity of the job encourages individuals to collect and combine knowledge therefore, it can be assumed that via the increase in KCB, job complexity can increase creativity. For the openness to experience trait, an increase in the JC stressor dampens the relationship between openness to experience and creativity intention. Although the T-value for this relationship is 1.756, it can be considered significant with a less-stringent significance level of 10%. Contrary to the common belief, job complexity has negatively moderated and dampened the relationship between openness to experience and creativity intention. This could be because, in this study, the complexity of the job is moderate in nature, whereas openness to experience manifests itself in higher work outcomes and creativity in highly complex jobs [99]. Moderate job complexity might be considered mundane and routine by open programmers. However, we suggest future studies to conclusively support the findings.

Table 6
The result summary for the moderator job complexity.

	Original Sample	Standard Deviation	T Statistics	P Values
JC x KCB → CI	0.137	0.057	2.416	0.016**
JC x Agree → CI	−0.072	0.059	1.225	0.221
JC x Open → CI	−0.102	0.058	1.756	0.079**
JC x Consc → CI	0.042	0.071	0.581	0.561
JC x Extra → CI	0.072	0.028	2.537	0.011**
JC x Neuro → CI	−0.003	0.031	0.090	0.928

*** Significant at $p < 0.001$.
** Significant at $p < 0.05$
JC: Job Complexity; KCB: Knowledge collection behaviour; Agree: Agreeableness; Open: Openness to Experience; Cons: Conscientiousness; Extra: Extraversion; Neuro: Neuroticism; CI: Creativity Intention.

As for the relationship of agreeableness, conscientiousness and neuroticism to creativity intention, JC plays an insignificant moderating role. For agreeableness, JC insignificantly strengthens its negative relationship to creativity intention. According to Salgado [100], in a complex job, the job performance of an individual high in agreeableness, declines. Furthermore, JC insignificantly and positively affects the conscientiousness relationship with creativity intention. According to Le et al. [91], conscientious individuals are most suitable for complex jobs. These individuals are likely to show dutifulness and persistence, which are required for accuracy and creativity, which in turn are two important ingredients of complex jobs [91]. Based on this we can assume that JC can be conducive to a conscientious programmer's intent to be creative. The insignificant impact of JC could be because (regardless of the level of complexity in the job) individuals with the conscientiousness trait are self-motivated to perform well in the job [101] through careful planning, setting of goals and persistence [91,102]. Based on this, it is assumed that for creativity intention, the complexity of the job might not be a significant factor for conscientious programmers. Lastly, JC plays an insignificant moderating role, while strengthening the negative relationship between neuroticism and creativity intention. Complex jobs enable individuals to use more of their advanced cognitive faculties and processes [36]. We believe that with the JC stressor, individuals high in neuroticism are encouraged to use more cognitive sources and hence it has a positive effect on their creativity. The result supports the notion that anxiety and depression (which are facets of neuroticism) bring a small variance in creativity [92]. We believe, therefore, that the job complexity stressor brought a negligible and insignificant change in the relationship.

4.2.3. Quantitative demand

The results shown in Table 7 illustrate that Quantitative Demand (QD) significantly moderates the relationship of neuroticism, openness to experience and agreeableness with creativity intention. Whereas for agreeableness, extraversion and KCB, the moderating role of QD is insignificant.

The results have shown that the higher the QD stressor, the stronger and more positive will be the relationship between neuroticism and

Table 7
The result summary for the moderator quantitative demand.

	Original Sample	Standard Deviation	T Statistics	P Values
QDxKCB→CI	−0.011	0.038	0.303	0.762
QDxAgree→CI	−0.115	0.052	2.239	0.025**
QDxOpen→CI	0.200	0.068	2.950	0.003**
QDxConsc→CI	−0.026	0.059	0.433	0.665
QDxExtra→CI	0.017	0.023	0.753	0.452
QDxNeuro→CI	0.079	0.031	2.499	0.012**

*** Significant at $p < 0.001$.
** Significant at $p < 0.05$
QD: Quantitative Demands; KCB: Knowledge collection behaviour; Agree: Agreeableness; Open: Openness to Experience; Cons: Conscientiousness; Extra: Extraversion; Neuro: Neuroticism; CI: Creativity Intention.

creativity intention (B: 0.079; T: 2.499). Generally, it is believed that individuals high in neuroticism trait are emotionally unstable and are disposed to experience negative feelings with a lack of control over impulses [96,102]. As a result, the positive impact of quantitative demands on the relationship between neuroticism and creativity intention was surprising. However, the findings can be explained by the fact that individuals high in neuroticism face anxiety over meeting work expectations and because of such anxiety, at times they exceed expectations [90]. It is stated that workload can also lead to anxiety [103], whereas according to Rubinstein [104], anxiety can lead to higher divergent thinking, which is one of the important facets of creativity. Hence, it is reasonable to believe that neurotic individuals who face anxiety about meeting task expectations will eventually intend to be more creative. However, we suggest further exploration of the phenomenon.

For the openness to experience trait, with the increase in QD stressor, the relationship between openness to experience and creativity intention becomes stronger. According to Baer and Oldham [58], at an intermediate level of quantitative demand (i.e., time pressure), individuals are more likely to explore new ideas and novel solutions. However, Baer and Oldham [58] further argue that for this to manifest into creativity, the individual must have a broad array of perspectives and approaches. According to McCrae and Costa [105], due to their curious nature in seeking new and novel ideas, open individuals possess a variety of perspectives and approaches. Hence, QD stress is likely to increase open programmers' intent to be creative.

Moving to the impact of the QD stressor on the relationship between agreeableness and creativity intention, the results show that the higher the quantitative demand the weaker the relationship between agreeableness and creativity intention. The findings can be justified through the distraction theory which posits that under pressure (i.e. time pressure), the available working memory, which is allocated for cognition-related tasks, decreases [106]. Moreover, according to Byrne et al. [107], under anxiety, which is induced by such pressure, agreeable individuals might receive a heavy demand on working memory. Hence, it is probable that with the heavy demand on the working memory of agreeable programmers, their intention to be creative shall also dampen.

Apart from the abovementioned relationships, QD does not significantly moderate the relationship between KCB, conscientiousness, extraversion and creativity intention. For the conscientiousness trait, QD negatively and insignificantly affects its relationship with creativity intention. A conscientious individual pays too much attention to small details [91]. Software development jobs, especially that of programmers, while requiring attention to detail, also require speed and accuracy. However, conscientious individuals can waste time and compromise speed by paying more attention to accuracy due to the characteristics of their personalities such as deliberateness, cautiousness, and dutifulness [108]. For this reason, it is rational to predict that in the presence of a QD stressor, highly conscientious programmers, may have less intent to be creative.

Furthermore, QD negatively and insignificantly affects the relationship between KCB and creativity intention. Time pressure or the lack of time is considered a hindrance in knowledge exchange [109]. It is rational to believe that during quantitative overload, programmers are likely to avoid collecting knowledge and combining it with their existing knowledge to come up with novel solutions.

Moreover, QD insignificantly strengthens the positive relationship between extraversion and creativity intention. Like FOO, in the case of QD, a high workload can lead to task enjoyment which is a combination of high arousal and pleasure [110,111]. Combined, arousal and pleasure are considered vitality, which can lead to creativity [112]. Therefore, it is reasonable to argue that an extraverted programmer, possessing attributes such as enthusiasm, excitement seeking and positive emotions [113], is more likely to feel vitality due to quantitative demands and consequently intend to be more creative. From the explanation provided earlier, it seems that QD affects extroverts indirectly (through challenge and vitality, respectively), which is why the moderating impact is non-significant.

4.2.4. Poor supervisory support

The results in Table 8 show that Poor Supervisory Support (PSS) significantly moderates the relationship between conscientiousness, extraversion, agreeableness and creativity intention. As for conscientiousness and creativity intention, PSS further significantly strengthens the relationship. Under poor supervisory support, an individual high in the conscientiousness trait is likely to handle the demands of the job independently [114]. Independence, or autonomy, also drives creativity [115]. So, it is plausible to assume that poor supervisory support shall positively affect the creativity intention of a programmer high in conscientiousness trait. Likewise, with an increase in PSS stress, the creativity intention of the programmer with a high extraversion trait will also increase. As mentioned earlier, extroverts are considered to have a better social support system [82]. Moreover, their personality is characterized by positivity and energy, which enables them to experience work or life situations as less stressful [116]. Coupled with these attributes, extroverts are self-reliant in nature [113]. While it is believed that over-support of a supervisor inhibits creativity [117], an extroverted individual equipped with individualistic, inspiration-seeking, and positive personality traits is likely to show creativity when the supervisory support is not high.

In contrast to conscientiousness and extraversion traits, PSS hurts the relationship between the agreeableness trait and creativity intention. It is argued that support from a supervisor is a predictor of employee motivation [118]. Furthermore, in cases of a poor supervisory support, the individual might not feel warmth and consideration from their supervisor [119]. Since an agreeable person values warmth and good ties with people around them [120] PSS might disrupt an agreeable person's motivation more than it would for those with other traits. It is also known that motivation (intrinsic or extrinsic) is the key to enhanced creativity [121]. Hence, it is reasonable to argue that poor supervisory support can decrease an agreeable programmer's motivation which can

Table 8
The result summary for the moderator supervisory support.

	Original Sample	Standard Deviation	T Statistics	P Values
SSxKCB → CI	−0.069	0.044	1.545	0.122
SSxagree → CI	−0.098	0.048	2.067	0.039**
SSxOpen → CI	0.024	0.069	0.356	0.722
SSxConsc → CI	0.154	0.059	2.597	0.009**
SSxExtra → CI	0.076	0.025	3.075	0.002**
SSxNeuro → CI	0.032	0.046	0.695	0.487

*** Significant at $p < 0.001$.
** Significant at $p < 0.05$
SS: Supervisory Support; KCB: Knowledge collection behaviour; Agree: Agreeableness; Open: Openness to Experience; Cons: Conscientiousness; Extra: Extraversion; Neuro: Neuroticism; CI: Creativity Intention.

subsequently dampen their creativity intention.

Apart from the above-mentioned significant effects of SS as a moderating variable, it plays an insignificant moderating role for other independent variables. For the relationship between KCB and creativity intention, SS insignificantly dampens the relationship. It is believed that PSS is crucial for knowledge exchange [122,123] as well as for creativity [124,125]. So, the findings show that poor support from supervisors may negatively affect the relationship between KCB and the creativity intention of the programmer. Furthermore, PSS insignificantly strengthens the relationships between neuroticism and creativity intention. We believe that with the PSS stressor, neurotic individuals may face further depression, anxiety and negative emotions. In addition to anxiety, which can lead to creativity [104], research shows that depression can also lead to creativity [126]. However, Silvia and Kimbrel [92] noted that anxiety and depression (which are facets of neuroticism) bring only a small variance in creativity. Similarly, the results of the present study show that besides being non-significant, the overall effect (through beta value) of the aforementioned stressor is very small. Moreover, for openness to experience and creativity intention, PSS insignificantly strengthens the relationships. Open individuals value autonomy and independence [99]. Hence, supervisory support may not be a significant predictor of their performance at work, especially for creativity. Open individuals are considered non-conformists who challenge authority [90], which can eventually decrease supervisory support for them. Moreover, it is believed that over-support from supervisors can diminish creativity [117]. Hence, it is safe to assume that supervisory support is not a significant factor for programmers high in openness trait and rather than increasing their creativity, it can have the opposite effect. Therefore, rather than worrying about it, open individuals take pride in being anti-authority [90]. For these reasons, we believe, that the findings of the present study are justified in demonstrating a positive but non-significant moderating role of the SS stressor in the relationship between openness to experience and creativity intention.

4.2.5. Bad peer relations / co-worker support

The results in Table 9 illustrate that Bad Peer Relations (BPR) significantly moderate the relationship between conscientiousness, extraversion, and openness to experience with creativity intention. For the relationship of other independent variables with creativity intention, BPR does not play a significant moderating role. The results show that with increased BPR, the creativity intention of highly conscientious programmers will increase. We believe that the rationale behind the above results is similar to that of poor supervisory support. That is, factors such as a co-worker or supervisory support are less likely to negatively affect an individual with a higher conscientiousness trait. It is believed that even a stressful life event such as divorce does not significantly affect conscientious individuals [127]. As in the case of poor supervisory support, an individual high in the conscientiousness trait is likely to handle the demands of the job independently [114,128]. We posit that the same shall be true in the case of poor co-worker support or bad peer relations. Hence, BPR does not adversely affect the creativity intention of a highly conscientious individual; rather it strengthens it and keeps the effect positive.

Table 9
The result summary for the moderator bad peer relations / co-worker support.

	Original Sample	Standard Deviation	T Statistics	P Values
BPRxKCB → CI	0.014	0.067	0.203	0.839
BPRxAgree → CI	−0.058	0.059	0.973	0.330
BPRxOpen → CI	−0.139	0.043	3.255	0.001***
BPRxConsc → CI	0.139	0.063	2.208	0.027**
BPRxExtra → CI	0.119	0.032	3.671	0.000***
BPRxNeuro → CI	−0.021	0.029	0.733	0.463

*** Significant at $p < 0.001$.
** Significant at $p < 0.05$

BRP: Bad Peer Relations; KCB: Knowledge collection behaviour; Agree: Agreeableness; Open: Openness to Experience; Cons: Conscientiousness; Extra: Extraversion; Neuro: Neuroticism; CI: Creativity Intention.

Secondly, in the presence of the BPR stressor, the creativity intention of programmers with a high extraversion trait will increase. In the case of BPR, as mentioned earlier, individuals with high extraversion, although socially active, are self-reliant in nature [113]. Moreover, we know that extrovert individuals are self-stimulated. This trait, together with the tendency of self-reliance, shows that a moderate level of BPR stress is likely to trigger the creativity of an individual with high extraversion.

Thirdly, BPR stress dampens the creativity intention of highly open programmers. One way of looking at the findings is by comparing the concept of BPR with the facets of openness to experience. According to Zhou and George [129], co-worker support exposes one to a great array of novel and unusual ideas as well as informational feedback, support, and communication, all of which leads to creativity. Open individuals are characterized by seeking novel and unusual experiences [99]. It is plausible that in the presence of poor co-worker support or bad peer relations, an open individual's motivation to seek novel and unusual ideas and experiences in the workplace will be negatively affected, which will dampen their intention to be creative. Furthermore, it is noteworthy that, according to Bono et al. [130], individuals with high openness are likely to engage themselves in arguments with others, and therefore are likely to have task as well as relationship conflicts. Consequently, it is likely they will receive poor co-worker support or have bad peer relations. Since co-worker support is important for employee creativity [131], open individuals will likely suffer from lesser creativity intention due to bad peer relations or co-worker support.

Besides the above-mentioned significant moderating effects of BPR, it insignificantly moderates the relationship between other independent variables and creativity intention. For the relationship between agreeableness and creativity intention, the effect of BPR is insignificant in further strengthening the negative relationship. Agreeable individuals maintain good relations with the people around them, and thus a disruption in their relations can result in a negative impact on their job-related outcomes (i.e. creativity). However, due to the high probability that agreeable individuals will comply and maintain strong ties, the BPR stressor might not significantly affect their intention to be creative. Moreover, BPR further strengthens the positive relationship between KCB and creativity intention. It is obvious that bad relationships with peers will negatively affect knowledge collection, which will dampen its relationship with creativity intention. Furthermore, the relationship, despite a decrease in the overall beta value, is still positive. This could be because, in the present research, one of the major purposes of knowledge collection amongst programmers is to collect official documents and work reports, which may not require any tacit knowledge collection from peers and hence, may not require good relationships with them. Lastly, BPR further strengthens the negative relationship between neuroticism and creativity intention. However, besides being non-significant, the overall effect (through beta value) of the stressor is small. The results can be attributed to the characteristics of neurotic individuals. Neurotic individuals face high rates of depression and anxiety. Bad peer relations may further enhance anxiety, which results in only a small variance in creativity [92].

4.2.6. Missing requirements from clients

According to the results in Table 10, MRC significantly moderates the relationship of only two independent variables, agreeableness and openness to experience to creativity intention. As for the relationship between agreeableness and creativity intention, the results indicate that with an increase in the MRC stressor, the agreeable programmer's creativity intention will increase significantly. Handling missing or incomplete requirements requires flexibility at the programmer's end. An agreeable individual's characteristic of flexibility [132] coupled with the attributes of a strong network and social support, makes it likely that an agreeable individual will respond to stress optimistically [82].

Table 10
The result summary for the moderator variable 'missing requirements from clients'.

	Original Sample	Standard Deviation	T Statistics	P Values
KCBxMRC → CI	0.105	0.065	1.608	0.108
AgreexMRC → CI	0.150	0.061	2.466	0.014**
OpenxMRC → CI	−0.163	0.053	3.050	0.002**
ConscxMRC → CI	−0.064	0.062	1.033	0.302
ExtraxMRC → CI	−0.005	0.034	0.135	0.892
NeuroxMRC → CI	−0.026	0.037	0.686	0.493

*** Significant at $p < 0.001$.
** Significant at $p < 0.05$

MRC: Missing Requirements from Clients; KCB: Knowledge collection behaviour; Agree: Agreeableness; Open: Openness to Experience; Cons: Conscientiousness; Extra: Extraversion; Neuro: Neuroticism; CI: Creativity Intention.

Furthermore, missing or incomplete requirements from clients offer autonomy to the programmer to suggest or implement their ideas. This autonomy is considered a prerequisite for creativity [115]. Hence, an agreeable programmer, due to a flexible nature, is likely to adapt to the MRC, and due to the supportive attributes of their personality and the chance to be autonomous, is likely to intend to be creative.

Moving on to the openness to experience trait, the results show that the greater the MRC stressor, the weaker will be an *open* programmer's intent to be creative. We believe that the dampening effect of MRC can be a result of the change that often occurs with MRC. Keeping this in mind, if we revisit the openness to experience trait, we find that it has two facets: openness to external experiences (i.e. actions, ideas or values) and openness to internal experiences (i.e. fantasy, feelings and aesthetics). According to Griffin and Hesketh [133], only individuals with a high openness to external experience trait are adaptive to changes. This could be one of the reasons behind such results. In addition, openness to internal experience is also positively correlated with job tension [133]. It is plausible that the programmers who participated in this research are high in openness to internal experience and low in openness to external experience, and thus feel intense job tension when faced with the changes resulting from MRC.

Apart from the above-mentioned relationships, MRC does not significantly affect the relationship between any other independent variable and creativity intention. Firstly, MRC insignificantly dampens the relationship between conscientiousness and creativity intention. We believe that MRC may negatively affect highly conscientious programmers for several reasons, such as their tendency to be on time [134], as MRC may hinder their desire to finish tasks on time. Furthermore, as mentioned earlier, conscientious individuals do careful planning and goal setting [91], and MRC is likely to interrupt the goals set by the conscientious programmer and can jeopardize their plans. It is a plausible explanation because due to their rigid and inflexible nature [91,135], conscientious individuals are less adaptive to change [90] and hence their creativity may suffer.

Similarly, MRC also insignificantly dampens the relationship between extrversion and creativity intention. However, the impact is very minimal (with a very small beta value). According to Alatis and Tan [136], when facing ambiguity, extroverts are at ease when the input is sufficient from outside. This means that in situations where the outside input (i.e., MRC) is not sufficient, extroverts may have a low tolerance for ambiguity. As MRC can lead to an ambiguous situation, which can have negative outcomes for extroverted programmers, such as decreased intent to be creative. However, since the findings of the present research regarding this relationship are non-significant, future studies should be conducted for conclusive evidence. In contrast, MRC insignificantly strengthens the positive relationship between KCB and creativity intention. We believe that MRC will lead to more knowledge collection by programmers to fill in the missing requirements, which will eventually lead to more creativity intention. Furthermore, it can also be argued that to fill in the missing pieces of the puzzle, the programmers will have to be creative.

Lastly, MRC insignificantly strengthens the negative relationship between neuroticism and creativity intention. We believe that the results are in congruence with most of the research which implies a negative effect of stressors on the neuroticism trait. However, MRC might not be a significant stressor, as it is not a huge stressor compared to other stressors.

4.2.7. Overall role of stressors

As can be seen from the findings of this research, the stressors played a diverse role as moderators. For some independent variables, the stressors played a positive role, i.e., they strengthened their relationship with creativity intention, whereas for others they played a negative role, i.e., they reduced their relationship with creativity intention. Still, for some independent variables, stressors play an insignificant role. However, for the majority of the relationships, all the stressors played a positive role, meaning that, for most of the independent variable's relationships, the presence of stress has increased programmers' intention to be creative.

In our opinion, this could be due to the level of stress faced by the respondents of this study. The mean values for each of the stressors, as highlighted in Table 11, highlight a moderate level of stress. This could be one of the reasons why the moderating impact of software engineering occupational stressors on the relationship between most of the independent variables and creativity intention is positive. These findings coincide with prior research, i.e., Baer and Oldham [58], which empirically demonstrated the curvilinear relationship between stress (i.e. time pressure) and creativity. Furthermore, other studies (e.g., [137–139]) also, empirically examined the curvilinear relationship between one of the facets of stress (i.e. time pressure and related constructs) and other individual responses (i.e. job satisfaction, enjoyment).

Furthermore, it is fruitful to discuss the level of stress of each stressor based on the mean values. As per the results, BPR has the highest mean value of 3.40, followed by FOO (Mean: 3.39), MRC (Mean: 3.26), JC (Mean: 3.23), QD (Mean: 3.12) and SS (Mean: 3.12). The mean values indicate that overall the level of stress is moderate. Moreover, the greatest stress faced by the programmers is bad peer relations/co-workers' support. It has been observed that poor supervisory support and bad peer relations can lead to burnout for software engineers [25]. Furthermore, our results indicate that FOO is also ranked high by programmers. According to Kaluzniacky [140], no other profession faces the FOO as much as programmers. Moreover, MRC is identified as the third most significant stressor by programmers. Interaction with clients was regarded as one of the major stressors by the programmers in another study conducted in the same context (i.e. Pakistan) [141]. As for the remaining three stressors, Sonnentag et al. [25] proposed poor supervisory support whereby Rashidi and Jalbani [141] proposed a quantitative workload. Similarly, programming is perceived to be one of those jobs which require greater complexity [142] because of the involvement of creative as well as administrative tasks [143]. Hence, prior studies support the results obtained by this research and confirm the high relevance of the stressors we identified.

4.3. The final framework

Fig. 4 illustrates the final validated framework of a programmer's creativity and the impact of individual and contextual factors.

Table 11
Descriptive results for the level of software engineering occupational stressors.

Variable	N	Mean	Std. Deviation
JC_Mean	294	3.23	0.84
QD_Mean		3.12	0.93
FOO_Mean		3.39	0.75
MRC_Mean		3.26	0.80
SS_Mean		3.12	0.86
BPR_Mean		3.40	0.78

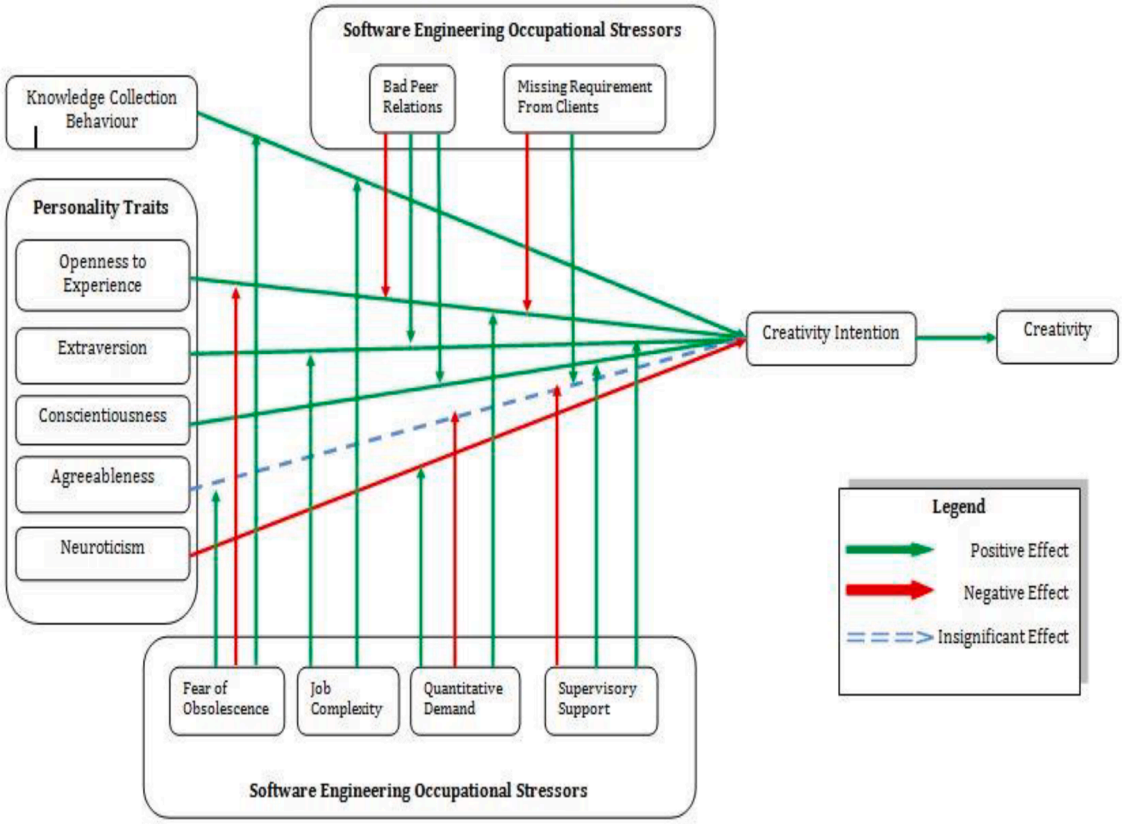

Fig. 4. The final validated framework.

5. Conclusion

This paper is a continuation of an earlier published work (i.e., [18]), whereby the impact of personality traits and knowledge collection behaviour on a programmer's creativity intention was studied. In the present research, the impact of 6 stressors on the relationship between personality traits, knowledge collection behaviour and programmer's creativity intention were studied. In the results and discussion section, the results were presented from the perspective of the stressors. In the forthcoming section, for an extended understanding of the reader, the results will be summarized according to the independent variables (knowledge collection behaviour and BF personality traits).

The results of the study indicated that the presence of two stressors, namely fear of obsolescence and job complexity, strengthened the positive relationship between knowledge collection behaviour and creativity intention. On the other hand, although the impact of stressors, including missing requirements from clients and supervisory support, on the relationship between knowledge collection behaviour and creativity intention, is not statistically significant, it is very near to the significant value hence further studies should be conducted for conclusive results.

As for the openness personality trait, three stressors weaken the creativity intention of the openness programmer. These stressors are 'fear of obsolescence', 'missing requirements from clients' and 'bad peer relations'. On the other hand, the creativity intention of the openness programmer strengthened due to the 'quantitative demands' stressor. As for the neuroticism trait, only 'quantitative demands' played a significant moderating role by slightly augmenting the neurotic programmer's intention to be creative. It implies that under 'quantitative demand stress', neurotic programmers, contrary to their usual behaviour, are likely to become creative. The impact of the neuroticism trait on creativity intention was not moderated by other stressors. Furthermore, for conscientious programmers, 'poor supervisory support' and 'bad peer relations' stressors augmented the creativity intention. However, the conscientious programmer's creativity intention was not moderated by other stressors. As for the extrovert programmer, due to the strong social support system and a positive and energetic personality, most of the stressors positively affected the creativity intention. Extravert programmer's creativity intention is boosted under stressors including 'poor supervisory support', 'job complexity' and 'bad peer relations', whereas extrvert programmer's creativity intention is not affected significantly by other stressors. The results highlighted that an agreeable programmer's creativity intention was boosted under two stressors namely 'fear of obsolescence' and 'missing requirements from clients'. On the other hand, an agreeable programmer's creativity intention dampened under two other stressors, namely 'quantitative demands' and 'poor supervisory support'. Hence, it is safe to assume that a moderate level of 'fear of obsolescence' and 'missing requirements from clients' is beneficial for an agreeable programmer's creativity intention and even a moderate level of 'quantitative demands' and 'poor supervisory support' stress is harmful to an agreeable programmer's intent to be creative.

In future, the research can be expanded to the other phases of software engineering as well as professions. Moreover, it is imperative to understand the interactional impact of other individual and contextual factors on creativity in software engineering. A mixed approach to understanding creativity with real outputs of programmers could enhance our understanding of the phenomenon.

5.1. Contribution of the work

5.1.1. Theoretical contribution

Firstly, this research has extended the theoretical understanding of creativity beyond its general literature by extending it to software engineering. Hence, the research significantly contributes to the body of knowledge pertaining to Behavioural Software Engineering (BSE). The research in BSE is a growing area where there are knowledge gaps and where past studies have concentrated on a small number of concepts that

have only been applied to a small number of software engineering domains [144]. Hence, the present study is a valuable addition to the BSE knowledge. Moreover, within BSE, the present research has contributed towards the holistic understanding of programmer's creativity with respect to individual and environmental factors.

Secondly, the research has holistically tested the componential theory of creativity in the context of software engineering, particularly programmers, by incorporating the environmental factors in the framework. This has explored the boundary condition, in the form of stressors, that influence the relationship between personality traits, knowledge collection behaviour and creativity intention.

Thirdly, the research has provided fresh insights into the impact of software engineering occupational stressors, as moderating variables, on the relationship between personality traits, knowledge collection behaviour and creativity intention of the programmers. This has unearthed the underlying mechanisms through which the stressors interact with the personality traits as well as knowledge collection behaviour of programmers to inspire creativity. Furthermore, the research has opened up new venues for future research regarding the role, and interplay of stressors, knowledge collection behaviour, personality traits and creativity. The study can inspire researchers to delve into different aspects and dimensions of personality traits and stressors and how they can interact to influence creativity.

Lastly, this research has proposed 6 stressors which are highly relevant to programmers working in a GSD environment. The identification of stressors particular to programmers is a valuable theoretical contribution.

5.1.2. Practical contribution

The present research has practical contributions and implications as well. Firstly, the study has provided important insight into how stressors affect programmers of different traits. Having such knowledge will enable software organizations to design the work environment which may foster programmer's creativity by mitigating occupational stress. Hence, software organizations should carefully study programmers' personality traits and should align and mitigate the stress level, types of stress and personality traits to increase creativity.

Secondly, the study also serves as a guideline for the software houses to identify and recruit the right programmers for the right projects. For example, If the project requires a high level of creativity in a short amount of time, the software companies should hire individuals with high openness to experience or neuroticism traits and should avoid hiring or assigning individual with high agreeableness traits to such projects. This is understood through the findings of the study which suggest that creativity intention of the programmer who scored high on openness to experience and neuroticism traits strengthened due to the 'quantitative demands' stressor and dampened for those who scored high on agreeableness trait.

Thirdly, the study can aid in developing stress management interventions as well as training programs, which are tailored specifically for software engineers and programmers. The development of these interventions may benefit largely from the findings of the study which examined the intersection of personality traits and stressors. Hence, the study can aid in developing personalized interventions and training programs that accommodate different personalities.

The study can also inform the software engineering project managers to optimize team compositions and dynamics. By understanding the interaction between the stressors, personality traits and creativity intention, software engineering project managers can create diverse teams with a harmonious blend of personality traits that play to each other's strengths to manage and mitigate stress and foster creativity. Furthermore, the study can also help managers to allocate work and manage resources in an optimized manner so that different personality traits with varied responses to stressors can be adequately supported. This, as a result, will create a supportive and conducive environment, not only for creativity but also for the overall well-being and satisfaction of the software engineers.

Lastly, alongside the aforementioned practical implications of the present study, the programmers and software engineering organizations in Pakistan and developing countries may benefit from the study in multiple ways as follows:

- The study may promote mental well-being and support of programmers in developing countries. Understanding the role of stressors and how they can affect a programmer's creativity by interplaying with different personality traits may amplify the importance of mental well-being amongst programmers and software engineering companies in developing countries.
- The practical contribution of the study can extend towards skill and capacity development initiatives for programmers in Pakistan. The software organizations may start to understand the importance of individual personalities and how they can react to stressors and eventually affect creativity.
- Furthermore, software organizations in developing countries, where the level of stress is relatively high, may be able to respond to the individual needs of programmers and mitigate stress and hence, promote creativity in their organizations.

5.2. Limitations of the study

The self-reporting responses, which were yielded by the programmers might include self-bias. However, because of the time limitations, this was unavoidable and the best available option. According to Silvia et al. [132], self-reporting has been underestimated in creativity research however it can be a good choice to measure creativity. Furthermore, the findings of this research should be carefully generalized as this research is conducted in Pakistani software houses. The culture of Pakistan is different from the cultures of other countries.

5.3. Future work

The relationship of other contextual factors should be studied in future research. Moreover, for further generalization of the findings of this research, more research should be conducted in Eastern countries such as India, Israel and China. Most of the existing studies on creativity have focused on Western cultures. This will enable more generalization of the findings in the Eastern context. In addition, it is recommended to conduct such research in multiple domains so that the moderating impact of stressors on creativity could be examined across different domains. Moreover, creativity in other phases of software engineering can also be examined holistically by bringing in contextual factors such as stressors.

Authors' contributions

Aamir Amin*: Dr Aamir Amin. The research work is part of Dr Aamir's PhD thesis. He conceptualized the whole research work along with his supervisors. At the same time, he selected the methodology, performed formal analysis, and wrote and visualized the original draft. He is also the corresponding author.

Dr Mobashar Rehman: Dr Mobashar Rehman was the field supervisor for this research work. His-primary contribution was in data collection, curation as well as formal analysis. He also assisted in designing the methodology of the research work.

Dr Shuib Basri: Dr Shuib Basri was the main supervisor for this research work. He supervised the work from the beginning (conceptualization) until the final thesis submission and viva voce. He also helped in acquiring resources, funds and scholarships during his PhD work. He also reviewed the overall research work.

Dr Luiz Fernando Capretz: Dr Luiz Fernando Capretz helped a great deal in terms of reviewing and editing the research work. He also contributed to the results and discussion sections of the paper.

Dr Rehan Akbar: Dr Rehan worked closely with the main author and contributed significantly due to his industrial experience and background in the field of software engineering. He assisted in the operationalization of the concepts. Moreover, he also contributed to the development of surveys.

Dr M. Awais Shakir Goraya: Dr M. Awais Shakir Goraya assisted in developing the hypotheses and literature review. He also reviewed the paper for its grammatical and lingual mistakes.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Aamir Amin reports administrative support, statistical analysis, travel, and writing assistance were provided by Universiti Teknologi PETRONAS Faculty of Science and Information Technology during his doctorate.

Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.infsof.2023.107288.

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