Behavioral Software Engineering: a Definition and Systematic Literature Review

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Abstract

Throughout the history of Software Engineering, the human aspects have repeatedly been recognized as important. Even though research that investigates them has been growing in the past decade, these aspects should be more generally considered.

The main objective of this study is to clarify the research area concerned with human aspects of Software Engineering and to create a common platform for future research. In order to meet the objective, we propose a definition of the research area Behavioral Software Engineering (BSE) and present results from a systematic literature review based on the definition.

The result indicates that there are knowledge gaps in the research area of Behavioral Software Engineering and that earlier research has been focused on a few concepts, which have been applied to a limited number of Software Engineering areas. The individual studies have typically had a narrow perspective focusing on few concepts from a single unit of analysis. Further, the research has rarely been conducted in collaboration by researchers from both Software Engineering and Social Science.

Altogether, this review can help put a broader set of human aspects higher on the agenda for future Software Engineering research and practice.

Keywords: Software Engineering, Human Aspects, Systematic Literature Review, Behavioral Software Engineering, Psychology

1. Introduction

Early in the development of the Software Engineering (SE) field it was recognized that one also had to consider the humans involved in software development [1]. However, much of the research and practice in subsequent years focused mainly on technological or process-related factors while research that considered organizational, social or psychological factors

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was rare [2]. Even if the introduction and focus on agile methods in the last 10 to 15 years has, yet again, highlighted the importance of people, teams and their communication and collaboration [3, 4] [108] these issues can still not be considered to be in the SE mainstream.

As an indication of this negative bias, we searched the ISI Web of Science and found that while 70% of papers in SE or software development also list a technology- or process-related topic less than 5% list a 'soft' or human-related topic[1]. Interestingly, even though this indicates there is still at least 10 times more technology- and process-focused research being carried out, our estimation shows that the percentage of research in ISI Web of Science that also considers softer, human aspects has increased from around 2% in 1993 to over 7% in 2013, more than a three-fold increase. Part of this increase can no doubt be attributed to an increasing number of workshops and outlets for this type of research [5, 6].

While this growth is encouraging we argue that these concerns must be more generally considered in SE research. We and others have argued [109] [7] that psychometric measurements should be taken into account in any SE research and there has been systematic literature reviews on other related aspects such as motivation [110, 111, 112], personality [113] and organizational culture [114]. These are a key aspect when describing the context for SE research, which are so crucial to building generally useful theories and results [8]. If we miss these aspects, we risk producing results that do not uncover key factors in determining the success or failure of software projects. As an example, the human reluctance to change [9] might be more important to consider in a software process improvement effort than exactly which process change is made or which tool is introduced. However, most research on software process improvement focus on the actual change rather than the people that will have to change their behavior [115].

The main objective of this study is to clarify the research area concerned with human aspects of Software Engineering and to create a common platform for future research. In order to meet the objective, we propose a definition of the research area Behavioral Software Engineering (BSE) and present results from a systematic literature review based on the BSE definition.

We argue that it is important to clearly define a specific area concerned with more realistic notions of human nature in order to better understand and improve software development processes and practices. In addition to the scientific value of having a clearly defined area of discourse we also argue that the definition is needed for political reasons. We need a definition and key concepts in arguments externally, to funding agencies and the society at large, as well as internally, to other SE researchers more focused on technical or process/method aspects of SE work. An inspiration is Behavioral Economics (see section 2) and the relative importance that this sub-field of Economics has gained in a relatively short time span.

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[1]We searched the ISI Web of Science on June 25th 2014 first for papers listing topics that match 'software engineering' or 'software development' and then checking how large a percentage of those that also list a topic among either a technology or process-related topic ('design', 'architecture', 'requirements', 'programming', 'testing', or 'verification') versus the ones that also list a 'soft' or human-related aspect ('social*', 'human factors', 'psychol*' or 'personality'). Even though this gives only a very coarse-grained indication we argue that it can at least act as a rough estimate of the relative amount of research done of each type.

Furthermore, the systematic literature review shall identify *what* have been studied, but also examine *how* the studies have been conducted. It aims to identify gaps in current research, identify trends and point to directions for future research. Thus, the primary focus of the SLR is the BSE research area as a whole, not the individual BSE concepts.

In the next section, we give further background and briefly present related research areas. After that, we present the methods used to define BSE and to conduct the systematic literature review. Next, the results are presented and discussed. Finally, the paper is concluded.

2. Background

More realistic understanding of the people involved in software development activities must be based on multiple scientific disciplines; software development is a very rich set of activities with connections to many existing fields. Over time, it is likely that many sub-fields of both psychology, social as well as organizational science will have to be considered for a fuller understanding of software development processes and practices.

In the following section we briefly describe the areas of research that we have deemed most relevant and that have affected our proposed definition and model of Behavioral Software Engineering (BSE). These main areas are work and organization psychology, psychology in programming and behavioral economics. Below we also review how these topics have been described in different conferences and sub-areas within software engineering. Finally, we briefly describe software literature reviews in Software Engineering.

2.1. Related Research
2.1.1. Work and Organizational Psychology

Psychology is defined as the scientific study of thinking, emotions and behavior. Naturally, organizational psychology[2] is the application of psychology in the workplace, i.e. is concerned with 'behavior in the workplace' [10].

Work and organizational psychology has only been in existence for about the last century. The question of what is significant for an individual's well-being and job satisfaction has been one of the most important research areas in organizational psychology since the 1920s. In the 1920s the research concentrated on physical work conditions such as lighting, ventilation and noise level and the beginning of the 1930s to the beginning of the 1940s, the interest in the social aspects of the work environment increased. In these years the human relations movement began, with Elton Mayo (1946) as one of its main spokesmen. Today work and organizational psychology raises important questions about how to manage effectively in organizations in particularly with the increasing number of knowledge workers whose commitment is critical to organizational success.

Knowledge workers such as IT consultants and software engineers live at the 'edge of change' such as new technologies and methods and the job involve a great deal of collaboration. Thus, this occupation has both a clear connection to other occupations that have been

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[2]Also sometimes referred to as industrial and organizational psychology, occupational psychology, or work psychology.

well studied within organizational psychology as well as at least a partly different context with unique aspects. It is important to study this occupation from the main perspectives of individual, group and organization.

2.1.2. Psychology of Programming

According to Sajaniemi [11], psychology of programming (PoP) is an interdisciplinary science that dates back to the late 1970s. The aim of PoP, which covers research in (1) computer programmers' cognition, (2) tools and methods for programming related activities and (3) programming education, was originally to make the programmers work more efficiently and to produce better software.

The Psychology of Programming Interest Group (PPIG) was established in the late 1980s [11]. The idea was to bring together researchers with a common interest in psychological aspects of programming but also to cover computational aspects of psychology. PPIG includes researchers from different communities such as cognitive science, psychology, software engineering, computer science etc. [12].

Even though The Psychology of Programming Interest Group (PPIG) defines the term programming quite broadly to include any aspects of software development the annual workshop series the group hosts mostly emphasize the individual perspective of programming. The research methods discussed and used in PPIG most often have been adopted from cognitive psychology [11].

2.1.3. Behavioral Economics

Behavioral Economics (BE) is an interdisciplinary science which aims to establish descriptively accurate findings about human cognitive ability and social interaction with implications on economic behaviors and processes. It uses models and knowledge from several neighboring sciences, and the most influential neighboring science has been psychology [13]. Some scientists argue that psychological economics is a separate strand of behavioral economics which borrows solely from psychology, especially cognitive psychology [14]. Others, single out behavioral finance defined as the area that argues that some financial phenomena can be better understood using models in which some agents are not fully rational' [15].

Nowadays, behavioral economics is a prosperous scientific field with its own conferences and journals. It has had a broad effect on the scientific thinking in the area of Economics. Daniel Kahneman received the Nobel prize in Economics in 2002 for his foundational work with Amos Tversky and gave his Nobel lecture on the 'Bounded Maps of Rationality: Psychology for Behavioral Economics' [16].

The state of affairs in SE shares similarities with the state of affairs in the field of Economics before the more widespread acceptance and rise of Behavioral Economics as one of its sub-disciplines.[3] While the prevailing assumption in Economics during the 20th century has been that of human beings making rational choices in order to maximize their economic

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[3]Even the historic evolution of first acknowledging the importance of behavioral and psychological factors, then mostly ignoring them and then reintroducing them can be seen within Economics [17, 18] and, thus, may indicate a natural progression in the maturation of any research field.

output, behavioral economists draw on psychology and sociology to explain economic phenomena [17]. The research is thus grounded on hypotheses based on empirical data of how human beings actually think and behave. This fundamental shift in the basic assumptions of Economics has helped create economic theories that can better account for the evident fact that humans show irrational as well as altruistic behavior, self-sabotage their own progress etc [18].

2.1.4. Conferences and workshops

A number of workshops and conferences have addressed concerns close to BSE over the years. Two examples are the workshop on cooperative and human aspects of software engineering (CHASE) and the psychology of programming (PoP) conference.

The CHASE workshops, which have been held in conjunction with the largest conference within SE (ICSE) since 2008, have highlighted two main strands: (a) human and (b) cooperative aspects of SE and emphasized that SE activities typically happen in the context of a group or team [6]. There has also been a special issue, based on work at CHASE, published in well circulated journals within the SE field [5]. The CHASE community has been key in creating more interest into human aspects on software engineering and the association with the main SE conference has surely helped in spreading the importance of these aspects.

The aim of PoP workshops, which covers research in (1) computer programmers' cognition, (2) tools and methods for programming related activities and (3) programming education, was originally to make the programmers work more efficiently and to produce better software. Even though the psychology of programming interest group (PPIG), which hosts the PoP workshop, defines the term programming quite broadly to include any aspects of software development the PoP workshop series emphasize the individual perspective of programming. The research methods discussed and used in PoP most often have been adopted from cognitive psychology [11].

A number of conferences, e.g. human-centered SE (HCSE) and conference on human factors in computing systems (CHI), have names that allude to this type of research but focus mainly on the human-computer interaction or on usability. Similarly, we acknowledge that there are many connections to the area of socio-technical systems and there have been several proposals for adopting such approaches to the design of software and information systems [19]. Even though there are plenty of and varied results and proposals in this area they are generally more focused on the system to be delivered and the people and organization that will use it rather than the people and organization that develop it.

2.2. Systematic Literature Review

A systematic literature review could be used to evaluate and interpret research for a particular field of interest. The guidelines suggested by Kitchenham [20] have been derived from guidelines in medical research and adjusted to suite software engineering. The guidelines, which aims to create a fair evaluation by using a trustworthy, rigorous, and auditable methodology, include three phases - planning, conducting and reporting the review.

3. Methods

The following sections describe the method used to define Behavioral Software Engineering (BSE) and the method used for conducting the systematic literature review (SLR).

3.1. Method for Defining BSE

This section describes the overall process for developing the definition of the BSE research area. We discuss the need for a definition and describe the considerations that were made.

Given the background it is clear that there are a number of research areas that study or touch on different human aspects in relation to the development of software. However, the relation and/or overlap between them and what they cover is unclear. While research within psychology of programming focuses on the individual and one specific software engineering activity (programming) it puts less focus on other important activities or on the group and organizational levels. Even though both work and organization psychology as well as socio-technical systems highlight all these three main units of analysis (individual, group and organization), the former has no specific focus on software development while the latter focus on the use of the developed system rather than its development.

Work and organizational psychology uses the individual, group and organization aspects in order to give structure to the activities it studies [21]. Even though software development is different from many other types of work, it is unlikely to constitute a whole different type of human endeavor. Hence, we argue that these three aspects also are a relevant starting point to give structure to Behavioral Software Engineering. The terms organization and group should here be considered in a general sense, i.e. the latter also includes different types of teams and other task-focused groups, while the former also includes more loose connections of multiple individuals such as communities.

We note that a problematic aspect of selecting the word Behavioral for the main term of the proposed area of study is that a slight distinction is often made between Social Sciences (SS) and Behavioral Sciences (BS) in that the former has the group while the latter has the individual as their main units of analysis. We do not want to imply that BSE should not concern itself with different groups of software engineers, on the contrary we think such research will be essential for progress. Also, both SS and BS is often described as including the relationships among individuals in groups in their fields of study. Thus, even though we can alternatively use the names Social Software Engineering or at least Behavioral and Social SE we argue that the former could give some a somewhat too narrow view of what is meant (psychological aspects of an individual developer not studied?) while the latter is somewhat long. Thus, we propose the shorter but still not optimal name of BSE as a compromise.

In an earlier publication [22], we proposed that BSE should be defined as *the study of behavioral and social aspects of software engineering activities performed by individuals, groups or organizations.* The definition was presented and discussed at the CHASE workshop in June of 2014.

Based on the discussion we propose two changes to the original definition. First, we want the definition to more clearly highlight cognitive aspects of SE. Even though this can be argued to be included within 'behavioral aspects' it is commonly used, implicitly or explicitly,

in definitions even of the field of psychology as a whole. For example, the American Psychology Association describes psychology as the 'study of the mind and behavior' [23]. We propose that cognitive is a better scientific term than using the more colloquial word 'mind'. Even though there is a slight risk that this can be interpreted as not as clearly including other aspects of mind, such as emotions and values etc., these are typically considered to be part of cognitive science. For example, the Stanford Encyclopedia of Philosophy defines cognitive science as 'the interdisciplinary study of mind and intelligence' even though it also notes that the field has often put less emphasis on emotions [24].

Second, we want BSE to include not only studies in relation to the activities within software development and engineering but also the studies of the individuals, groups and organizations themselves without a connection to a specific SE activity.

Based on these concerns we define *Behavioral Software Engineering (BSE) as the study of cognitive, behavioral and social aspects of software engineering performed by individuals, groups or organizations.*

We appreciate that the processes of defining the BSE research area is iterative and that the definition will most certainly have to evolve as it is discussed further at conferences and workshops, and as the knowledge in the area refines.
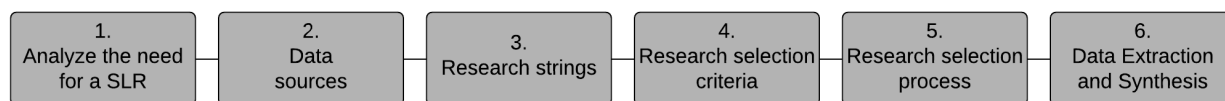
3.2. Systematic Literature Review Method

Figure 1: Overview of the steps in the systematic literature review.

The SLR shall, as stated in the introduction, identify *what* have been studied in the BSE research area, but also examine *how* the studies have been conducted. It aimed to identify gaps in current research and research methods, identify trends and point to directions for future research. Thus, the primary focus of the SLR was the BSE research area as a whole, not the individual BSE concepts.

The SLR was based on the guidelines described by Kitchenham [20]. In order to reduce the possibility of researcher bias, a pre-defined review protocol was produced. The protocol described the review process, which included the following stages (also shown in Figure 2); (1) analyzing the need for a systematic literature review, (2) selecting data sources, (3) selecting search string, (4) defining research selection criteria, (5) defining research selection process and (6) defining data extraction and synthesis. The next sections describe these stages in more detail and the considerations that we made.

3.2.1. Analyzing the need for a systematic literature review

For a detailed motivation, we refer to the reasoning in sections Introduction 1 and Background 2 above. BSE is a unifying term that includes a large number of related concepts.

Existing systematic reviews have studied specific concepts but there is a lack of overviews that consider multiple concepts together. Since cognitive, behavioral and social sciences are all inter-disciplinary with many interacting factors it is important that software engineering research also consider multiple factors within a single study and setting. This further motivates the need to complement existing systematic reviews with a broader, overview review.

3.2.2. Select Data Sources

BSE is interdisciplinary, therefore we selected databases likely to cover both technical as well as psychological research; IEEE Xplore Digital library, ACM Digital library, PsycINFO and Google Scholar. Even if the latter is not always recognized as a 'proper' research database we argue that it was important to be included here since the more topic-specific databases might not cover papers that are in between research areas and thus might have been published in less well known journals or conferences.

3.2.3. Search Strings

Figure 2: Steps included to generate the search strings.

The goal was to cover a substantial part of the BSE research area. Therefore, we identified concepts related to the definition. Since it was not possible to encapsulate the whole research area with a single string, multiple search strings had to be generated.

3.1 In order to identify concepts related to cognitive, behavioral and social aspects of software engineering (see BSE definition in section 3.1) we used a three-step process.

    3.1.1 First, we identified concepts in work and organizational psychology textbooks [25, 26, 27, 28, 29, 30, 31, 32, 33, 34].

    3.1.2 Second, we sough information in papers published in related conferences and workshops (see 2.1).

    3.1.3 Third, we interviewed experts in the field of organizational psychology and social psychology.

3.2 Each identified concept was classified as a BSE concept or discarded. The criterion for classifying the concepts was simple and straightforward. If none of the authors found any argument that the concept was not aligned with the definition of BSE, i.e. would not contribute to study of cognitive, behavioral and social aspects of Software Engineering, the concept was included. The three authors did this process first independently and then discussed any discrepancies. There were very few discrepancies and they could easily be resolved in a discussion.

The final 55 BSE concepts and a brief description of them can be found in Table 7.

3.2 Finally, one search string was generated for each of the 55 identified BSE concepts. These are shown in Table 8.

The quality of the search strings was verified by a pilot search for two BSE concepts - self-efficacy and locus of control. For each concept, three relevant publications where known [116, 117, 118, 119, 120, 121] and the pilot search captured all of them.

We also considered other approaches for generating search strings. Instead of first identifying concepts related to the BSE definition and from these generate search strings, one option would be to use synonyms for 'human aspect' or 'human factors'. Although we think that the latter is a valid approach, we argue that the one we used has benefits. For example, we believe that it, by using multiple and more specific search strings, will be able find more relevant primary studies. In addition, the BSE concepts could be used to identify gaps in the research area and provide future research topics. One weakness is that the search strings will not find studies that do not include any of the BSE concepts and consequently they will not be identified as primary studies. Hence, the number of identified primary studies is directly related to the number of identified concepts.

We recognize that we were not be able compile a complete list of all concepts related to BSE. However, we argue that the process described above ensures that we identify enough BSE concepts to fulfill the purpose of the SLR. We acknowledge that additional concepts will likely need to be added as the research area develops and gains a clearer sense of what it includes and studies.

3.2.4. Research Selection Criteria

The study selection criteria were intended to identify those primary studies that provide direct evidence regarding the aim of the systematic literature review [20]. In order to reduce the likelihood of bias, the following criteria were derived.

Inclusion Criteria

Publication Year: We limited the search to include publications between January 1997 and December 2013. This limitation was required since the number of search hits was very large despite of it. The start date was set in order to capture studies related to the agile software development approach, which has had a major influence on Software Engineering.

Publication Type: We choose to include papers published both in journals, in conference proceedings and in workshop proceedings.

Content: The BSE concept had to have been studied in relation Software Engineering activities or to software engineers. No complete list of Software Engineering activities or Software Engineering roles was compiled. Instead, we used a publication by Yilmaz, O'Connor and Clarke [35], and SWEBOK version 3 [36] to provide general guidance.

Exclusion Criteria

Language: We limited this study to only include papers written in English.

Publication Type: We excluded papers where we could not locate a full paper version, although very few papers were affected by this exclusion criterion.

A pilot of the selection process, described in the next section 3.2.5, resulted in an update of the content criteria. The pilot showed that the researchers were unsure what roles to include in Software Engineering. Therefore, we added a publication by Yilmaz, O'Connor and Clarke [35], and SWEBOK version 3 [36] to provide general guidance.

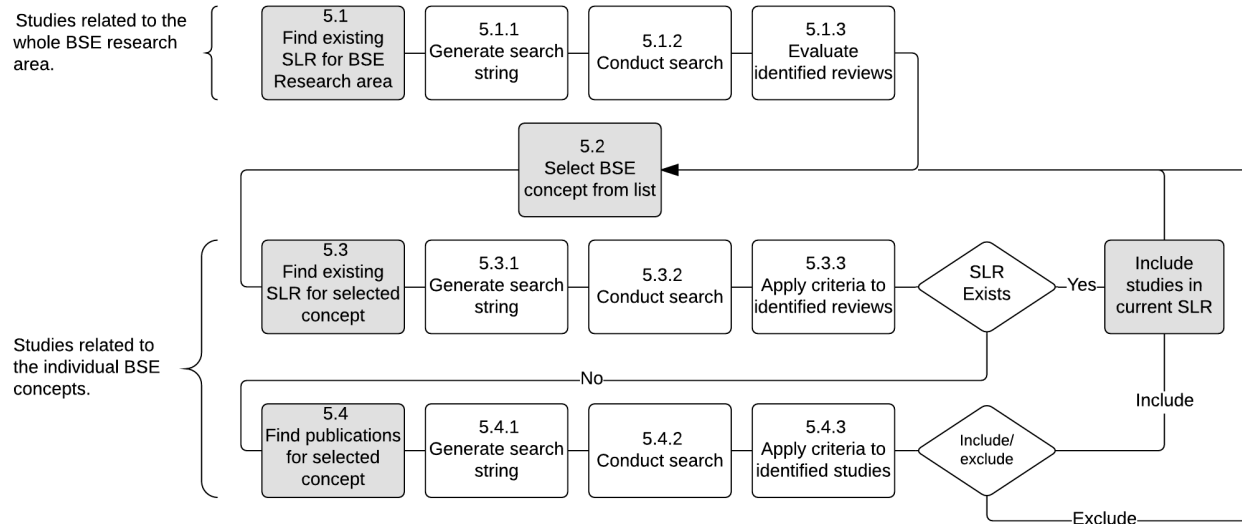## 3.2.5. Research Selection Process

Figure 3: Steps included in the selection process.

As shown in Figure 3 the research selection included three main step. In the first step we identified if there existed any reviews that covered a major part of the whole BSE research area. Next, we explored if there existed any literature reviews for the BSE concepts in Table 7. If no reviews were found, we identified studies related to the BSE concept. These main steps are detailed below.

5.1 First, we explore if any systematic literature reviews existed for the whole BSE research area.

    5.1.1 The search string was generated by combining synonyms for system engineers (defined by Cruz et al. [113]) and synonyms for systematic review (defined by Biolchini et al. [37]) with a logical AND operator.

    5.1.2 Next, the search string was applied to the selected data sources.

    5.1.3 The search identified three meta literature reviews which listed literature reviews in the SE domain [38, 39, 40]. In these studies three human factors literature reviews were found, all of which related to motivation [110, 112, 111]. Further, the search identified literature reviews for motivation, stress, personality, intention to leave, organizational climate, organizational change and organizational learning. These studies are briefly described in the result section 4.1. No literature review was found covering a substantial part of the BSE research area.

5.2 For each of the 55 BSE concepts identified in section 3.2.2, the following steps were conducted.

5.3 We explored if any systematic literature reviews existed for the BSE concept.

    5.3.1 The research sting was generated by combining synonyms for systematic review (defined by Biolchini et al. [37]) with the BSE concept with a logical AND operator. The search string for the BSE concept is shown in Table 8.

    5.3.2 Next, the search string was applied to the selected data sources.

    5.3.3 The criteria used in the evaluation are defined in section 3.2.4. As suggested by Kitchenham [20] the selection criteria were initially interpreted liberally, so that unless the identified systematic reviews could be clearly excluded based on titles and abstracts, full copies were obtained.

5.4 If a systematic review, conducted year 2008 or later, was identified for the BSE concept in the previous step, no additional search was performed. If no systematic review was identified we explored if any studies existed for BSE concept.

    5.4.1 The research sting was generated by combining synonyms for software engineers (defined by Cruz et al [113] and Beecham et al. [110]) and the BSE concept with the logical AND operator. The search string for the BSE concept is shown in Table 8.

    For example, the research string for the BSE concept self-efficacy was *("self efficacy" OR "self-efficacy") AND ("software engineering" OR "software development" OR "agile development" OR "systems engineering" OR "systems development" OR "software project")*.

    A list of all 55 search strings are found in Table 8.

    5.4.2 Next, the search string was applied to the selected data sources.

    5.4.3 The criteria used in the evaluation are defined in section 3.2.4. As suggested by Kitchenham [20] the selection criteria were initially interpreted liberally, so that unless the studies could be clearly excluded based on titles and abstracts, full copies were obtained.

    It was not possible to evaluate all search results returned by Google Scholar due to the large amount of results. Instead, for Google Scholar, if no relevant publications were included for three consecutive pages (10 results per page) the process was terminated. As a safeguard, random checks on at least one percent of the remaining results were performed.

    On average, more than 500 papers were screened per BSE concept.

In order to verify the reliability, a selection process pilot was conducted in which two researchers applied one BSE concept (Self Efficacy) to Google Scholar. The pilot resulted in the constraint described in step [5.4.3] above.

3.2.6. Data Extraction and Synthesis

The properties to extract for each included paper were chosen to meet the primary purpose of the SLR. Table 1 shows the complete list of properties (P1-P9) each with a brief description, and, where applicable, its possible value range. Four properties (P1-P4)

extracted information regarding *what* had been studied, i.e. what BSE concept(s) (P1) and what unit(s) of analysis (P2) had been studied, in what software engineering areas the research had been conducted (P3) and what were the primary outcome of the studies (P4). As shown in Table 1 the value range for these properties were nominal. In addition, P1-P3 could be assigned multiple values, while P4 only could be assigned a single value.

Three properties (P5-P7) extracted information related to *how*, or in what way, the studies had been conducted, i.e. what research design was used (P5), what were the research context (P6) and what faculties performed the research (P7). In addition, to get an overview of the BSE research area and identify temporal trends we also extracted the publication type (P8) and the publication year (P9).

In order to verify the reliability of the extraction process a pilot extraction was conducted, where three researchers classified 12 randomly selected publications [41]. Comparing the results from the researchers showed that the extraction process was straightforward for all properties except for P5, research design. Therefore, to reduce the risk of miss-classification we reduced the original number of choices leaving only two alternatives, empirical and theoretical studies.

In addition to extracting properties, we also summarized the actual contents and results for the studies. In these summations, we focused efforts on the studies including multiple units of analysis (UoA), i.e. studies that include concepts from more than one UoA. There were three main reasons for this choice. The first reason was primarily of a practical nature. It would not be possible to summarize and report on all of the 250 studies in this single paper. It was necessary to introduce some limitation otherwise this article would simply be too long. Second, the primary focus of the SLR was the BSE research area as a whole, not the individual BSE concepts. Hence, a summary of each study would not contribute to the purpose of this paper. Third, the definition of BSE emphasizes the UoA, and we believe it is of special interest to analyze studies that take on a broader approach, and that, in a way, cover a larger part of the BSE definition.

Property	Description
P1 - BSE Concept	Sociological or psychological concepts included in the publication as defined in Table 7.
P2 - Unit of Analysis	The units of analysis are the major entities that are analyzed in the publication [42]. The publications were classified as individual, group or organization, based on the included BSE concepts. A publication could be classified as covering more than one unit of analysis.
P3 - SWEBOK Knowledge Area	The published version of SWEBOK V3 [36] has the following 15 knowledge areas (KAs) within the field of software engineering - Software Requirements, Software Design,Software Construction, Software Testing, Software Maintenance, Software Configuration Management, Software Engineering Management, Software Engineering Process, Software Engineering Models and Methods, Software Quality, Software Engineering Professional Practice, Software Engineering Economics, Computing Foundations, Mathematical Foundations and Engineering Foundations. If no clear knowledge area could be identified the property was assigned the value Not Applicable.

P4 - Primary Outcome	The property primary outcome was grouped into four categories; People, Process, Product or Not Applicable. People included outcomes that affect the individual's or group's norms, values, feelings, attitudes or behaviors, e.g. stress level, intention to quit, level of communication, etc. Process included extrinsic outcomes that affect individual's or group's way of work, processes, practices, methods or tools. Product included outcome related to quality of the developed product or system, the individual or group performance, efficiency or task success. Finally, if no clear primary outcome could be identified the property was assigned the value Not Applicable.
P5 - Research Design	Empirical or Theoretical. In empirical studies the theories are supported through the collection of data rather than through theoretical reasoning. Theoretical studies develop new theories through analyzing existing theory and explanations, and the new theories are not verified through collecting evidence. For empirical studies, we also extracted if they used an experimental research design or not. We did not use a more detailed set of alternatives here since our internal validation showed that it was hard to reach consensus on which research design had been employed.
P6 - Research Context	Industrial, Academic or Not Applicable
P7 - Faculty affiliation	The faculty affiliation of the researcher(s) conducting the study, classified as (1) social sciences (i.e. anthropology, sociology or psychology), (2) software engineering or computer sciences, (3) other faculty or (4) unknown.
P8 - Publication type	Journal, Conference or Workshop
P9 - Publication year	Publication year

Table 1: Properties extracted for each paper in the systematic literature review.

4. Results

The presented result follow the process described in the method section. First, we briefly present the existing SLR we identified and analyze them from a UoA perspective. Next, we present an overview of the SLR result, where we focus on the extracted properties (P1-P9) in Table 1. Finally, we summarize the multi-UoA studies, i.e. studies that cover BSE concepts from more than one UoA.

4.1. Existing Literature Reviews

We identified existing literature reviews related to four individual BSE concepts (motivation, stress, personality and intention to leave) and to three organizational BSE concepts (organizational culture, organizational change and organizational learning). No reviews were found for any of the group UoA concepts.

4.1.1. Individual UoA Reviews

Four literature reviews were found covering *motivation* in SE [110, 111, 112, 122]. The reviews have an overall individual focus and showed that motivation mainly has been studied together with other individual UoA concepts. For example, Beecham et al. [110] stated that software engineers are likely to be motivated according to individual concepts, i.e. their characteristics (e.g. their need for variety) and their internal controls (e.g. their personality).

Regarding models of motivation in SE, Sharp et. al [111] conclude that the models in use heavily rely on the job characteristics model, which has a strong individual focus. The most recent review, conducted by Csar et al. [122] in 2011, summarize the research and state that there is no clear understanding of what motivates software engineers, how they are motivated or the benefits of motivating software engineers.

Ghapanchi et al. performed a literature to gain insight into existing studies on *intention to leave* of information technology (IT) personnel [123]. The review, which included 72 studies from 1980 to 2008, indicate that the research has had a broad perspective in terms of UoA. The authors identified 70 drivers and classified them into the 5 broad categories of individual, organizational, job-related, psychological, and environmental.

Regarding *stress* a relative small literature review by Maudgalya et al. [124], which included 12 publications, identified a relationship between burnout and the variables job task, role ambiguity and role conflict. Hence, this review focuses on the individual UoA.

Further, a review by Shirley et al. [113], which included 42 publications between 1970 and 2010, studied the BSE concept *personality*. The review shows that personality has been studied in conjunction with concepts from both the individual and the group UoA. For example, among the most recurring research topics was team building which is a group UoA concept. However, the review did not identify any publications that study personality together with a concept from the organizational UoA.

4.1.2. Organizational UoA Reviews.

Two reviews related to *organizational learning* were identified. These studies mainly focus on the individual and the organizational UoA, whereas the group aspect is not analyzed at all. A review by Bjrnson and Dingsyr [125] concludes that the research so far have been divided and have very little overlap. However, a major finding repeated over several studies is the need to not focus exclusively on explicit knowledge, but also on tacit knowledge. The first review [126] from 2000 identified two main streams of research: (1) studies that apply organizational learning concepts, and (2) studies concerned with the design of information technology applications to support organizational learning.

Further, software process improvement (SPI) is the most dominant *organizational change* paradigm that software organizations implement. Three reviews related to SPI were found. Common for all three studies were that they solely focus on the organizational UoA. The first review including 148 publications identified seven evaluation strategies [115], where the most common Pre-Post Comparison was applied in nearly half of the publications. The second review analyzed published case studies on the SPI efforts carried out in small and medium sized software enterprises [127]. A review by Lavalle and Robillard, which included 26 SPI related studies, lists positive and negative impacts on software developers, e.g. that SPI is oriented toward management and process quality and not towards developers and product quality [128].

A relative small review by Leidner and Kayworth [114] found three publications related to *organizational culture* in the SE domain published before 2004. A common finding in the three studies was the importance of a fit between the values on the group and organizational levels, e.g. the values of groups and the values embedded in the software development pro-

cesses. This indicates that the research on *organizational culture* has had a broad perspective in terms of UoA.

4.2. Overview of the Result

A total of more than 10,000 publication titles and abstracts were screened for relevance. After all the screening and filtering steps, 250 publications were finally included in the SLR. The included publications are listed per concept in Table 9 in the Appendix.

4.2.1. What has been studied

Properties P1-P4 (Unit of Analysis, BSE Concept, SWEBOK Knowledge Area and Primary Outcome) extracted information related to what had been studied in the included publications. As shown in Table 9, 42 of the 55 BSE concepts had ten or less publications, and for 11 concepts no publications at all were found. Only seven concepts were studied in more than 20 publications. Even though no explicit search was conducted for Personality this was one of the most common concept, included in 31 publications. Other common concepts were Communication (39 publications), Group composition (24), Job Satisfaction (24) and leadership (23).

The researchers have so far focused on a few BSE concepts per study as can be seen in Figure 4. Of the 250 publications 149 (60%) included only one BSE concept and only one publication include more than five BSE concepts. The average number of BSE concepts per publication was 1.5, with a median of 1 and a maximum of six concepts included in one publication. In addition, only 41 (16%) of the publications included BSE concepts from more than one unit of analysis (P2) and only three (1%) included concepts from all three units of analysis.
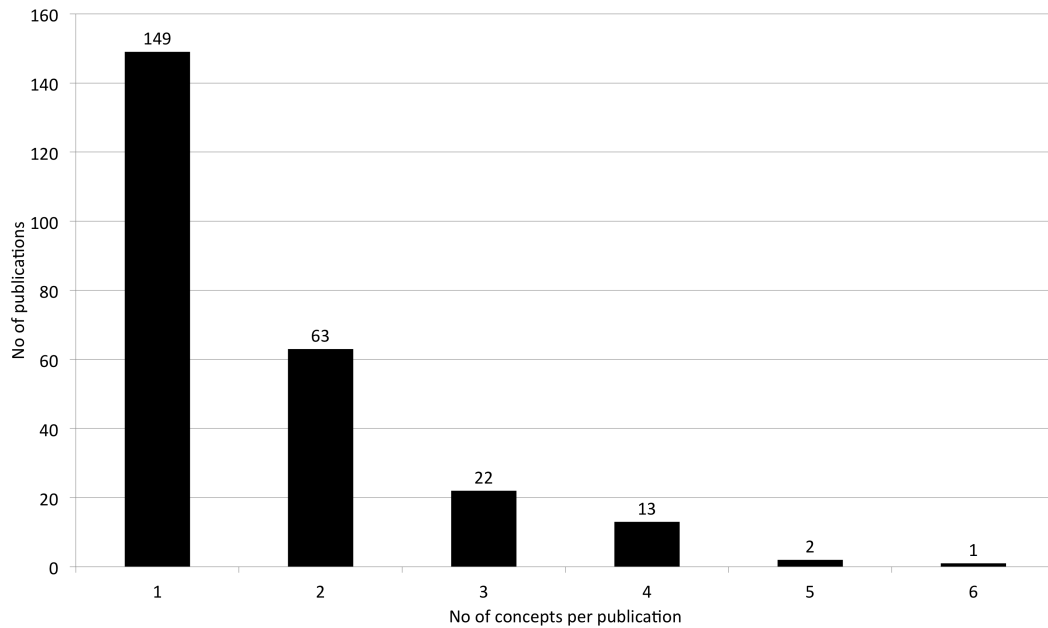
Figure 4: Figure showing the number of BSE concepts per publication. For example, in 149 of the 250 publications only one BSE concept was studied.

Further, the results indicate that the BSE research has focused on a few of the SWE-BOK knowledge areas (P3), see Table 2. In five of the fifteen SWEBOK knowledge areas no related publications were found, and in nine of the areas less than three publications were found. The most common knowledge area (66% of the publications) was number 11 (Software Engineering Professional Practice). Worth noticing is that for 28 publications (11%) no appropriate knowledge area could be assigned. These publications focused on the software engineers themselves and studied them as individuals, or as a part of a group or an organization, without a connection to a specific knowledge area. An example of such a publication is Trimmer et. al [129], which studies conflicts in Software Engineering.

As shown in Table 3, the primary outcome (P4) for 105 (42%) of the included publications was People. The distribution of the other outcomes was even, approximately 20% each. The individual UoA publications were more focused on the People factor than both the group and organizational UoA. For the organizational UoA only 16% had a People focus, while the Figure was 32% for the group UoA. Unfortunately, the primary outcome property was insufficient for the organizational UoA publications and approximately 30% of these could not be assigned to any of the three defined classes People, Process or Product. Example of primary outcome for the unclassified studies was culture and climate.

4.2.2. How have the studies been conducted

Properties P5-P7 (Research Design, Research Context, Faculty affiliation) extracted information regarding how, or in what way, the study had been conducted. The majority

P3 - Knowledge Area	No. of publications
1: Software Requirements	0
2: Software Design	1(0%)
3: Software Construction	7(3%)
4: Software Testing	1(0%)
5: Software Maintenance	0
6: Software Configuration Management	1(0%)
7: Software Engineering Management	47(19%)
8: Software Engineering Process	13(5%)
9: Software Engineering Models and Methods	35(14%)
10: Software Quality	3(1%)
11: Software Engineering Professional Practice	166(66%)
12: Software Engineering Economics	40(16%)
13: Computing Foundations	0
14: Mathematical Foundations	0
15: Engineering Foundations	0
Not Applicable	28(11%)

Table 2: Result for P3 - Number of publications per SWEBOK Knowledge Area.

P4 - Primary Outcome	Ind.	Group	Org.	All
People	78(60%)	40(32%)	6(16%)	105(42%)
Process	15(11%)	26(21%)	16(43%)	55(22%)
Product	22(17%)	34(27%)	4(11%)	44(18%)
Not Applicable	16(12%)	25(20%)	11(30%)	46(18%)
SUM	131	125	37	250

Table 3: Result for P4 - Number of publications per Primary Outcome.

of the publications were empirical (76%). Approximately 80% of the individual and group UoA publications had an empirical research design, while the Figure was around 60% the organizational UoA. Worth noticing is that only 13 (5%) publications used an experimental research design (see Table 4).

As shown in Table 5, most of the publications (56%) were conducted in an industrial context, 18% in an academic context, 5% used dual contexts and 20% had no clearly identifiable research context. The organizational UoA have, naturally, a smaller proportion of publications in an academic context than the other UoA; it is hard to study an organization out of context.

Regarding the faculty affiliation (P7), 32 of the publications, approximately one in eight, had a researcher from a social science faculty, and ten publications, one in 25, had researchers from both the software engineering and social sciences faculties.

4.2.3. Publication type and temporal distribution

The distribution between publication types (P8) differs slightly between the UoA. The individual UoA had a greater proportion of conference publications and smaller proportion of journal publications than the group and organizational UoA. 154 (62%) were journal publications, 80 (32%) were conference publications and 16 (6%) were workshop publications

P5 - Research Design	Ind.	Group	Org.	All
Empirical	104(79%)	98(78%)	22(59%)	190(76%)
Experimental	7(5%)	8(6%)	0(0%)	13(5%)
Theoretical	27(21%)	28(22%)	15(41%)	60(24%)
SUM	131	126	37	250

Table 4: Result for P5 - Number of publications per Research Design. For the empirical publication we also extracted, as stated in Table 1, how many that used an experimental research design.

P6 - Research Context	Ind.	Group	Org.	All
Industry	80(60%)	66(52%)	20(54%)	141(56%)
Academia	25(19%)	31(25%)	1(3%)	46(18%)
Ind. and Acad.	10(7%)	4(3%)	2(5%)	13(5%)
Not Applicable	19(14%)	25(20%)	14(38%)	50(20%)
SUM	134	126	37	250

Table 5: Result for P6 - Number of publications per Research Context

(see Table 6).

The temporal distribution (P9) for all the publications are shown in Figure 5. As can be seen, the general trend is that the number of BSE relevant publications is increasing with time. It is too early to decide if the downward trend seen for the last two years reflects an actual decrease or if not all publications have yet found their way to the databases. In particular, this might be a challenge with Google Scholar.

P8 - Publication Type	Ind.	Group	Org.	All
Journal	74(56%)	81(65%)	26(70)	154(62%)
Conference	51(39%)	34(27%)	9(24%)	80(32%)
Workshop	6(5%)	10(8%)	2(5%)	16(5%)
Sum	131	125	37	250

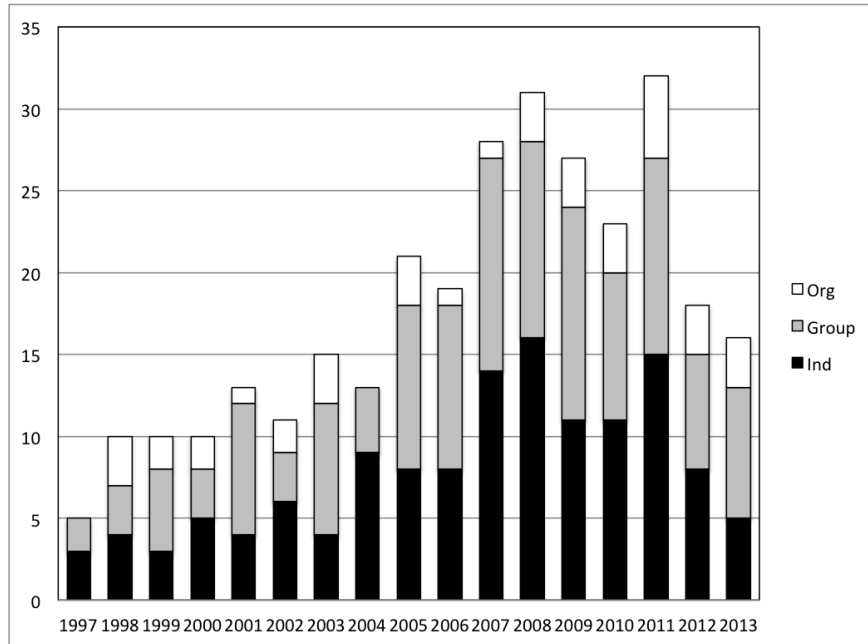Table 6: Result for P8 - Number of publications per Publication Type.

Figure 5: Temporal distribution of included papers per UoA.

4.3. Multi-UoA Studies

This section focuses on the multi-UoA publications, i.e. the publications that include BSE concepts from more than one UoA. The definition of BSE emphasizes the UoA, and it is therefore of special interest to analyze publications that take on a broader approach, and that, in a way, cover a larger part of the BSE definition. We present which concepts are the most common among these publications (see Figure 6 and we also briefly summarize result of the multi-UoA publications.

Of the 250 included publications, only 41 (16%) covered more than one unit of analysis (UoA). Of these, 38 covered two UoA and only three covered all three UoA. As shown in Figure 6, the multi-UoA studies included 30 of the 55 BSE concepts, and the most frequent concepts were personality (included in 20 publications), communication (13) and group composition (11).
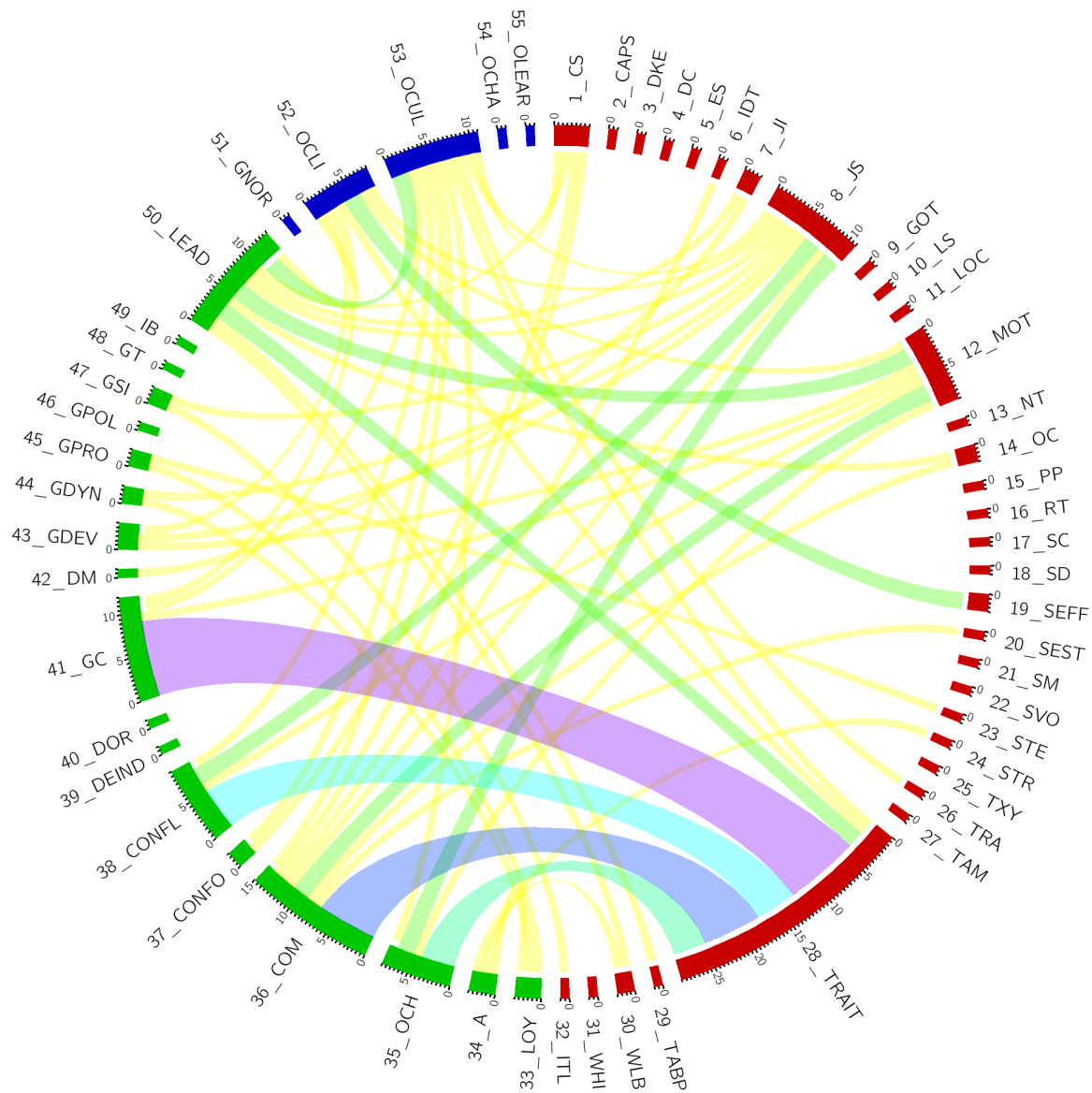
19

Figure 6: The figure shows which BSE concepts that have been studied together. The colors in the outer circle relate to the unit of analysis, where red represents the individual BSE concepts, green the group concepts and blue the organizational concepts. The size of the curved lines connecting the concepts relate to the number of publications where the connected concepts have been studied together. The figure shows, for example, that the BSE concept Personality (28_TRAIT) has frequently been studied together with Group Composition (41_GC) and Communication (36_COM); whereas Inter-group Behavior (49_IB) has not been studied together with any group or organizational BSE concept. The abbreviations in the figure are shown in Table 9.

4.3.1. Individual-Group Studies

Of the multi-UoA studies, the Individual-Group combination was, with 32 studies, the most common. The top three combinations of BSE concepts were personality-group composition (9 studies), personality-communication (7) and personality-conflicts (3). A study by Pieterse and Kourie [130] showed that personality diversity was a strong predictor of success, especially during the initial phases of team growth. The single most common tools used in the personality-group composition studies were Myers-Briggs Type Indicator (MBTI) [131, 132, 133, 134, 135]. It was used both to verify personality as a factor in teams and as a base to assemble teams.

Only one of the studies that included personality and communication concepts investigated their relationship explicitly. This study showed that divergent teams, i.e. teams including members with different personalities, positively correlated with communication quality[136]. In the other studies these concepts, i.e. personality and communication, were used as separate independent variables when studying pair and team programming [137, 138, 139], and team performance [140]. Though, the results of these studies were inconclusive.

Further, three studies included the concepts of personality and conflict. Two studies by Lewis and Smith, which used problem-solving style, found that the diverse groups reported less conflict and fewer negative comments than the dominant groups [131, 141]. The study also concluded, as the authors expected, that there was a significant negative correlation between conflict and performance. The negative effects of conflicts were also acknowledged in a study by Acuna et al. [142] which found that the level of satisfaction and cohesion dropped the greater the level of task conflict there was among team members. The same study also found a correlation between an average score for the personality factor extraversion and the evaluated quality of the developed software product.

4.3.2. Individual-Organization Studies

Three studies included concepts from both the individual and the organizational UoA. First, a study by Tsai et al. [120] concluded that organizational climate has a positive effect on self-efficacy, which in turn has a positive effect on the intention to share knowledge. Second, using theory of planned behavior (TPB) Passos et al. formed a conceptual framework in which organizational culture was identified as a component affecting the behavioral intentions [143]. The results pointed to a strong influence of past experience and showed that it is possible to characterize belief systems in software project contexts within a behavioral perspective. Third, results from a field study [144] indicated that individual personality (e.g. personality, self efficacy) differences and factors of the work environment (e.g. organizational climate) do affect professional competency levels.

4.3.3. Group-Organization Studies

In a meta study Sudhakar et al. [145] found that soft factors such as group composition and organizational climate had an effect on software development team performance. Further, an action research study reported on the importance of communication and organizational learning for virtual teams [146]. Last, in a study related to the culture and conflict

concepts Leidner et al. developed themes of IT-culture, upon which they then formed a theory of IT, values, and team conflicts. Based upon the theory, they developed propositions concerning three types of cultural team conflicts and the results of these conflicts [114].

4.3.4. Individual-Group-Organization Studies

Excluding the literature review [147] only 2 (1%) of all included studies included all three units of analysis. A model for individual adoption of technology was presented by Sultan and Chan [148], which include group (communication, leadership), and organizational (organizational culture) concepts. The study showed that the proposed model predicted which employees that will adopt new technology with an accuracy of 86%. Using a research model analyzing organizational learning and group development effect on job satisfaction, Janz examined the effects of self-directed work teams [149]. Results indicate that the level of cooperative learning that takes place on the teams may be more important to achieving improved work outcomes.

5. Discussion

5.1. Result Summary

Based on a definition of the behavioral software engineering (BSE) research area this study performed a systematic literature review (SLR). Over ten thousand publications were screened into a final set of 250 BSE publications included for detailed analysis. Together with existing literature reviews, our review provides an overview of this growing area of software engineering research.

The results from the SLR indicate that the BSE research area is growing and considering an increasing number of concepts from psychology and social science, at least for the investigated years 1997 to 2013. But the results also show that there are gaps in BSE research; several concepts that are widely considered to be part of organizational and work psychology have not yet been studied in SE. There are also a number of SE areas where no BSE research has been performed. Furthermore, the result indicate that the research performed so far have been unbalanced, with a heavy focus on a few BSE concepts on a limited number of SE areas.

BSE is an increasingly important aspect of SE research and should be recognized as such. Clarifying its definition and creating an initial list of concepts that it includes should help this type of research be more commonly considered by SE researchers and practitioners alike.

5.2. Overall Trend

The total number of relevant BSE publications is larger than what is often assumed [7] [109] and with more than 250 publications since 1997 the research area is neither new nor unresearched. Though, the results indicate that the research so far has been unbalanced both in terms of which BSE concepts that are studied, and in terms of which SE areas the concepts have been studied in.

For more than half of the identified 55 BSE concepts less than five publications were found, and for eleven concepts no publications were found. The BSE research has so far focused on a few well-known concepts, which also is supported by the fact that nine of the concepts include more than 15 publications each. The same pattern can be seen for the SE knowledge areas defined in SWEBOK, where the research so far has been focused on a selective few.

The top studied BSE concepts, with the most included studies, are communication, personality and job satisfaction.[4] The result shows three categories of publications related to communication; publications that stress the importance of communications, publications investigating factors affecting communication and publications focusing on the impact of different types of and amount of communication. The research was unanimous regarding the importance of communication, and it was recognized as an important factor in several areas, e.g. in distributed team environments [150] and as a skill for team members and project managers [151]. The publications identified several factor that affected the communication, examples of such are team composition [131] and agile methodology [108]. Furthermore, the result showed that communication quality has an impact on e.g. product quality [152] and organizational trust [153].

Regarding personality, the result in this study confirms previous research [113] and the most common themes, where personality was used, were in relation to pair programming and team composition. The most commonly used test was MBTI followed by tests based on the five factor model. Furthermore, the included studies also support the conclusion in previous research that evidence in some cases are inconclusive [113]. For example, this applies to the common theme of pair programming, where the research is inconclusive regarding if teams with different personality perform better compared to homogeneous teams [154, 155, 156, 137].

Most of the job satisfaction related studies investigated factors that affect job satisfaction. The research has so far been rather fragmented in the sense that it is unusual that several studies examined the same factors. Examples of factors reported to have a positive effect on job satisfaction are organizational trust [157] and high job fit [158]. Factors with a negative effect on job satisfaction are role conflicts and role ambiguity [159]. Four studies showed, as expected, that job satisfaction was related to the intention to quit [160, 161, 121, 162].

That a number of BSE concepts and SWEBOK knowledge areas are un-researched also implies that there are gaps in current research and that more research is needed. A threat to this conclusion is that the list of BSE concepts we identified is incorrect or misaligned and that (some of) the BSE concepts are not applicable to the SE domain. Even though we recognize this possibility, we consider it unlikely for all BSE concepts with few or no studies. It is our opinion that the methods described in section 3, which are used to identify the BSE concepts and perform the SLR, reduce the risk of making such errors.

At the individual UoA, we believe that SE research could benefit by broadening the focus from the commonly studied personality traits, e.g. MBTI [154, 155, 156, 163, 139, 164] and

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[4]We do not count all the papers in the concept-specific systematic literature reviews; only the ones in our set of included papers.

five factor models [165, 166, 142, 109].

There are several unexplored BSE concepts at the individual level that might of interest, e.g. social value orientations (SVO) [43]. The SVO construct has its origin in social psychology, but has also been studied in other disciplines [44] and may well be applicable within SE. In addition, when it comes to the group UoA we expect to find a number of important BSE concepts that can be considered. In particular, since the focus on and importance of the group has increased and been more clearly recognized with the use of agile development methodologies. As one example, a potentially important concept can be group polarization [45], a phenomenon that when placed in group situations, people will make decisions and form opinions to more of an extreme than when they are in individual situations. We did not find any papers that consider the concept within SE.

As a general strategy for the research area we propose that exploratory research that consider several BSE concepts at the same time could be helpful. Such studies can help create understanding of which concepts should be considered in more detail in subsequent research and which ones can be excluded. As an example, Kosti et al. recently considered emotional intelligence and self-compassion in a software engineering context but found that the former added only very little improvement in terms of predictive power compared to trait personality psychometrics [46].

5.3. Units of Analysis

Of the included publications, 42 (16%) covered concepts from more than one UoA and only two (< 1%) include concepts from all three UoAs. That only two studies covered all three UoA depends to a certain degree on that there are currently only four organizational BSE concepts. Still, we believe that the concepts on different UoA are related to and dependent of each other, and that the behavior of humans is too complex to be described using only one UoA. Klein et al. [47] states that multi-UoA theories are desirable because they provide a deeper and richer portrait of organizational life, and according to Crowstone [48] many organizational issues are multi-UoA and thus incompletely captured by single-UoA theories. We also believe that the multi-UoA studies are needed from an industrial perspective. For example, from a management point of view the understanding of what effects a change in the organizational level has on the group and individual level and vice versa is valuable information, making it possible to understand the consequences of the decisions to be taken.

There are without any doubt many reasons for the lack of multi-UoA studies. Klein et al. identified five barriers that relate to these types of studies. The first barrier is simply the mass of potential and relevant research. The second relates to the interest, values and heuristics of the researchers, i.e. the researcher are not used to these types of studies. The third barrier is the difficulty to determine the scope of the multi-UoA theory. The fourth barrier is the difficulty to publish, i.e. multi-UoA studies seems to belong everywhere and nowhere. The fifth and final barrier is the difficulty and complexity of conducting multi-UoA research, a barrier also supported by Crowstone [48].

5.4. Interdisciplinary Research

Further, the result from the SLR shows that 13 (5%) studies used an experimental research design. Compared to SE studies in general this figure is quite high. Sjøberg et al. showed that only 1.9% of over 5000 SE publication between 1993 and 2003 reported controlled experiments [49]. However, compared to work and organizational psychology (WOP) this figure is low. In a literature review Austin et al. [50] sampled and analyzed in total 609 empirical studies that were published in every 10th volume of Journal of Applied Psychology from 1920 to 2000. The study showed that experimental designs were the second most common research design and used in approximately 30% of the studies for the last two decades prior to the study (i.e. 1980's and 1990's).

A possible reason for the difference in terms of research design between WOP and BSE can be related to the background of researchers and their faculty affiliation. Our results show that only 32 publications, approximately one in eight, had a researcher from a social science faculty, and that ten publications, one in 25, had researchers from both the SE and social science (SS) fields. The absence of social scientists has also been noted in previous research [113]. Even though our result gives only an indication, since the affiliation might not correctly describe the specific background or experience that a researcher has, it supports our conclusion that BSE researchers in general should seek more cross-faculty collaborations.

We argue that BSE would benefit from becoming even more interdisciplinary, meaning that more studies should be performed in collaboration by researchers from SE and SS faculties. The social sciences have over hundred year of history of studying human behavior [51]. Clearly, the knowledge that has been built up could be leveraged for research in BSE not only directly (subject matter) but indirectly, through selected research approaches and methods. Without a broad, serious and systematic consideration of social science results and methods, SE researchers risk having to invent the wheel again and again. On the other hand, software engineering is a complex activity and the SS researchers need the SE researchers domain knowledge in order to design proper studies and analyze results. As the importance of software in society grows it seems likely that more behavioral and social science researchers will find software projects and organizations a viable area for specialization [110].

5.4.1. Limitations of this study

We have identified the following main threats to the validity of our results based on the methods we have used: (1) publication selection bias, (2) identification of publications, (3) inaccuracy in data extraction, and (4) mis-classification.

Publication selection bias is the phenomena where more positive than negative research results tend to be published, which can lead to an overestimation of the effect size in systematic reviews and an under-reporting of risks [52]. We regard this risk as moderate, and to reduce it we did not restrict the sources of information to a certain publisher, journal or conference. Further, we did not include grey literature (technical reports, books, etc.) as these tend to be secondary sources [53]. Some relevant papers may therefore have been excluded. Also, to help ensure an unbiased selection process, we defined the purpose of the study in advance, organized the selection of articles as a multistage process and documented the execution.

We acknowledge that the included publications do not cover the entire BSE research area. First, the result of the SLR is directly related to the identified BSE concepts, which, as stated previously, only acts as a starting point and does not cover all conceivable concepts. Though, we argue that the database and search string selection combined with the choice to include journal, conference as well as workshop proceedings ensure that the included publications will constitute a representative part of all publications, and that we will identify a sufficient number of studies to meet the purpose of this study. In addition, the search string quality was verified by a pilot search for the BSE concepts self-efficacy and locus of control. For each of these two concepts three relevant publications where known and all of them were captured in the pilot search. Since BSE is a nascent area of research and covers a multitude of different topics it is hard to identify a clear 'golden set' of publications that our search should have identified. With time this threat can more easily be mitigated. In fact, our results can help future researchers create such 'golden sets' for specific UoA's or concepts.

The selection and the data extraction process were mainly conducted by a single researcher. Although this approach is weaker in terms of consistency than having multiple researchers conducting the complete extraction in parallel and cross-checking the result, it was a necessary trade off in order to fulfill the schedule and the targeted breadth of the systematic review. To mitigate the threat we validated the steps through a random sampling of papers from which the other authors extracted results. However, since we cannot guarantee that some papers have not mistakenly been excluded or missed we have been careful, in our analysis, not to draw any conclusions based on a single paper or a single concept. Rather, the discussions and conclusions are related to the research area as a whole and reflect the overall trends.

Finally, our approach in this study has been to assess and evaluate research concerned with behavioral aspects of Software Engineering from a psychological perspective. This chosen interdisciplinary approach has affected the methods used in the systematic literature review. For example, the primary studies included in the SLR are related to psychological concepts found in work- and organizational psychology literature. It is our experience, from attending workshops and conferences, that some SE researchers perceive this approach as rather controversial. One reason for the skepticism might very well be related to the difficulties in conducting interdisciplinary research [54, 55, 56]. For example, Miller [54] states that an initial difficulty in interdisciplinary research is a terminological problem across the disciplines, where terms used in each discipline mean such different things that problem arise due to disagreements over those definitions and how to use the terms. The later problem can at least partly be mitigated by, and thus also further motivates the need for, the BSE definition and a future taxonomy. They can help provide a common communication platform among BSE researchers as well as towards social science researchers. However, we acknowledge that the present definition and investigated topics are not the final say in this regard; we can only claim to take an initial step and hope that others can build on and refine it.

6. Conclusions

Human aspects of software engineering is a growing area of research that has been recognized as important for a long time. Even though research that considers them has been growing in the past decade, these aspects should be more generally recognized and considered.

Therefore, in this study we present an updated definition of the behavioral software engineering (BSE) research area and conduct a systematic literature review based on identified concepts aligned with the definition.

The definition highlights that BSE is the study of cognitive, behavioral and social aspects at different levels relating to the work of software engineers. It is focused on the software developers and engineers themselves or in aggregates but excludes human aspects in relation to the use of the actual software; the latter is already studied in the human-computer interaction (HCI) field.

We found a total of 55 related concepts from organizational and social psychology and classified them as belonging to one of three main units of analysis. Even though these concepts are not likely to be complete it includes more concepts than has been previously considered together. As the area matures the number of concepts can expand to include a more refined view of relevant concepts.

The main results from our systematic review are that there are gaps in the existing BSE research and that the research has been unbalanced. For 11 out of 55 concepts, we found no published papers and for nine concepts we found more than 15 publications per concept. Thus, the research so far has had a heavy focus on a few BSE concepts that have been applied to limited number of SE areas. Existing BSE research focus on software engineers, teams or organizations in general and is not frequently connected to a specific phase or activity. Only one or a few (mean is 1.5, median is 1, max is 6) BSE concepts are included per study. Further, the result shows that the research seldom focuses on multiple units of analysis, and that it rarely is conducted in collaboration with researchers from both the software engineering and social science faculties. BSE is inherently applied and real-world; a majority of studies are empirical and conducted in an industrial context. In contrast to research in psychology, BSE research also less commonly use experiments, even if they are used more in BSE than in SE in general.

We have argued that future BSE research would benefit from focusing on several units of analysis and becoming more interdisciplinary, meaning that more studies should be performed by researchers from both software engineering and social science faculties. At least, SE researcher should explore more concepts within the cognitive, behavioral and social sciences and build on the many results from these areas. These scientific fields have over hundred years of history of studying different aspects of human behavior. Clearly, this gained knowledge could be leveraged for research in BSE and can help create a richer understanding of how humans involved in software development and engineering behave, think and feel. Software engineers as well as the end users of the software they produce stand to benefit.

7. Acknowledgments

References

[1] G. M. Weinberg, The psychology of computer programming, Vol. 932633420, Van Nostrand Reinhold New York, 1971.

[2] D. E. Perry, N. A. Staudenmayer, L. G. Votta, People, organizations, and process improvement, Software, IEEE 11 (4) (1994) 36–45.

[3] J. Highsmith, Agile software development ecosystems, Addison-Wesley Longman Publishing Co., Inc., 2002.

[4] A. Cockburn, Agile software development: the cooperative game, Pearson Education, 2006.

[5] C. R. de Souza, H. Sharp, J. Singer, L.-T. Cheng, G. Venolia, Guest editors' introduction: Cooperative and human aspects of software engineering, Software, IEEE 26 (6) (2009) 17–19.

[6] H. Sharp, R. Prikladnicki, A. Begel, C. D. Souza, Call for papers – CHASE 2014, IEEE ICSE Workshops, 2014.

[7] L. Fernando Capretz, Bringing the human factor to software engineering, Software, IEEE 31 (2) (2014) 104–104.

[8] K. Petersen, C. Wohlin, Context in industrial software engineering research, in: Proceedings of the 2009 3rd International Symposium on Empirical Software Engineering and Measurement, IEEE Computer Society, 2009, pp. 401–404.

[9] S. Oreg, Resistance to change: developing an individual differences measure., Journal of applied psychology 88 (4) (2003) 680.

[10] P. M. Muchinsky, Psychology applied to work: An introduction to industrial and organizational psychology ., Thomson Brooks/Cole Publishing Co, 1997.

[11] J. Sajaniemi, Psychology of programming: Looking into programmers' heads, The Problems of Professionals (2008) 3.

[12] M. Kutar, Psychology of programming interest group (2013).
URL http://www.ppig.org

[13] M. Rabin, A perspective on psychology and economics, European economic review 46 (4) (2002) 657–685.

[14] J. F. Tomer, What is behavioral economics?, The Journal of Socio-Economics 36 (3) (2007) 463–479.

[15] N. Barberis, R. Thaler, A survey of behavioral finance, Handbook of the Economics of Finance 1 (2003) 1053–1128.

[16] D. Kahneman, Maps of bounded rationality: Psychology for behavioral economics, American economic review (2003) 1449–1475.

[17] L. Bruni, R. Sugden, The road not taken: how psychology was removed from economics, and how it might be brought back*, The Economic Journal 117 (516) (2007) 146–173.

[18] C. Lambert, The marketplace of perceptions, Harvard Magazine 108 (4) (2006) 50.

[19] G. Baxter, I. Sommerville, Socio-technical systems: From design methods to systems engineering, Interacting with Computers 23 (1) (2011) 4–17.

[20] B. Kitchenham, Procedures for performing systematic reviews, Keele, UK, Keele University 33 (2004) 2004.

[21] A. Furnham, The psychology of behaviour at work, Psychology Press, 2005.

[22] P. Lenberg, R. Feldt, L.-G. Wallgren, Towards a behavioral software engineering, in: Proceedings of the 7th International Workshop on Cooperative and Human Aspects of Software Engineering, ACM, 2014, pp. 48–55.

[23] American Psychology Association: Definition of psychology (Jun. 2014).
URL http://www.apa.org/support/about/apa/psychology.aspx#answer

[24] Stanford Encyclopedia of Philosophy: Cognitive science (Jun. 2014).
URL http://plato.stanford.edu/archives/fall2008/entries/cognitive-science/

[25] M. A. Hogg, G. Vaughan, Social psychology: An introduction, Pearson Education, 2002.

[26] B. Levitt, J. G. March, Organizational learning, Annual review of sociology (1988) 319–340.

[27] B. Senior, J. Fleming, Organizational change, Pearson Education, 2006.

[28] D. Forsyth, Group dynamics, Cengage Learning, 2009.

[29] B. Nilsson, A.-K. Waldemarsson, Kommunikation: samspel mellan människor, Studentlitteratur,, 2007.

[30] A. Engquist, Kommunikation på arbetsplatsen: chefen, medarbetaren, gruppen, Rabén Prisma, 1992.

[31] J. Maxwell, Leadership 101: What every leader needs to know, Thomas Nelson Inc, 2002.

[32] N. Chmiel, An introduction to work and organizational psychology: a European perspective, John Wiley & Sons, 2008.

[33] C. Fahlke, P. M. Johansson, Personlighetspsykologi, Natur och Kultur,, 2007.

[34] E. E. Smith, R. L. Atkinson, E. R. Hilgard, Atkinson & Hilgard's introduction to psychology, Wadsworth Pub Co, 2003.

[35] M. Yilmaz, R. V. OConnor, P. Clarke, A systematic approach to the comparison of roles in the software development processes, in: Software Process Improvement and Capability Determination, Springer, 2012, pp. 198–209.

[36] A. Abran, P. Bourque, SWEBOK: Guide to the software engineering Body of Knowledge, IEEE Computer Society, 2004.

[37] J. Biolchini, P. G. Mian, A. C. C. Natali, G. H. Travassos, Systematic review in software engineering, System Engineering and Computer Science Department COPPE/UFRJ, Technical Report ES 679 (05) (2005) 45.

[38] B. Kitchenham, O. Pearl Brereton, D. Budgen, M. Turner, J. Bailey, S. Linkman, Systematic literature reviews in software engineering–a systematic literature review, Information and software technology 51 (1) (2009) 7–15.

[39] B. Kitchenham, R. Pretorius, D. Budgen, O. Pearl Brereton, M. Turner, M. Niazi, S. Linkman, Systematic literature reviews in software engineering–a tertiary study, Information and Software Technology 52 (8) (2010) 792–805.

[40] F. Q. Da Silva, A. L. Santos, S. Soares, A. C. C. França, C. V. Monteiro, F. F. Maciel, Six years of systematic literature reviews in software engineering: An updated tertiary study, Information and Software Technology 53 (9) (2011) 899–913.

[41] P. Brereton, B. A. Kitchenham, D. Budgen, M. Turner, M. Khalil, Lessons from applying the systematic literature review process within the software engineering domain, Journal of systems and software 80 (4) (2007) 571–583.

[42] E. Babbie, The practice of social research .

[43] J. K. Beggan, D. M. Messick, S. T. Allison, Social values and egocentric bias: Two tests of the might over morality hypothesis., Journal of Personality and Social Psychology 55 (4) (1988) 606.

[44] A. Nauta, C. K. De Dreu, T. Van Der Vaart, Social value orientation, organizational goal concerns and interdepartmental problem-solving behavior, Journal of Organizational Behavior 23 (2) (2002) 199–213.

[45] D. G. Myers, H. Lamm, The group polarization phenomenon., Psychological Bulletin 83 (4) (1976) 602.

[46] M. V. Kosti, R. Feldt, L. Angelis, Personality, emotional intelligence and work preferences in software engineering: An empirical study, Information and Software Technology Journal (in press).

[47] K. J. Klein, H. Tosi, A. A. Cannella, Multilevel theory building: Benefits, barriers, and new developments, Academy of Management review 24 (2) (1999) 248–253.

[48] K. Crowston, Processes as theory in information systems research, in: In Proceedings of the IFIP WG8.2 International Working Conference, 2000, pp. 149–164.

[49] D. I. Sjøberg, J. E. Hannay, O. Hansen, V. B. Kampenes, A. Karahasanovic, N.-K. Liborg, A. C. Rekdal, A survey of controlled experiments in software engineering, Software Engineering, IEEE Transactions on 31 (9) (2005) 733–753.

[50] J. T. Austin, C. A. Scherbaum, R. A. Mahlman, History of research methods in industrial and organizational psychology: Measurement, design, analysis, Handbook of research methods in industrial and organizational psychology (2002) 3–33.

[51] F. D. Richard, C. F. Bond Jr, J. J. Stokes-Zoota, One hundred years of social psychology quantitatively described., Review of General Psychology 7 (4) (2003) 331.

[52] B. A. Kitchenham, T. Dyba, M. Jorgensen, Evidence-based software engineering, in: Software Engineering, 2004. ICSE 2004. Proceedings. 26th International Conference on, IEEE, 2004, pp. 273–281.

[53] M. Genero, A. M. Fernández-Saez, H. J. Nelson, G. Poels, M. Piattini, Research review: a systematic literature review on the quality of uml models, Journal of Database Management (JDM) 22 (3) (2011) 46–70.

[54] J. Miller, Methodological issues for interdisciplinary research, in: Postgraduate English: A Journal and Forum for Postgraduates in English, no. 23, 2011.

[55] T. A. Heberlein, Improving interdisciplinary research: integrating the social and natural sciences, Society & natural resources 1 (1) (1988) 5–16.

[56] L. M. Campbell, Overcoming obstacles to interdisciplinary research, Conservation Biology 19 (2) (2005) 574–577.

[57] S. Messick, The nature of cognitive styles: Problems and promise in educational practice, Educational psychologist 19 (2) (1984) 59–74.

[58] W. Mischel, Y. Shoda, A cognitive-affective system theory of personality: reconceptualizing situations, dispositions, dynamics, and invariance in personality structure., Psychological review 102 (2) (1995) 246.

[59] J. Kruger, D. Dunning, Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments., Journal of personality and social psychology 77 (6) (1999) 1121.

[60] R. Karasek, Demand/control model: A social, emotional, and physiological approach to stress risk and active behaviour development, Encyclopedia of occupational health and safety 2 (1998) 34–6.

[61] M. E. Seligman, P. Schulman, Explanatory style as a predictor of productivity and quitting among life insurance sales agents., Journal of personality and social psychology 50 (4) (1986) 832.

[62] L. Greenhalgh, Z. Rosenblatt, Job insecurity: Toward conceptual clarity, Academy of Management review 9 (3) (1984) 438–448.

[63] E. A. Locke, The nature and causes of job satisfaction., Handbook of industrial and organizational psychology.

[64] D. VandeWalle, Development and validation of a work domain goal orientation instrument, Educational and Psychological Measurement 57 (6) (1997) 995–1015.

[65] OECD, Oecd better life index, [Online; accessed 12-November-2014] (2014).
URL http://www.oecdbetterlifeindex.org/topics/life-satisfaction/

[66] J. B. Rotter, Generalized expectancies for internal versus external control of reinforcement., Psychological monographs: General and applied 80 (1) (1966) 1.

[67] R. L. Pardee, Motivation theories of maslow, herzberg, mcgregor & mcclelland. a literature review of selected theories dealing with job satisfaction and motivation.

[68] D. C. McClelland, Human motivation, CUP Archive, 1987.

[69] M. E. Sheldon, Investments and involvements as mechanisms producing commitment to the organization, Administrative Science Quarterly (1971) 143–150.

[70] M. E. Seligman, M. Csikszentmihalyi, Positive psychology: An introduction., Vol. 55, American Psychological Association, 2000.

[71] J. G. March, Z. Shapira, Managerial perspectives on risk and risk taking, Management science 33 (11) (1987) 1404–1418.

[72] A. L. Duckworth, The significance of self-control, Proceedings of the National Academy of Sciences

108 (7) (2011) 2639–2640.

[73] T. F. Dictionary, Self discipline, [Online; accessed 12-November-2014] (2014).
URL http://www.thefreedictionary.com/self-discipline

[74] A. Bandura, Self-efficacy mechanism in human agency., American psychologist 37 (2) (1982) 122.

[75] About.com, What is self-esteem, [Online; accessed 12-November-2014] (2014).
URL http://psychology.about.com/od/sindex/f/what-is-self-esteem.htm

[76] M. Snyder, Self-monitoring of expressive behavior., Journal of personality and social psychology 30 (4) (1974) 526.

[77] D. W. Griesinger, J. W. Livingston, Toward a model of interpersonal motivation in experimental games, Behavioral science 18 (3) (1973) 173–188.

[78] M. Cardwell, Dictionary of psychology, Routledge, 2014.

[79] C. McGarty, V. Y. Yzerbyt, R. Spears, Stereotypes as explanations: The formation of meaningful beliefs about social groups, Cambridge University Press, 2002.

[80] A. P. Association, Stress, [Online; accessed 12-November-2014] (2014).
URL http://www.apa.org/research/action/glossary.aspx?tab=18

[81] D. McGregor, The human side of enterprise, New York 21 (1960) 166.

[82] I. Ajzen, The theory of planned behavior, Organizational behavior and human decision processes 50 (2) (1991) 179–211.

[83] J. Feist, Theories of Personality, Brown & Benchmark, 1994.
URL http://books.google.se/books?id=98U55toW68MC

[84] M. Friedman, R. H. Rosenman, Association of specific overt behavior pattern with blood and cardio-vascular findings: blood cholesterol level, blood clotting time, incidence of arcus senilis, and clinical coronary artery disease, Journal of the American Medical Association 169 (12) (1959) 1286–1296.

[85] S. C. Clark, Work/family border theory: A new theory of work/family balance, Human relations 53 (6) (2000) 747–770.

[86] J. Albano, Developing a measure and an understanding of the individual experience of happiness at work.

[87] R. P. Tett, J. P. Meyer, Job satisfaction, organizational commitment, turnover intention, and turnover: path analyses based on meta-analytic findings, Personnel psychology 46 (2) (1993) 259–293.

[88] J. Lee, A. Graefe, et al., Psychological commitment as a mediator of the relationship between involvement and loyalty, in: Proceedings of the 2001 Northeastern Recreation Research Symposium, April 1-3, 2001, The Sagamore on Lake George in Bolton Landing, New York, Vol. 289, US Department of Agriculture, Forest Service, Northeastern Research Station, 2001, p. 281.

[89] W. ODonohue, L. Nelson, Alienation: An old concept with contemporary relevance for human resource management, International Journal of Organizational Analysis 22 (3) (2014) 301–316.

[90] E. Durkheim, The division of labor in society, Simon and Schuster, 2014.

[91] D. Katz, R. L. Kahn, The social psychology of organizations.

[92] R. S. Crutchfield, Conformity and character., American Psychologist 10 (5) (1955) 191.

[93] Psychwiki, Deindividuation, [Online; accessed 12-November-2014] (2014).
URL http://www.psychwiki.com/wiki/Deindividuation

[94] B. Latane, J. M. Darley, Group inhibition of bystander intervention in emergencies., Journal of personality and social psychology 10 (3) (1968) 215.

[95] S. T. Bell, Deep-level composition variables as predictors of team performance: a meta-analysis., Journal of applied psychology 92 (3) (2007) 595.

[96] A. P. Association, Decision making, [Online; accessed 12-November-2014] (2014).
URL http://www.apa.org/research/action/glossary.aspx?tab=4

[97] A. Adnan, A. Akram, F. Akram, Group development: Theory and practice, Middle-East Journal of Scientific Research 16 (10) (2013) 1428–1435.

[98] N. J. Smelser, P. B. Baltes, et al., International encyclopedia of the social & behavioral sciences, Vol. 11, Elsevier Amsterdam, 2001.

[99] A. P. Association, Group polarization, [Online; accessed 12-November-2014] (2014).

URL `http://www.apa.org/research/action/glossary.aspx?tab=7`

[100] A. P. Association, Group think, [Online; accessed 12-November-2014] (2014).
URL `http://www.apa.org/research/action/glossary.aspx?tab=7`

[101] Wikipedia, Leadership, [Online; accessed 12-November-2014] (2014).
URL `http://en.wikipedia.org/wiki/Leadership_psychology`

[102] D. C. Feldman, The development and enforcement of group norms, Academy of management review 9 (1) (1984) 47–53.

[103] S. G. Isaksen, G. Ekvall, H. Akkermans, G. V. Wilson, J. P. Gaulin, Assessing the Context for Change: A Technical Manual for the Situational Outlook Questionnaire, Enhancing Performance of Organizations, Leaders and Teams for Over 50 Years, Creative Problem Solving Group, 2007.

[104] D. R. Denison, What is the difference between organizational culture and organizational climate? a native's point of view on a decade of paradigm wars, Academy of management review 21 (3) (1996) 619–654.

[105] E. Portal, What is organizational change?, [Online; accessed 12-November-2014] (2014).
URL `http://education-portal.com/academy/lesson/what-is-organizational-change-theory-example-qui` `html#lesson`

[106] C. Argyris, D. A. Schön, Organizational learning: A theory of action perspective, Reis (1997) 345–348.

[107] H. A. Simon, Administrative behavior, Vol. 4, Cambridge Univ Press, 1965.

Review References

[108] M. Pikkarainen, J. Haikara, O. Salo, P. Abrahamsson, J. Still, The impact of agile practices on communication in software development, Empirical Software Engineering 13 (3) (2008) 303–337.

[109] R. Feldt, R. Torkar, L. Angelis, M. Samuelsson, Towards individualized software engineering: empirical studies should collect psychometrics, in: Proceedings of the 2008 international workshop on Cooperative and human aspects of software engineering, ACM, 2008, pp. 49–52.

[110] S. Beecham, N. Baddoo, T. Hall, H. Robinson, H. Sharp, Motivation in software engineering: A systematic literature review, Information and Software Technology 50 (9) (2008) 860–878.

[111] H. Sharp, N. Baddoo, S. Beecham, T. Hall, H. Robinson, Models of motivation in software engineering, Information and Software Technology 51 (1) (2009) 219–233.

[112] T. Hall, N. Baddoo, S. Beecham, H. Robinson, H. Sharp, A systematic review of theory use in studies investigating the motivations of software engineers, ACM Transactions on Software Engineering and Methodology (TOSEM) 18 (3) (2009) 10.

[113] S. S. Cruz, F. Q. da Silva, C. V. Monteiro, P. Santos, I. Rossilei, Personality in software engineering: Preliminary findings from a systematic literature review, in: Evaluation & Assessment in Software Engineering (EASE 2011), 15th Annual Conference on, IET, 2011, pp. 1–10.

[114] D. E. Leidner, T. Kayworth, Review: a review of culture in information systems research: toward a theory of information technology culture conflict, MIS quarterly 30 (2) (2006) 357–399.

[115] M. Unterkalmsteiner, T. Gorschek, A. M. Islam, C. K. Cheng, R. B. Permadi, R. Feldt, Evaluation and measurement of software process improvementa systematic literature review, Software Engineering, IEEE Transactions on 38 (2) (2012) 398–424.

[116] M. Ozer, Personal and task-related moderators of leader-member exchange among software developers., Journal of Applied Psychology 93 (5) (2008) 1174.

[117] D. P. Darcy, M. Ma, Exploring individual characteristics and programming performance: Implications for programmer selection, in: System Sciences, 2005. HICSS'05. Proceedings of the 38th Annual Hawaii International Conference on, IEEE, 2005, pp. 314a–314a.

[118] B. Arya, M. Sharma, S. Singh, Moderating effect of gender role orientation on the relationship between organizational commitment and self efficacy, commitment 42 3–96178.

[119] S. Ohly, C. Fritz, Challenging the status quo: What motivates proactive behaviour?, Journal of Occupational and Organizational Psychology 80 (4) (2007) 623–629.

[120] M.-T. Tsai, N.-C. Cheng, Programmer perceptions of knowledge-sharing behavior under social cognitive theory, Expert Systems with Applications 37 (12) (2010) 8479–8485.

[121] F. Calisir, C. Gumussoy, I. Iskin, Factors affecting intention to quit among IT professionals, in: Industrial Engineering and Engineering Management, 2009. IEEM 2009. IEEE International Conference on, IEEE, 2009, pp. 49–53.

[122] A. C. C. França, T. B. Gouveia, P. C. Santos, C. A. Santana, F. Q. da Silva, Motivation in software engineering: A systematic review update, in: Evaluation & Assessment in Software Engineering (EASE 2011), 15th Annual Conference on, IET, 2011, pp. 154–163.

[123] A. H. Ghapanchi, A. Aurum, Antecedents to IT personnel's intentions to leave: A systematic literature review, Journal of Systems and Software 84 (2) (2011) 238–249.

[124] T. Maudgalya, S. Wallace, N. Daraiseh, S. Salem, Workplace stress factors and burnoutamong information technology professionals: A systematic review, Theoretical Issues in Ergonomics Science 7 (3) (2006) 285–297.

[125] F. O. Bjørnson, T. Dingsøyr, Knowledge management in software engineering: A systematic review of studied concepts, findings and research methods used, Information and Software Technology 50 (11) (2008) 1055–1068.

[126] D. Robey, M.-C. Boudreau, G. M. Rose, Information technology and organizational learning: a review and assessment of research, Accounting, Management and Information Technologies 10 (2) (2000) 125–155.

[127] F. J. Pino, F. García, M. Piattini, Software process improvement in small and medium software enterprises: a systematic review, Software Quality Journal 16 (2) (2008) 237–261.

[128] M. Lavallée, P. N. Robillard, The impacts of software process improvement on developers: a systematic review, in: Proceedings of the 2012 International Conference on Software Engineering, IEEE Press, 2012, pp. 113–122.

[129] K. J. Trimmer, R. W. Collins, R. P. Will, J. E. Blanton, Information systems development: Can there be “good” conflict?, in: Proceedings of the 2000 ACM SIGCPR Conference on Computer Personnel Research, SIGCPR '00, ACM, New York, NY, USA, 2000, pp. 174–179. doi: 10.1145/333334.333389.
URL http://doi.acm.org/10.1145/333334.333389

[130] V. Pieterse, D. G. Kourie, I. P. Sonnekus, Software engineering team diversity and performance, in: Proceedings of the 2006 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries, South African Institute for Computer Scientists and Information Technologists, 2006, pp. 180–186.

[131] T. L. Lewis, W. J. Smith, Building software engineering teams that work: The impact of dominance on group conflict and performance outcomes, in: Frontiers in Education Conference, 2008. FIE 2008. 38th Annual, IEEE, 2008, pp. S3H–1.

[132] M. Omar, S.-L. Syed-Abdullah, Identifying effective software engineering (se) team personality types composition using rough set approach, in: Information Technology (ITSim), 2010 International Symposium in, Vol. 3, IEEE, 2010, pp. 1499–1503.

[133] A. R. Peslak, The impact of personality on information technology team projects, in: Proceedings of the 2006 ACM SIGMIS CPR conference on computer personnel research: Forty four years of computer personnel research: achievements, challenges & the future, ACM, 2006, pp. 273–279.

[134] S. Licorish, A. Philpott, S. G. MacDonell, Supporting agile team composition: A prototype tool for identifying personality (in) compatibilities, in: Proceedings of the 2009 ICSE Workshop on Cooperative and Human Aspects on Software Engineering, IEEE Computer Society, 2009, pp. 66–73.

[135] R. H. Rutherford, Using personality inventories to help form teams for software engineering class projects, in: ACM SIGCSE Bulletin, Vol. 33, ACM, 2001, pp. 73–76.

[136] P. Sfetsos, I. Stamelos, L. Angelis, I. Deligiannis, Investigating the impact of personality types on communication and collaboration-viability in pair programming–an empirical study, in: Extreme Programming and Agile Processes in Software Engineering, Springer, 2006, pp. 43–52.

[137] N. Salleh, E. Mendes, J. Grundy, Empirical studies of pair programming for cs/se teaching in higher

education: A systematic literature review, Software Engineering, IEEE Transactions on 37 (4) (2011) 509–525.

[138] K. Choi, Team programming influencing factors: A field survey, Journal of International Technology and Management 18 (2007) 1–13.

[139] K. S. Choi, F. P. Deek, I. Im, Pair dynamics in team collaboration, Computers in Human Behavior 25 (4) (2009) 844–852.

[140] J. H. Bradley, F. J. Hebert, The effect of personality type on team performance, Journal of Management Development 16 (5) (1997) 337–353.

[141] T. L. Lewis, W. J. Smith, Creating high performing software engineering teams: the impact of problem solving style dominance on group conflict and performance, Journal of Computing Sciences in Colleges 24 (2) (2008) 121–129.

[142] S. T. Acuña, M. Gómez, N. Juristo, How do personality, team processes and task characteristics relate to job satisfaction and software quality?, Information and Software Technology 51 (3) (2009) 627–639.

[143] C. Passos, D. S. Cruzes, M. Mendonça, Beliefs underlying teams intention and practice: An application of the theory of planned behavior, Proc. of ESELAW 13.

[144] K. J. Trimmer, J. Ellis Blanton, T. Schambach, An evaluation of factors affecting professional obsolescence of information technology professionals, in: System Sciences, 1998., Proceedings of the Thirty-First Hawaii International Conference on, Vol. 6, IEEE, 1998, pp. 406–414.

[145] G. P. Sudhakar, A. Farooq, S. Patnaik, Soft factors affecting the performance of software development teams, Team Performance Management 17 (3/4) (2011) 187–205.

[146] J. Suchan, G. Hayzak, The communication characteristics of virtual teams: A case study, Professional Communication, IEEE Transactions on 44 (3) (2001) 174–186.

[147] T. Dybå, T. Dingsøyr, Empirical studies of agile software development: A systematic review, Information and software technology 50 (9) (2008) 833–859.

[148] F. Sultan, L. Chan, The adoption of new technology: the case of object-oriented computing in software companies, Engineering Management, IEEE Transactions on 47 (1) (2000) 106–126.

[149] B. D. Janz, Self-directed teams in is: correlates for improved systems development work outcomes, Information & Management 35 (3) (1999) 171–192.

[150] M. Jiménez, M. Piattini, A. Vizcaíno, Challenges and improvements in distributed software development: a systematic review, Advances in Software Engineering 2009 (2009) 3.

[151] N. P. Napier, M. Keil, F. B. Tan, IT project managers' construction of successful project management practice: a repertory grid investigation, Information Systems Journal 19 (3) (2009) 255–282.

[152] M. Ikonen, J. Kurhila, Discovering high-impact success factors in capstone software projects, in: Proceedings of the 10th ACM conference on SIG-information technology education, ACM, 2009, pp. 235–244.

[153] P. B. Lowry, D. Zhang, L. Zhou, X. Fu, Effects of culture, social presence, and group composition on trust in technology-supported decision-making groups, Information Systems Journal 20 (3) (2010) 297–315.

[154] L. Williams, L. Layman, J. Osborne, N. Katira, Examining the compatibility of student pair programmers, in: Agile Conference, 2006, IEEE, 2006, pp. 10–pp.

[155] N. Katira, L. Williams, E. Wiebe, C. Miller, S. Balik, E. Gehringer, On understanding compatibility of student pair programmers, in: ACM SIGCSE Bulletin, Vol. 36, ACM, 2004, pp. 7–11.

[156] N. Katira, L. Williams, J. Osborne, Towards increasing the compatibility of student pair programmers, in: Proceedings of the 27th international conference on Software engineering, ACM, 2005, pp. 625–626.

[157] D. Scholarios, A. Marks, Work-life balance and the software worker, Human Resource Management Journal 14 (2) (2004) 54–74.

[158] H. K. Lee, M. Gallivan, A review of difference score research in the is discipline with an application to understanding the expectations and job experiences of IT professionals, in: Proceedings of the 49th SIGMIS annual conference on Computer personnel research, ACM, 2011, pp. 119–125.

[159] Y. Shen, A meta-analysis of role ambiguity and role conflict on is professional job satisfaction, in: System Sciences, 2005. HICSS'05. Proceedings of the 38th Annual Hawaii International Conference

34

on, IEEE, 2005, pp. 263b–263b.

[160] S. G. Westlund, J. C. Hannon, Retaining talent: assessing job satisfaction facets most significantly related to software developer turnover intentions, Journal of Information Technology Management 19 (4) (2008) 1–15.

[161] M. W. Buche, Influence of gender on IT professional work identity: Outcomes from a pls study, in: Proceedings of the 2008 ACM SIGMIS CPR conference on computer personnel doctoral consortium and research, ACM, 2008, pp. 134–140.

[162] C.-Y. Tseng, M. Wallace, Retention of software employees in the IT industry in Taiwan, Journal of Human Resources Management 12 (1) (2012) 34–45.

[163] L. F. Capretz, Personality types in software engineering, International Journal of Human-Computer Studies 58 (2) (2003) 207–214.

[164] G. Mourmant, M. Gallivan, How personality type influences decision paths in the unfolding model of voluntary job turnover: an application to is professionals, in: Proceedings of the 2007 ACM SIGMIS CPR conference on Computer personnel research: The global information technology workforce, ACM, 2007, pp. 134–143.

[165] J. W. Lounsbury, R. S. Studham, R. P. Steel, L. W. Gibson, A. W. Drost, Y. Dwivedi, B. Lal, M. Williams, S. Schneberger, M. Wade, Personality traits and career satisfaction of information technology professionals, Handbook of research on contemporary theoretical models in information systems (2009) 529–543.

[166] T. A. Judge, D. Heller, M. K. Mount, Five-factor model of personality and job satisfaction: a meta-analysis., Journal of applied psychology 87 (3) (2002) 530.

[167] G. L. White, M. P. Sivitanides, A theory of the relationships between cognitive requirements of computer programming languages and programmers' cognitive characteristics, Journal of Information Systems Education 13 (1) (2002) 59–68.

[168] K. Jablokow, M. Myers, Managing cognitive and cultural diversity in global IT teams, in: Global Software Engineering (ICGSE), 2010 5th IEEE International Conference on, IEEE, 2010, pp. 77–86.

[169] M. J. Gallivan, The influence of system developers' creative style on their attitudes toward and assimilation of a software process innovation, in: System Sciences, 1998., Proceedings of the Thirty-First Hawaii International Conference on, Vol. 6, IEEE, 1998, pp. 435–444.

[170] D. Rui, S. Wei, Z. Li, Y. Hong, A study on the cognitive style of software developers, ACM Inroads 2 (3) (2011) 43–46.

[171] R. Mancy, N. Reid, N.: Aspects of cognitive style and programming, in: Proceedings of the Sixteenth Annual Workshop of the Psychology of Programming Interest Group (PPIG, 2004, pp. 1–9.

[172] R. Agarwal, J. Prasad, A field study of the adoption of software process innovations by information systems professionals, Engineering Management, IEEE Transactions on 47 (3) (2000) 295–308.

[173] M. A. Chilton, B. C. Hardgrave, D. J. Armstrong, Person-job cognitive style fit for software developers: the effect on strain and performance, Journal of Management Information Systems 22 (2) (2005) 193–226.

[174] D. Rui, S. Wei, Z. Li, Y. Hong, A study on the cognitive style of software developers, ACM Inroads 2 (3) (2011) 43–46. doi:10.1145/2003616.2003633.
URL http://doi.acm.org/10.1145/2003616.2003633

[175] P. J. Schreurs, T. W. Taris, Construct validity of the demand-control model: A double cross-validation approach, Work & Stress 12 (1) (1998) 66–84.

[176] Y. Shen, M. Gallivan, An empirical test of the job demand/control model among IT users, in: Proceedings of the 2004 SIGMIS conference on Computer personnel research: Careers, culture, and ethics in a networked environment, ACM, 2004, pp. 39–47.

[177] L. G. Wallgren, J. J. Hanse, Job characteristics, motivators and stress among information technology consultants: A structural equation modeling approach, International journal of industrial ergonomics 37 (1) (2007) 51–59.

[178] M. Jørgensen, B. Faugli, T. Gruschke, Characteristics of software engineers with optimistic predictions, Journal of Systems and Software 80 (9) (2007) 1472–1482.

[179] G. C. Green, A. R. Hevner, The successful diffusion of innovations: guidance for software development organizations, IEEE software 17 (6) (2000) 96–103.

[180] N. Lim, J. Ang, F. Pavri, Diffusing software-based innovation with a software factory approach for software development, in: Management of Innovation and Technology, 2000. ICMIT 2000. Proceedings of the 2000 IEEE International Conference on, Vol. 2, IEEE, 2000, pp. 549–555.

[181] F. Woo, R. Mikusauskas, D. Bartlett, R. Law, Is oo the systems development technology for your organization?, in: Software Engineering Research, Management and Applications, 2006. Fourth International Conference on, IEEE, 2006, pp. 354–363.

[182] P. Beynon-Davies, M. D. Williams, The diffusion of information systems development methods, The journal of strategic information systems 12 (1) (2003) 29–46.

[183] B. C. Hardgrave, R. A. Johnson, Toward an information systems development acceptance model: the case of object-oriented systems development, Engineering Management, IEEE Transactions on 50 (3) (2003) 322–336.

[184] D. Dysart-Gale, K. Pitula, T. Radhakrishnan, Culture, communication, and ict for development: A caribbean study, Professional Communication, IEEE Transactions on 54 (1) (2011) 43–55.

[185] R. Agarwal, J. Prasad, Targeting cobol programmers for c training: the role of job insecurity and organizational tenure, Journal of Systems and Software 37 (1) (1997) 5–17.

[186] D. Smith, J. de Passos, R. Isaacs, How IT project managers cope with stress, in: Proceedings of the 2010 Special Interest Group on Management Information System's 48th annual conference on Computer personnel research on Computer personnel research, ACM, 2010, pp. 15–24.

[187] C.-P. Lin, C. G. Ding, Modeling information ethics: The joint moderating role of locus of control and job insecurity, Journal of Business Ethics 48 (4) (2003) 335–346.

[188] E. Y. Li, H.-G. Chen, W. Cheung, Total quality management in software development process, The Journal of Quality Assurance Institute 14 (1) (2000) 4–6.

[189] B. Tessem, F. Maurer, Job satisfaction and motivation in a large agile team, in: Agile Processes in Software Engineering and Extreme Programming, Springer, 2007, pp. 54–61.

[190] K. Lee, K. Joshi, Y. Kim, J. Lee, A proposed investigation of the IS employee job context, in: Proceedings of the 2008 ACM SIGMIS CPR conference on Computer personnel doctoral consortium and research, ACM, 2008, pp. 151–156.

[191] W. Pedrycz, B. Russo, G. Succi, A model of job satisfaction for collaborative development processes, Journal of Systems and Software 84 (5) (2011) 739–752.

[192] K. R. Linberg, Software developer perceptions about software project failure: a case study, Journal of Systems and Software 49 (2) (1999) 177–192.

[193] G. Melnik, F. Maurer, Comparative analysis of job satisfaction in agile and non-agile software development teams, in: Extreme Programming and Agile Processes in Software Engineering, Springer, 2006, pp. 32–42.

[194] A. Jain, Notice of violation of ieee publication principles impact of tqm on employees' job satisfaction in indian software industry, in: e-Education, e-Business, e-Management, and e-Learning, 2010. IC4E'10. International Conference on, IEEE, 2010, pp. 378–382.

[195] G. Succi, W. Pedrycz, M. Marchesi, L. Williams, Preliminary analysis of the effects of pair programming on job satisfaction, in: Proceedings of the 3rd International Conference on Extreme Programming (XP), 2002, pp. 212–215.

[196] L.-H. Chen, Job satisfaction among information system (is) personnel, Computers in Human Behavior 24 (1) (2008) 105–118.

[197] R. Sach, M. Petre, Feedback: How does it impact software engineers?, in: Cooperative and Human Aspects of Software Engineering (CHASE), 2012 5th International Workshop on, IEEE, 2012, pp. 129–131.

[198] S. Khan, I. A. Khan, K. Ghani, Software professionals job satisfaction: A pakistani cultural context, in: Systems and Informatics (ICSAI), 2012 International Conference on, IEEE, 2012, pp. 2547–2551.

[199] S. Sonnentag, M. Frese, F. C. Brodbeck, T. Heinbokel, Use of design methods, team leaders' goal orientation, and team effectiveness: A follow-up study in software development projects, International

journal of human-computer interaction 9 (4) (1997) 443–454.

[200] L. McLeod, S. G. MacDonell, Factors that affect software systems development project outcomes: A survey of research, ACM Computing Surveys (CSUR) 43 (4) (2011) 24.

[201] D. Stenmark, Group cohesiveness and extrinsic motivation in virtual groups: Lessons from an action case study of electronic brainstorming, in: System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on, IEEE, 2002, pp. 160–169.

[202] K. Siau, X. Tan, H. Sheng, Important characteristics of software development team members: An empirical investigation using repertory grid, Information Systems Journal 20 (6) (2010) 563–580.

[203] T. Seger, O. Hazzan, R. Bar-Nahor, Agile orientation and psychological needs, self-efficacy, and perceived support: a two job-level comparison, in: Agile, 2008. AGILE'08. Conference, IEEE, 2008, pp. 3–14.

[204] S. A. Kumar, A. K. Thangavelu, Factors affecting the outcome of global software development projects: An empirical study, in: Computer Communication and Informatics (ICCCI), 2013 International Conference on, IEEE, 2013, pp. 1–10.

[205] S. Bin Basri, R. V. O'Connor, Organizational commitment towards software process improvement an irish software vses case study, in: Information Technology (ITSim), 2010 International Symposium in, Vol. 3, IEEE, 2010, pp. 1456–1461.

[206] S. Stavru, Organizational values and agile methods deployment, in: Software Engineering and Advanced Applications (SEAA), 2012 38th EUROMICRO Conference on, IEEE, 2012, pp. 282–285.

[207] P. Abrahamsson, Commitment development in software process improvement: critical misconceptions, in: Proceedings of the 23rd international conference on Software engineering, IEEE Computer Society, 2001, pp. 71–80.

[208] P. Singh, D. Suar, M. P. Leiter, Antecedents, work-related consequences, and buffers of job burnout among indian software developers, Journal of Leadership & Organizational Studies 19 (1) (2012) 83–104.

[209] K. A. Demir, A survey on challenges of software project management., in: Software Engineering Research and Practice, 2009, pp. 579–585.

[210] D. Graziotin, X. Wang, P. Abrahamsson, Are happy developers more productive?, in: Product-Focused Software Process Improvement, Springer, 2013, pp. 50–64.

[211] M. Zarb, Measuring flow in programming education, in: Visual Languages and Human-Centric Computing (VL/HCC), 2011 IEEE Symposium on, IEEE, 2011, pp. 239–240.

[212] M. Höst, C. Lindholm, Different conceptions in software project risk assessment, in: Proceedings of the 2007 ACM symposium on Applied computing, ACM, 2007, pp. 1422–1426.

[213] M. Fisher, A. Cox, L. Zhao, Using sex differences to link spatial cognition and program comprehension, in: Software Maintenance, 2006. ICSM'06. 22nd IEEE International Conference on, IEEE, 2006, pp. 289–298.

[214] V. Ramalingam, D. LaBelle, S. Wiedenbeck, Self-efficacy and mental models in learning to program, in: ACM SIGCSE Bulletin, Vol. 36, ACM, 2004, pp. 171–175.

[215] M. N. Giannakos, P. Hubwieser, A. Ruf, Is self-efficacy in programming decreasing with the level of programming skills?, in: Proceedings of the 7th Workshop in Primary and Secondary Computing Education, ACM, 2012, pp. 16–21.

[216] A. Lopez, K. Zhang, F. G. Lopez, Gender and race: Stereotyping, coping selfefficacy and collective self-esteem in the cset undergraduate pipeline, in: Frontiers in Education Conference, 2008. FIE 2008. 38th Annual, IEEE, 2008, pp. F4B–20.

[217] H.-L. Yang, H.-H. Cheng, Creative self-efficacy and its factors: An empirical study of information system analysts and programmers, Computers in Human Behavior 25 (2) (2009) 429–438.

[218] P. J. Ambrose, A. Chiravuri, A socio-cognitive interpretation of the potential effects of downsizing on software quality performance, Information Systems Journal 20 (3) (2010) 239–265.

[219] J. C. Dunlap, Problem-based learning and self-efficacy: How a capstone course prepares students for a profession, Educational Technology Research and Development 53 (1) (2005) 65–83.

[220] S. Sethuraman, M. D. Medley, Age and self-efficacy in programming, Journal of Computing Sciences

in Colleges 25 (2) (2009) 122–128.

[221] V. Mellarkod, R. Appan, D. R. Jones, K. Sherif, A multi-level analysis of factors affecting software developers intention to reuse software assets: An empirical investigation, Information & Management 44 (7) (2007) 613–625.

[222] T. Beaubouef, W. Zhang, Where are the women computer science students?, Journal of Computing Sciences in Colleges 26 (4) (2011) 14–20.

[223] A. D. Ruslanov, A. P. Yolevich, College student views of computer science: opinion survey, Journal of Computing Sciences in Colleges 25 (4) (2010) 142–148.

[224] L. Williams, Debunking the geek stereotype with software engineering education, in: Proc. 18th Conf. on Software Engineering Education and Training, IEEE Computer Society Press, Vol. 4, 2005.

[225] A. Garcia-Crespo, R. Colomo-Palacios, J. M. Gomez-Berb?, E. Tovar-Caro, The IT crowd: Are we stereotypes?, IT Professional 10 (6) (2008) 24–27. doi:http://doi.ieeecomputersociety.org/10.1109/MITP.2008.134.

[226] D. M. Grant, L. V. Knight, T. A. Steinbach, Young women's misinformation concerning IT careers: exchanging one negative image for another, Informing Science 10 (2007) 91.

[227] L. F. Capretz, Psychological types of brazilian software engineering students, Journal of Psychological Types 68 (5) (2008) 37–42.

[228] S. S. Zadeh, K. Begum, Association between insomnia and quality of life: An exploratory study among software engineers, Applied Research in Quality of Life 6 (4) (2011) 335–347.

[229] P. Singh, D. Suar, Health consequences and buffers of job burnout among indian software developers, Psychological Studies 58 (1) (2013) 20–32.

[230] T. W. Taris, P. J. Schreurs, W. B. Schaufeli, Construct validity of the maslach burnout inventory-general survey: A two-sample examination of its factor structure and correlates, Work & Stress 13 (3) (1999) 223–237.

[231] M. Nishikitani, M. Nakao, K. Karita, K. Nomura, E. Yano, Influence of overtime work, sleep duration, and perceived job characteristics on the physical and mental status of software engineers, Industrial health 43 (4) (2005) 623–629.

[232] U. E. Hallberg, G. Johansson, W. B. Schaufeli, Type a behavior and work situation: Associations with burnout and work engagement, Scandinavian Journal of Psychology 48 (2) (2007) 135–142.

[233] M. P. Adya, Work alienation among IT workers: A cross-cultural gender comparison, in: Proceedings of the 2008 ACM SIGMIS CPR conference on Computer personnel doctoral consortium and research, ACM, 2008, pp. 66–69.

[234] M. Umarji, C. Seaman, Predicting acceptance of software process improvement, in: ACM SIGSOFT Software Engineering Notes, Vol. 30, ACM, 2005, pp. 1–6.

[235] E. F. Darehshori, N. Mohamed, Exploring IT professionals intention to use software development risk assessment framework.

[236] C. K. Riemenschneider, B. C. Hardgrave, F. D. Davis, Explaining software developer acceptance of methodologies: a comparison of five theoretical models, Software Engineering, IEEE Transactions on 28 (12) (2002) 1135–1145.

[237] C. K. Riemenschneider, B. C. Hardgrave, Explaining software development tool use with the technology acceptance model, Journal of Computer Information Systems 41 (4) (2001) 1–8.

[238] G. Polančič, M. Heričko, L. Pavlič, Developers perceptions of object-oriented frameworks–an investigation into the impact of technological and individual characteristics, Computers in Human Behavior 27 (2) (2011) 730–740.

[239] M. Ciolkowski, J. Heidrich, J. Munch, F. Simon, M. Radicke, Evaluating software project control centers in industrial environments, in: Proceedings of the First International Symposium on Empirical Software Engineering and Measurement, IEEE Computer Society, 2007, pp. 314–323.

[240] S. Overhage, S. Schlauderer, D. Birkmeier, J. Miller, What makes IT personnel adopt scrum? a framework of drivers and inhibitors to developer acceptance, in: System Sciences (HICSS), 2011 44th Hawaii International Conference on, IEEE, 2011, pp. 1–10.

[241] F. D. Davis, V. Venkatesh, Toward preprototype user acceptance testing of new information systems:

implications for software project management, Engineering Management, IEEE Transactions on 51 (1) (2004) 31–46.

[242] J. Keung, R. Jeffery, B. Kitchenham, The challenge of introducing a new software cost estimation technology into a small software organisation, in: Software Engineering Conference, 2004. Proceedings. 2004 Australian, IEEE, 2004, pp. 52–59.

[243] B. C. Hardgrave, F. D. Davis, C. K. Riemenschneider, Investigating determinants of software developers' intentions to follow methodologies, Journal of Management Information Systems 20 (1) (2003) 123–152.

[244] F. K. Chan, J. Y. Thong, Acceptance of agile methodologies: A critical review and conceptual framework, Decision Support Systems 46 (4) (2009) 803–814.

[245] H.-R. Kang, H.-D. Yang, C. Rowley, Factors in team effectiveness: Cognitive and demographic similarities of software development team members, Human Relations 59 (12) (2006) 1681–1710.

[246] J. Karn, S. Syed-Abdullah, A. J. Cowling, M. Holcombe, A study into the effects of personality type and methodology on cohesion in software engineering teams, Behaviour & Information Technology 26 (2) (2007) 99–111.

[247] G. Gelade, P. Gilbert, Work climate and organizational effectiveness: the application of data envelopment analysis in organizational research, Organizational Research Methods 6 (4) (2003) 482–501.

[248] N. Gorla, Y. W. Lam, Who should work with whom?: building effective software project teams, Communications of the ACM 47 (6) (2004) 79–82.

[249] F. Q. da Silva, A. C. C. Franca, T. B. Gouveia, C. V. Monteiro, E. S. Cardozo, M. Suassuna, An empirical study on the use of team building criteria in software projects, in: Empirical Software Engineering and Measurement (ESEM), 2011 International Symposium on, IEEE, 2011, pp. 58–67.

[250] A. Bal, A study on the perception of work-life balance policies among software professionals, The IUP Journal of Management Research 9 (2) (2010) 51–79.

[251] A. P. K. Pandu, A.and Balu, Assessing work-life balance among indian women professionals., ndian Journal of Industrial Relations 48 (4) (2013) 611–620.

[252] S. Ang, S. A. Slaughter, Work outcomes and job design for contract versus permanent information systems professionals on software development teams, in: Information Systems Outsourcing, Springer, 2006, pp. 403–441.

[253] J. McAvoy, Evaluating the evaluations: Preconceptions of project post-mortems, Electronic Journal of Information Systems Evaluation 9 (2) (2006) 65–72.

[254] J. McAvoy, T. Butler, The role of project management in ineffective decision making within agile software development projects, European Journal of Information Systems 18 (4) (2009) 372–383.

[255] M. Hoegl, H. G. Gemuenden, Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence, Organization science 12 (4) (2001) 435–449.

[256] S. Sarker, C. Schneider, Seeing remote team members as leaders: A study of us-scandinavian teams, Professional Communication, IEEE Transactions on 52 (1) (2009) 75–94.

[257] C. A. Wellington, T. Briggs, C. D. Girard, Comparison of student experiences with plan-driven and agile methodologies, in: Frontiers in Education, 2005. FIE'05. Proceedings 35th Annual Conference, IEEE, 2005, pp. T3G–18.

[258] R. J. Ocker, The mediating effect of group development on satisfaction in a virtual and mixed-mode environment, in: System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on, IEEE, 2002, pp. 143–152.

[259] N. Ramasubbu, C. F. Kemerer, J. Hong, Structural complexity and programmer team strategy: an experimental test, Software Engineering, IEEE Transactions on 38 (5) (2012) 1054–1068.

[260] H.-L. Yang, J.-H. Tang, Team structure and team performance in is development: a social network perspective, Information & Management 41 (3) (2004) 335–349.

[261] M. Hoegl, K. Praveen Parboteeah, H. G. Gemuenden, When teamwork really matters: task innovativeness as a moderator of the teamwork–performance relationship in software development projects, Journal of Engineering and Technology Management 20 (4) (2003) 281–302.

[262] B. Bahli, M. Buyukkurt, Group performance in information systems project groups: An empirical

study, Journal of Information Technology Education: Research 4 (1) (2005) 97–113.

[263] M. Z. Last, Understanding the group development process in global software teams, in: Frontiers in Education, 2003. FIE 2003 33rd Annual, Vol. 3, IEEE, 2003, pp. S1F–20.

[264] M. Hoegl, K. P. Parboteeah, Creativity in innovative projects: How teamwork matters, Journal of Engineering and Technology Management 24 (1) (2007) 148–166.

[265] G. Lohan, T. Acton, K. Conboy, The impact of group cohesiveness on decision-making outcomes under conditions of challenging and hindrance time pressure.

[266] S. H. Burton, P. M. Bodily, R. G. Morris, C. D. Knutson, J. L. Krein, Design team perception of development team composition: Implications for conway's law, in: Replication in Empirical Software Engineering Research (RESER), 2011 Second International Workshop on, IEEE, 2011, pp. 52–60.

[267] S. Lasser, M. Heiss, Collaboration maturity and the offshoring cost barrier: the tradeoff between flexibility in team composition and cross-site communication effort in geographically distributed development projects, in: Professional Communication Conference, 2005. IPCC 2005. Proceedings. International, IEEE, 2005, pp. 718–728.

[268] K. Dullemond, B. van Gameren, M.-A. Storey, A. van Deursen, Fixing the out of sight out of mind-problem one year of mood-based microblogging in a distributed software team, in: Mining Software Repositories (MSR), 2013 10th IEEE Working Conference on, IEEE, 2013, pp. 267–276.

[269] A. Chang, C.-C. Chu, S.-C. Chi, H.-H. Lo, Users verses it: Understanding prejudice in information systems development project teams, in: Academy of Management Annual Meeting Proceedings 2010, 2010.

[270] K. Swigger, M. Hoyt, F. C. Serçe, V. Lopez, F. N. Alpaslan, The temporal communication behaviors of global software development student teams, Computers in Human Behavior 28 (2) (2012) 384–392.

[271] S. Sonnentag, Excellent performance: The role of communication and cooperation processes, Applied Psychology 49 (3) (2000) 483–497.

[272] S. Sawyer, P. J. Guinan, Software development: Processes and performance, IBM Systems Journal 37 (4) (1998) 552–569.

[273] D. Mishra, A. Mishra, Effective communication, collaboration, and coordination in extreme programming: Human-centric perspective in a small organization, Human Factors and Ergonomics in Manufacturing & Service Industries 19 (5) (2009) 438–456.

[274] M. J. Gallivan, M. Keil, The user–developer communication process: a critical case study, Information Systems Journal 13 (1) (2003) 37–68.

[275] F. C. Brodbeck, Communication and performance in software development projects, European Journal of Work and Organizational Psychology 10 (1) (2001) 73–94.

[276] V. W. Pine, M. L. Barrett, What kinds of communication are required on the job?, Journal of Computing Sciences in Colleges 21 (2) (2005) 313–321.

[277] C. B. Seaman, V. R. Basili, Communication and organization: An empirical study of discussion in inspection meetings, Software Engineering, IEEE Transactions on 24 (7) (1998) 559–572.

[278] C. B. Seaman, V. R. Basili, Communication and organization in software development: an empirical study, IBM Systems Journal 36 (4) (1997) 550–563.

[279] J. D. Herbsleb, A. Mockus, An empirical study of speed and communication in globally distributed software development, Software Engineering, IEEE Transactions on 29 (6) (2003) 481–494.

[280] L. Layman, L. Williams, D. Damian, H. Bures, Essential communication practices for extreme programming in a global software development team, Information and software technology 48 (9) (2006) 781–794.

[281] H. P. Andres, A comparison of face-to-face and virtual software development teams, Team Performance Management 8 (1/2) (2002) 39–48.

[282] A. H. Dutoit, B. Bruegge, Communication metrics for software development, Software Engineering, IEEE Transactions on 24 (8) (1998) 615–628.

[283] R. Colomo-Palacios, C. Casado-Lumbreras, P. Soto-Acosta, Á. García-Crespo, Decisions in software development projects management. an exploratory study, Behaviour & Information Technology 32 (11) (2013) 1077–1085.

[284] R. L. Wakefield, D. E. Leidner, G. Garrison, Research notea model of conflict, leadership, and performance in virtual teams, Information Systems Research 19 (4) (2008) 434–455. `doi:10.1287/isre.1070.0149`.

[285] M. Cataldo, K. Ehrlich, The impact of communication structure on new product development outcomes, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM, 2012, pp. 3081–3090.

[286] T.-C. Lin, C.-C. Huang, Withholding effort in knowledge contribution: the role of social exchange and social cognitive on project teams, Information & Management 47 (3) (2010) 188–196.

[287] I. Seeber, Facilitating team processes with recommender systems: A behavioral science perspective, in: Proceedings of the 13th International Conference on Knowledge Management and Knowledge Technologies, ACM, 2013, p. 25.

[288] H. Sassenburg, A multi-disciplinary view on software release decisions, in: Proceedings of the 2006 international workshop on Workshop on interdisciplinary software engineering research, ACM, 2006, pp. 45–52.

[289] S. Sawyer, Effects of intra-group conflict on packaged software development team performance, Information Systems Journal 11 (2) (2001) 155–178.

[290] I. Steinmacher, A. P. Chaves, M. A. Gerosa, Awareness support in distributed software development: A systematic review and mapping of the literature, Computer Supported Cooperative Work (CSCW) 22 (2-3) (2013) 113–158.

[291] M. A. Domino, R. W. Collins, A. R. Hevner, C. F. Cohen, Conflict in collaborative software development, in: Proceedings of the 2003 SIGMIS conference on Computer personnel research: Freedom in Philadelphia–leveraging differences and diversity in the IT workforce, ACM, 2003, pp. 44–51.

[292] X. Zhang, J. S. Dhaliwal, M. L. Gillenson, Interpersonal conflict between developers and testers in software development, in: Proceedings of 1 st International Research Workshop on Advances and Innovations in Software Testing (IRWAIST 2007), 2007, pp. 6–8.

[293] A. Sukhoo, A. Barnard, M. M. Eloff, J. A. Van der Poll, M. Motah, Accommodating soft skills in software project management.

[294] Z. J. CHEN, X. Zhang, D. Vogel, Exploring the underlying processes between conflict and knowledge sharing: A work-engagement perspective1, Journal of Applied Social Psychology 41 (5) (2011) 1005–1033.

[295] T.-P. Liang, J. Jiang, G. S. Klein, J.-C. Liu, Software quality as influenced by informational diversity, task conflict, and learning in project teams, Engineering Management, IEEE Transactions on 57 (3) (2010) 477–487.

[296] D. H. Gobeli, H. F. Koenig, I. Bechinger, Managing conflict in software development teams: a multi-level analysis, Journal of Product Innovation Management 15 (5) (1998) 423–435.

[297] J. Y.-C. Liu, H.-G. Chen, C. C. Chen, T. S. Sheu, Relationships among interpersonal conflict, requirements uncertainty, and software project performance, International Journal of Project Management 29 (5) (2011) 547–556.

[298] P. Dewan, R. Hegde, Semi-synchronous conflict detection and resolution in asynchronous software development, in: ECSCW 2007, Springer, 2007, pp. 159–178.

[299] K. Wieland, P. Langer, M. Seidl, M. Wimmer, G. Kappel, Turning conflicts into collaboration, Computer Supported Cooperative Work (CSCW) 22 (2-3) (2013) 181–240.

[300] N. G. Leveson, Role of software in spacecraft accidents, Journal of spacecraft and Rockets 41 (4) (2004) 564–575.

[301] I. Flechais, M. A. Sasse, S. Hailes, Bringing security home: a process for developing secure and usable systems, in: Proceedings of the 2003 workshop on New security paradigms, ACM, 2003, pp. 49–57.

[302] D. Gotterbarn, Informatics and professional responsibility, Science and Engineering Ethics 7 (2) (2001) 221–230.

[303] C. Melo, D. S. Cruzes, F. Kon, R. Conradi, Agile team perceptions of productivity factors, in: Agile Conference (AGILE), 2011, IEEE, 2011, pp. 57–66.

[304] E. Tinelli, S. Colucci, E. Di Sciascio, F. M. Donini, Knowledge compilation for automated team

composition exploiting standard sql, in: Proceedings of the 27th Annual ACM Symposium on Applied Computing, ACM, 2012, pp. 1680–1685.

[305] C. V. Monteiro, F. Q. da Silva, I. R. dos Santos, F. Farias, E. S. Cardozo, A. R. do A Leitão, D. N. Neto, M. J. Pernambuco Filho, A qualitative study of the determinants of self-managing team effectiveness in a scrum team, in: Proceedings of the 4th International Workshop on Cooperative and Human Aspects of Software Engineering, ACM, 2011, pp. 16–23.

[306] M. Senapathi, A. Srinivasan, Sustained agile usage: a systematic literature review, in: Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering, ACM, 2013, pp. 119–124.

[307] F. Q. da Silva, A. C. C. França, M. Suassuna, L. M. de Sousa Mariz, I. Rossiley, R. C. de Miranda, T. B. Gouveia, C. V. Monteiro, E. Lucena, E. S. Cardozo, et al., Team building criteria in software projects: A mix-method replicated study, Information and Software Technology 55 (7) (2013) 1316–1340.

[308] R. N. Thomas, Group dynamics and software engineering.

[309] T.-P. Liang, C.-C. Liu, T.-M. Lin, B. Lin, Effect of team diversity on software project performance, Industrial Management & Data Systems 107 (5) (2007) 636–653.

[310] M. Rajendran, Analysis of team effectiveness in software development teams working on hardware and software environments using belbin self-perception inventory, Journal of Management Development 24 (8) (2005) 738–753.

[311] R. A. Ribeiro, A. M. Moreira, P. Van den Broek, A. Pimentel, Hybrid assessment method for software engineering decisions, Decision Support Systems 51 (1) (2011) 208–219.

[312] T. N. Nguyen, A decision model for managing software development projects, Information & Management 43 (1) (2006) 63–75.

[313] N. B. Moe, A. Aurum, Understanding decision-making in agile software development: a case-study, in: Software Engineering and Advanced Applications, 2008. SEAA'08. 34th Euromicro Conference, IEEE, 2008, pp. 216–223.

[314] J. F. Mcgrew, J. G. Bilotta, J. M. Deeney, Software team formation and decay extending the standard model for small groups, Small group research 30 (2) (1999) 209–234.

[315] A. Ounnas, H. C. Davis, D. E. Millard, Semantic modeling for group formation, in: Workshop on Personalisation in E-Learning Environments at Individual and Group Level (PING) at the 11th International Conference on User Modeling UM2007, 2007.

[316] R. J. Ocker, The relationship between interaction, group development, and outcome: A study of virtual communication, in: System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on, IEEE, 2001, pp. 10–pp.

[317] S. Faraj, A. Yan, Boundary work in knowledge teams., Journal of Applied Psychology 94 (3) (2009) 604.

[318] C. Rosen, The influence of intra team relationships on the systems development process: A theoretical framework of intra-group dynamics, in: 17th Workshop of the Psychology of Programming Interest Group, Sussex University, Citeseer, 2005.

[319] A. Teh, E. Baniassad, D. Van Rooy, C. Boughton, Social psychology and software teams: Establishing task-effective group norms, Software, IEEE 29 (4) (2012) 53–58.

[320] K. Moløkken-Østvold, M. Jørgensen, Group processes in software effort estimation, Empirical Software Engineering 9 (4) (2004) 315–334.

[321] A. Piri, Challenges of globally distributed software development–analysis of problems related to social processes and group relations, in: Global Software Engineering, 2008. ICGSE 2008. IEEE International Conference on, IEEE, 2008, pp. 264–268.

[322] E. Whitworth, Experience report: The social nature of agile teams, in: Agile, 2008. AGILE'08. Conference, IEEE, 2008, pp. 429–435.

[323] D. L. Ager, The emotional impact and behavioral consequences of post-m&a integration: An ethnographic case study in the software industry, Journal of Contemporary Ethnography 40 (2) (2011) 199–230.

[324] E. Whitworth, R. Biddle, The social nature of agile teams, in: Agile Conference (AGILE), 2007, IEEE,

2007, pp. 26–36.

[325] I. Akman, S. Misra, F. Cafer, The role of leadership cognitive complexity in software development projects: An empirical assessment for simple thinking, Human Factors and Ergonomics in Manufacturing & Service Industries 21 (5) (2011) 516–525.

[326] S. Faraj, V. Sambamurthy, Leadership of information systems development projects, Engineering Management, IEEE Transactions on 53 (2) (2006) 238–249.

[327] W. Royce, Successful software management style: Steering and balance, IEEE software 22 (5) (2005) 40–47.

[328] U. Y. Eseryel, D. Eseryel, Action-embedded transformational leadership in self-managing global information systems development teams, The Journal of Strategic Information Systems 22 (2) (2013) 103–120.

[329] C. Tansley, S. Newell, Project social capital, leadership and trust: A study of human resource information systems development, Journal of Managerial Psychology 22 (4) (2007) 350–368.

[330] L. Gumusluoglu, A. Ilsev, Transformational leadership, creativity, and organizational innovation, Journal of Business Research 62 (4) (2009) 461–473.

[331] S. Dhomne, S. P. Hall, The impact of teambuilding and leadership styles on successful project management, Journal of Computing Sciences in Colleges 28 (2) (2012) 65–72.

[332] J.-E. J. Tevis, K. Rouse, Using industry-style software engineering and project management in a group project, Journal of Computing Sciences in Colleges 25 (4) (2010) 77–82.

[333] N. M. Agrawal, M. Thite, Nature and importance of soft skills in software project leaders, IIM Bangalore Research Paper (214).

[334] D. Tuffley, Optimising virtual team leadership in global software development, Software, IET 6 (3) (2012) 176–184.

[335] B. C. Tan, H. J. Smith, M. Keil, R. Montealegre, Reporting bad news about software projects: Impact of organizational climate and information asymmetry in an individualistic and a collectivistic culture, Engineering Management, IEEE Transactions on 50 (1) (2003) 64–77.

[336] V. A. Clincy, Software development productivity and cycle time reduction, Journal of Computing Sciences in Colleges 19 (2) (2003) 278–287.

[337] J. Mathew, T. K. Kallarakal, U. Selvi, K. A. Thomas, An empirical study on the organizational climate of information technology industry in india, Journal of Business and Policy Research 6 (2) (2011) 136–152.

[338] C.-C. Shih, S.-J. Huang, Exploring the relationship between organizational culture and software process improvement deployment, Information & Management 47 (5) (2010) 271–281.

[339] C. Verma, S. A. Amin, Significance of healthy organizational culture for superior risk management during software development, in: Developments in E-systems Engineering (DESE), 2010, IEEE, 2010, pp. 182–189.

[340] N. Iivari, P. Abrahamsson, The interaction between organizational subcultures and user-centered design-a case study of an implementation effort, in: System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on, IEEE, 2002, pp. 3260–3268.

[341] A. Boden, G. Avram, L. Bannon, V. Wulf, Knowledge management in distributed software development teams-does culture matter?, in: Global Software Engineering, 2009. ICGSE 2009. Fourth IEEE International Conference on, IEEE, 2009, pp. 18–27.

[342] H. Robinson, H. Sharp, Organisational culture and xp: three case studies., in: AGILE, IEEE Computer Society, 2005, pp. 49–58.

[343] O. Ngwenyama, P. A. Nielsen, Competing values in software process improvement: an assumption analysis of cmm from an organizational culture perspective, Engineering Management, IEEE Transactions on 50 (1) (2003) 100–112.

[344] K. V. Siakas, What has culture to do with spi?, in: Euromicro Conference, 2002. Proceedings. 28th, IEEE, 2002, pp. 376–381.

[345] S. D. Müller, P. Kræmmergaard, L. Mathiassen, Managing cultural variation in software process improvement: A comparison of methods for subculture assessment, Engineering Management, IEEE

Transactions on 56 (4) (2009) 584–599.

[346] W. M. Campbell, M. Ratcliffe, P. Moore, An exploration of the impact of organizational culture on the adoption of green it, in: Green Computing and Communications (GreenCom), 2013 IEEE and Internet of Things (iThings/CPSCom), IEEE International Conference on and IEEE Cyber, Physical and Social Computing, IEEE, 2013, pp. 126–133.

[347] D. E. Strode, S. L. Huff, A. Tretiakov, The impact of organizational culture on agile method use, in: System Sciences, 2009. HICSS'09. 42nd Hawaii International Conference on, IEEE, 2009, pp. 1–9.

[348] J. Iivari, M. Huisman, The relationship between organizational culture and the deployment of systems development methodologies, Mis Quarterly (2007) 35–58.

[349] C. Tolfo, R. S. Wazlawick, M. G. G. Ferreira, F. A. Forcellini, Agile methods and organizational culture: Reflections about cultural levels, Journal of Software Maintenance and Evolution: Research and Practice 23 (6) (2011) 423–441.

[350] L. Dubé, D. Robey, Software stories: three cultural perspectives on the organizational practices of software development, Accounting, Management and Information Technologies 9 (4) (1999) 223–259.

[351] J. Iivari, N. Iivari, The relationship between organizational culture and the deployment of agile methods, Information and Software Technology 53 (5) (2011) 509–520.

[352] L. Dubé, Teams in packaged software development: The software corp. experience, Information Technology & People 11 (1) (1998) 36–61.

[353] R. Thomas, L. D. Sargent, C. Hardy, Managing organizational change: Negotiating meaning and power-resistance relations, Organization Science 22 (1) (2011) 22–41.

[354] V. Dirksen, A. Huizing, B. Smit, A cultural critique of organizational change: Getting in touch with reality stream: Social networks, in: Paper for the 4th International Critical Management Studies Conference, 2005.

[355] M. Strens, J. Chudge, Using responsibility modeling to match organizational change to changes in the systems development process, ACM SIGSOFT Software Engineering Notes 23 (3) (1998) 102–104.

[356] S. Nerur, R. Mahapatra, G. Mangalaraj, Challenges of migrating to agile methodologies, Communications of the ACM 48 (5) (2005) 72–78.

[357] T. J. Gandomani, H. Zulzalil, A. A. A. Ghani, A. B. M. Sultan, M. Z. Nafchi, Obstacles in moving to agile software development methods; at a glance, Journal of Computer Science 9 (5) (2013) 620.

8. Appendix

BSE Concept (UoA)	Description
Cognitive Style (I)	Individual differences regarding strategies for perceiving, remembering, thinking, and problem solving [57].
Cognitive Affective Personality System (I)	A theory for personality that states that behavior is explained by the personality, the situation and the integration between them [58].
Dunning Kruger effect (I)	A cognitive bias that refers to the seemingly pervasive tendency of poor performers to overestimate their abilities and for high performers to underestimate their abilities [59].
Demand control (I)	In the model, workplace stress is a function of how demanding a persons job is and how much control the person has over their own responsibilities [60].
Explanatory Style (I)	The model refers to how people explain why events happen in their lives, either positive or negative. There are three components in explanatory style; personal (internal vs. external), permanent (stable vs. unstable) and pervasive (global vs. local) [61].
Job Insecurity (I)	A state or condition wherein individuals lack the assurance that their jobs will remain stable [62].

Job Satisfaction (I)	Defined by Locke as a pleasurable or positive emotional state resulting from the appraisal of one's job or job experiences [63].
Goal Orientation (I)	Defined by VandeWalle as disposition toward developing or demonstrating ability in achievement situations [64].
Life Satisfaction (I)	Life satisfaction measures how people evaluate their life as a whole rather than their current feelings [65].
Locus of Control (I)	In personality psychology, locus of control refers to the extent to which individuals believe they can control events affecting them [66].
Motivation (I)	According to Pardee [67] motivation can be defined as those forces within an individual that push or propel him to satisfy basic needs. It is what prompts a person to act in a certain way or at least develop an inclination for specific behavior.
Need Theory (I)	A motivational theory developed by David McClelland in the 1960s that explain how the needs for achievement, power and affiliation affect the behavior [68].
Organizational Commitment (I)	Organizational commitments is a positive evaluation of the organization and the organizations goals [69].
Positive Psychology (I)	Positive psychology is the branch of psychology that study the strengths and virtues that enable individuals and communities to thrive [70].
Risk Taking (I)	Risk taking is the tendency to engage in potential harmful behavior that, at the same time, could have some kind of positive outcome [71].
Self Control (I)	Self control, or self regulation, is a persons ability to control emotions, behavior and desires, and to limit impulses [72].
Self Discipline (I)	The act of disciplining or power to discipline one's own feelings, desires, etc, esp. with the intention of improving oneself [73].
Self Efficacy (I)	Is the extent or strength of persons belief in his or her own ability to complete tasks and reach goals [74].
Self Esteem (I)	A person's overall emotional evaluation of his or her own worth [75].
Self Monitoring (I)	Is the ability to observe and evaluate your own behavior [76].
Social Value Orientation (I)	The stable preferences for certain patterns of outcomes for oneself and others, e.g. how to allocate resources (e.g. money) between your self and another person [77].
Stereotypes (I)	A thought that can be adopted about specific types of individuals or certain ways of doing things, i.e. a fixed and over generalized belief about a particular group or class of people [78, 79].
Stress (I)	Defined by the American Psychological Association as a transient state of arousal with typically clear onset and offset patterns [80].
Theory X Theory Y (I)	Theories of human motivation, more specific the perceptions managers hold on their employees [81].
Theory of Reasoned Action (I)	Is a model for the prediction of behavioral intention, attitude and behavior, where an individuals behavior is determined by his or her's intention to perform the behavior. This intention is a function of the attitude toward the behavior and the subjective norm [82].
Personality (I)	According to Feist and Feist [83] personality is a pattern of relatively permanent traits and unique characteristics that give both consistency and individuality to a person's behavior

Type A(B) Personality (I)	Defines two contrasting personality types, where type A individuals are ambitious, rigidly organized, highly status-conscious, impatient and want other people to get to the point and type B persons are quite the opposite and have a lower stress level and enjoying achievement but do not become stressed when they do not achieve. Originally, in the 1950s cardiologists Meyer Friedman and Ray Rosenman described type A behavior as a potential risk factor for heart disease. [84].
Work Life Balance (I)	Clark views worklife balance as satisfaction and good functioning at work and at home with a minimum of role conflict [85].
Workplace Happiness Index (I)	A measure that indicates an individual's level of satisfaction with the experience of work on a personal, psychological level [86].
Intentions to Leave (I)	Refers to conscious and deliberate willfulness to leave the organization [87].
Loyalty (I)	Can be described as devotion or faithfulness towards something - e.g. person, group or company. Loyalty involves both dedication and consistency [88].
Alienation (G)	Is as a state of mind, a subjective feeling that can vary between individuals in the following for dimensions; powerlessness, meaninglessness, isolation and self-estrangement [89].
Cohesion (G)	The degree to which those in a social system identify with it and feel bound to support it [90].
Communication (G)	The process that allows people to exchange information, feeling or thoughts [91].
Conformity (G)	Defined by Crutchfield in 1955 as simply as *yielding to group pressures* [92].
Deindividuation (G)	The loss of self awareness and of individual accountability in a group [93].
Diffusion of Responsibility (G)	A phenomenon in which people are less likely to take action or less likely to feel a sense of responsibility in a large group of people [94].
Group Composition (G)	Is the configuration of member attributes in a team/group [95].
Decision Making (G)	Is the process of choosing between alternatives or as selecting/rejecting available options [96].
Group Development (G)	Describes how and why groups develop and evolve [97].
Group Dynamics (G)	Is a system of behaviors and psychological processes that occurs within a group or between groups [28].
Group Processes (G)	Is Group processes concerns the cognitive and social causes and consequences of human aggregation [98].
Group Polarization (G)	Is the tendency for groups to make decisions that are more extreme than the decisions that would be made by the members acting alone [99].
Group Social Identity (G)	Defined by Hogg and Waughn as an self-concept derived from perceived membership of social groups, i.e. the aspects of a person that are defined in terms of his or her group memberships [25].
Group Think (G)	The tendency of a decision-making group to filter out undesirable input so that a consensus may be reached, especially if it is in line with the leader's viewpoint [100].
Intergroup Behavior (G)	Behavior that involves interaction between members of distinct social groups [25].
Leadership (G)	Is the art of influencing followers to achieve success by identifying joint goals, finding best-fit roles in teams, collaborating constructively and dynamically, and adapting to change within their environments [101].
Group Norms (G)	Are informal rules that regulates the behavior of the group [102].

Organizational Climate (O)	Is defined as the recurring patterns of behavior, attitudes and feelings that characterize life in the organization [103, 104].
Organizational Culture (O)	Organizational culture is the behavior of humans within an organization and the meaning that people attach to those behaviors [103, 104].
Organizational Change (O)	Is both the process in which an organization changes and the effects of these changes on the organization [105].
Organizational Learning (O)	Refers to models, theories and processes about the way an organization learns new knowledge [106, 107].

Table 7: BSE Concepts and description.

BSE Concept (UoA)	Search String
Cognitive Style	("cognitive style" OR "thinking style" OR "adaption-innovation")
Cognitive Affective Personality System	("cognitive-affective personality system" OR "cognitive affective processing system" OR "CAPS")
Dunning-Kruger effect	("dunning-kruger effect" OR "dunning kruger effect")
Demand-control	("demand-control model" OR "demand control model")
Explanatory Style	("explanatory style" OR "attributional style")
Innovation Diffusion Theory	("diffusion of innovations" OR "innovation diffusion theory")
Job Insecurity	("job insecurity")
Job Satisfaction	("job satisfaction")
Goal Orientation Theory	("goal orientation")
Life Satisfaction	("life satisfaction")
Locus of Control	("locus of control")
Motivation	("motivation")
Need Theory	("McClelland" OR "need theory" OR "needs theory")
Organizational Commitment	("organizational commitment" OR "organisational commitment")
Positive Psychology	("positive psychology" OR "flow")
Risk Taking	("taking risks" OR "risk taking" OR "risk-taking" OR "risk aversion" OR "risk seeking" OR "risk-seeking")
Self Control	("self control" OR "self-control" OR "self regulation" OR "self-regulation")
Self Discipline	("self discipline" OR "self-discipline")
Self Efficacy	("self efficacy" OR "self-efficacy")
Self Esteem	("self esteem" OR "self-esteem")
Self Monitoring	("self-monitoring" OR "self monitoring")
Social Value Orientation	("social value orientation")
Stereotypes	("stereotypes" OR "stereotype")
Stress	("stress" OR "stressors" OR "burnout" OR "burn out" OR "burn-out")
Theory X Theory Y	("theory x" OR "theory y")
Theory of Reasoned Action	("theory of reasoned action" OR "theory of planned behavior")
Technology Acceptance Model	("technology acceptance model")
Personality	("personality" OR "trait")
Type A(B) Personality	("type a personality" OR "type b personality" OR "type-a personality" OR "type-b personality")
Work Life Balance	("work-life balance" OR "work life balance")
Workplace Happiness Index	("workplace happiness index")
Intentions to Leave	("intention to leave")
Loyalty	("loyalty")
Alienation	("alienation")
Cohesion	("cohesion" OR "cohesiveness") AND ("team" OR "group")
Communication	("communication")
Conformity	("conformity") AND ("group" OR "team")
Conflicts	("conflicts")

Deindividuation	("deindividuation" OR "SIDE model" OR "SIDE theory")
Diffusion of Responsibility	("diffusion of responsibility")
Group Composition	("team composition" OR "group composition" OR "team design" OR "group design")
Decision Making	(AB("decision making"))
Group Development	("group development" OR "group formation")
Group Dynamics	("group dynamics")
Group Processes	("group processes")
Group Polarization	("group polarization")
Group Social Identity	("social identity")
Group Think	("group think" OR "groupthink" OR "group-think")
Intergroup Behavior	("intergroup" OR "intragroup")
Leadership	("leadership")
Group Norms	("group norms") OR ("group norm")
Organizational Climate	("organizational climate" OR "organisational climate")
Organizational Culture	("organizational culture" OR "organisational culture")
Organizational Change	("organizational change" OR "organisational change")
Organizational Learning	("organizational learning" OR "organisational learning")

Table 8: BSE Concepts and Search String.

Abr	BSE Concept (UoA)	No.	Search Result	Publications
1_CS	Cognitive Style (I)	10	2880 8 45 4	[148] [167] [168] [169] [170] [171] [138] [172] [173] [174]
2_CAPS	Cognitive Affective Personality System (I)	0	11 0 0 0	
3_DKE	Dunning-Kruger effect (I)	0	20 0 2 0	
4_DC	Demand-control (I)	3	200 0 1 0	[175] [176] [177]
5_ES	Explanatory Style (I)	1	120 0 1 0	[178]
6_IDT	Innovation Diffusion Theory (I)	6	6210 8 0 3	[179] [180] [181] [182] [183] [184]
7_JI	Job Insecurity (I)	7	826 1 5 0	[185] [122] [186] [187] [172] [188] [189]
8_JS	Job Satisfaction (I)	24	8700 11 104 19	[116] [121] [147] [162] [157] [190] [169] [160] [191] [192] [158] [193] [164] [175] [194] [166] [195] [196] [197] [198] [159] [161] [149] [142]
9_GOT	Goal Orientation Theory (I)	3	2260 13 48 4	[117] [199] [183]
10_LS	Life Satisfaction (I)	0	864 0 3 0	
11_LOC	Locus of Control (I)	3	3060 5 48 2	[116] [117] [121]
12_MOT	Motivation (I)	12	na na na na	[119] [112] [177] [122] [197] [200] [201] [149] [202] [189] [110] [111]
13_NT	Need Theory (I)	3	154 0 3 0	[203] [112] [197]
14_OC	Organizational Commitment (I)	10	3620 5 41 3	[121] [157] [204] [205] [206] [207] [118] [208] [190] [209]
15_PP	Positive Psychology (I)	2	938 0 10 0	[210] [211]
16_RT	Risk Taking (I)	2	14100 13 118 9	[212] [213]
17_SC	Self Control (I)	0	9710 16 119 3	
18_SD	Self Discipline (I)	0	1980 10 26 0	
19_SEFF	Self Efficacy (I)	14	7370 13 161 6	[119] [117] [120] [214] [203] [215] [216] [217] [218] [219] [220] [221] [118] [144]
20_SEST	Self Esteem (I)	6	7330 5 97 1	[216] [154] [155] [156] [137] [167]
21_SM	Self Monitoring (I)	0	3690 15 117 0	
22_SVO	Social Value Orientation (I)	0	51 0 1 1	
23_STE	Stereotypes (I)	8	8660 25 206 5	[216] [163] [222] [223] [224] [225] [226] [227]
24_STR	Stress (I)	12	18900 6 116 12	[121] [124] [208] [228] [229] [230] [231] [232] [177] [175] [186] [233]
25_TXY	Theory X Theory Y (I)	0	852 1 13 0	
26_TRA	Theory of Reasoned Action (I)	5	3070 6 34 1	[183] [234] [143] [235] [236]
27_TAM	Technology Acceptance Model (I)	16	5870 29 106 6	[215] [221] [185] [237] [238] [239] [183] [240] [241] [242] [234] [235] [172] [243] [244] [236]

28_TRAIT	Personality (I)	31	na na na na	[117] [154] [155] [156] [137] [147] [112] [113] [163] [138] [165] [139] [164] [166] [134] [131] [130] [245] [132] [140] [246] [133] [247] [141] [135] [136] [109] [142] [248] [249] [144]
29_TABP	Type A(B) Personality (I)	3	108 2 0 0	[190] [232] [122]
30_WLB	Work Life Balance (I)	5	1940 2 0 0	[162] [157] [250] [251] [233]
31_WHI	Workplace Happiness Index (I)	0	0 0 0 0	
32_ITL	Intentions to Leave (I)	2	na na na na	[123] [161]
33_LOY	Loyalty (I)	1	16800 26 189 0	[252]
34_A	Alienation (G)	2	4150 3 38 1	[252] [233]
35_OCH	Cohesion (G)	17	17100 171 1114 9	[147] [253] [254] [140] [255] [256] [257] [258] [201] [259] [260] [261] [262] [263] [264] [246] [265]
36_COM	Communication (G)	39	17400 917 1001 263	[137] [138] [191] [139] [131] [266] [267] [268] [152] [153] [200] [209] [140] [255] [269] [270] [271] [272] [247] [273] [274] [275] [202] [151] [276] [277] [184] [146] [278] [279] [280] [108] [281] [282] [150] [283] [284] [136] [285]
37_CONFO	Conformity (G)	4	16400 31 299 2	[148] [263] [286] [272]
38_CONFL	Conflicts (G)	23	16700 317 3746 26	[131] [200] [258] [260] [269] [287] [288] [289] [290] [291] [292] [129] [284] [293] [114] [294] [295] [296] [297] [298] [141] [142] [299]
39_DEIND	Deindividuation (G)	0	188 1 22 0	
40_DOR	Diffusion of Responsibility (G)	3	218 0 6 0	[300] [301] [302]
41_GC	Group Composition (G)	24	8000 18 256 3	[134] [131] [266] [267] [268] [303] [152] [304] [305] [130] [306] [245] [153] [132] [307] [145] [200] [308] [133] [309] [135] [310] [248] [249]
42_DM	Decision Making (G)	7	16200 155 18 87	[187] [288] [283] [311] [312] [265] [313]
43_GDEV	Group Development (G)	8	4270 11 0 1	[263] [264] [269] [149] [314] [315] [316] [151]
44_GDYN	Group Dynamics (G)	12	6860 9 175 16	[192] [255] [317] [252] [260] [263] [264] [269] [287] [318] [308] [289] [319]
45_GPRO	Group Processes (G)	10	4360 3 98 0	[224] [255] [317] [252] [260] [263] [269] [287] [320] [321]
46_GPOL	Group Polarization (G)	0	221 0 3 0	
47_GSI	Group Social Identity (G)	5	3070 2 47 2	[322] [323] [324] [161] [269]
48_GT	Group Think (G)	2	2570 2 1 1	[253] [254]
49_IB	Intergroup Behavior (G)	1	4150 5 67 2	[318]
50_LEAD	Leadership (G)	23	16100 255 1341 29	[148] [162] [325] [122] [145] [200] [209] [140] [256] [318] [133] [151] [326] [327] [328] [329] [330] [284] [331] [332] [333] [334] [293]
51_GNOR	Group Norms (G)	1	1360 1 21 0	[319]
52_OCLI	Organizational Climate (O)	7	2640 2 15 13	[120] [335] [145] [336] [149] [337] [144]
53_OCUL	Organizational Culture (O)	21	16600 48 197 6	[148] [147] [143] [338] [339] [340] [341] [342] [343] [344] [345] [346] [347] [348] [349] [145] [146] [114] [350] [351] [352]
54_OCHA	Organizational Change (O)	8	17200 40 200 17	[128] [353] [354] [355] [356] [357] [115] [127]
55_OLEAR	Organizational Learning (O)	3	na na na na	[354] [126] [125]

Table 9: The table show; (1) Index number and abbreviation (2) the BSE concepts and unit of analysis, (3) the number of included publications, (4) number of search result for Google Scholar, IEEE Digital Library, ACM Xplore Digital Library and PsycINFO, respectively, that were included for further screening, (5) reference to the included publications.