

Towards Understanding Motivation in Software Engineering

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ABSTRACT

Understanding motivation of software engineers has important implications for industrial practice. Motivation is a complex construct that seems to be affected by diverse environmental conditions and is likely to be moderated by personality and individual values, beliefs, and needs. Although research on motivation in software engineering has made important scientific progress, the majority of the methods adopted quantitative approaches, towards generalizable statements. Given the complexity of the human behavior, contextualized and explanatory theories are needed to account for this diversity. This article describes a research agenda of a PhD project that aims to build explanatory theories of motivation in software organizations. As research approach, it brings together qualitative evidence-based empirical methods such as systematic literature review, case studies and meta-ethnography. Research phases, current status, threats to validity and future plans are described in details but, since it is an ongoing work, it claims for feedback from the community in order to improve the general research consistency and credibility.

Categories and Subject Descriptors

D.2.9 [Software Engineering]: Management – programming teams.

Keywords

People Motivation, people management, software development, software engineering

1. INTRODUCTION

At the course of time, industrial and academic research effort has reached enough evidence on the benefits that the motivated behavior of individuals may bring into the work environment, which in turn may represent a basis to organizational success (e.g. [30][32][41]). However, general research on motivation has been highly careful when it comes to the management of or the intervention in human motivation at work, because there is a wide range of interrelated individual and context-dependent variables that may affect both the effectiveness of motivators and the

process by which motivation occurs (e.g. [7][17][18]).

Motivational specificities among practitioners from different areas (e.g. health and sports), for a long time, has been object of study. In the software engineering field, a seminal work of Couger and Zawacki [12] has brought light to the issue that Information Systems people could be a distinctive group from the average population, regarding individual needs, and for this reason, what motivates software engineers is likely to be different from what motivates the population in general. In fact, the academy has struggled to reach an agreement about their initial claim ([8][10][14][24][54]). Regardless of this issue about the distinctive nature of information systems personnel, other researchers have historically pointed out many different motives for studying motivation in the specific domain of software engineering. For instance, Leduc [30] mentions a general job dissatisfaction among programmers, which may have been caused by a “Gold Rush” problem that has driven people into the profession primarily for money; Burns et al [8] mentions a world generalized scarcity of skilled professionals, causing high levels of competition for human resources and high levels of turnover among software companies (labeled as “The Brain Drain” problem), which due to the specific nature of software development, represents a significant knowledge loss risk, and employee motivation could be an effective strategy to avoid turnover; more recently, scholars have been trying to understand how Agile processes meet software engineers’ motivational needs (e.g.[4]), and what factors drive people to contribute to not-for-profit Open Source initiatives (e.g. [51]). In summary, due to the socio-technical nature of the software development, the complex understanding of problems that relate social and technical aspects in software engineering spawned significant research and industrial efforts, and it seems that understanding the motivation of software engineers has been one of the key issues.

The body of research in this field has provided important insights in characterizing the factors and outcomes related to motivation, as synthesized in recent literature reviews ([5][15]). However, these studies represent an unconnected body of work, and are dominated by quantitative studies, the vast majority of which adopting survey research as the main research methodology. The core limitation of these survey studies is that they do not necessarily provide deep explanations on what it is about the job that motivates Software Engineers and how this effect happens. Besides, to design an effective motivation measurement instrument, per se, has been a challenging subject of research ([6][20]). Moreover, it is natural that research trials adopt clear-cut simplifications of the motivation phenomenon, ignoring either relevant contextual variables, or the complex relationship that may exists among these variables [11]. Although the Systems

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IDOESE'12, September 21, 2012, Lund, Sweden.

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Theory is claimed to be an effective tool to tackle this complex relationship ([37][50]), and has been effective in other research areas (e.g.[1][34]) including the study of motivation [11], hitherto it has not been adopted to this specific end in software engineering.

Therefore, the general goal of this PhD research is to build a grounded theory of motivation towards the performance of software engineers, described in terms of systems thinking, and based on integrative knowledge generated from distinctive organizational settings, in order to provide rich and useful explanations about motivation for software organizations, taking to account not only individual differences, but also specific norms, values and complementary contextual elements. The present paper aims to describe the research agenda, to submit its specificities to the discussion of experienced researchers from the empirical software engineering community, and to create means to improve the general research strategy from the valuable contributions that the feedback of the community may represent.

The rest of this article is organized as follows: Section 2 pictures the current state of art on motivation research, as well as the study of motivation in the software engineering field; Section 3 present details about the whole research design, including objectives, methods, current status and threats to validity; and Section 4 discuss the general research limitation, main contributions and the planned next steps. Section 5, finally, presents some conclusions about the work.

2. RESEARCH BACKGROUND

Motivation is generically understood as the set of “factors or events that energize, channel, and sustain human behavior over time” [47], as described by classical content theories of motivation, such as the Hierarchy of Needs Theory [35], the Motivation-Hygiene Theory [25], and the Needs Theory [36]. The process by which motivation occurs is also a focus of other processes theories of motivation, such as the Expectancy Theory [52], the Goal-setting Theory [31], the Stimulus-response Theory [46], and the Job Characteristics Theory [20]. It is the investigation of such factors and their relationships and effects on job outcomes that guide our research.

Research in software engineering has made an important progress towards the identification of factors related to motivation of software engineers, but has yet to produce theories capable of explaining why some software engineers seem to be motivated to perform their work while others, working in similar contexts and performing similar tasks, do not. Recent literature reviews [5][15] analyzed 140 studies about motivation in software engineering from the 1980’s, towards a consolidation of a set of factors that could summarize, make sense, and help managers to deal with the motivation of software engineers. However, only part of these studies was appropriately underpinned by classical motivation theories. Besides, classical theories may “overlap, address issues at different levels of abstraction, and occasionally contradict each other” [23], which make those research results even more difficult to integrate.

The body of research in this field has been dominated by quantitative studies using survey research as the main research methodology (85/140), while a little number of studies presents other approaches, such as quasi-experiments, interviews, focus groups and case studies. These studies indeed provide important insights in characterizing what are the factors and outcomes related to motivation. Most of the results of these surveys point to

the software engineering job itself as the main motivator, while performance improvements (e.g. product quality, productivity, and job excitement) and intention to leave the organization are highlighted as the most important outcomes of, respectively, high and low motivation. However, these studies lack in providing further explanation on what it is about the job that motivates software engineers and how motivation affects performance and intention to leave.

Theoretical and empirical research from different areas indicated that motivation is context dependent and varies among individuals. Therefore, addressing the gaps identified above requires investigations that provide explanatory theories of motivation and these theories are likely to be context dependent. Few case studies providing in depth understanding of motivation of software engineers have been developed (e.g.[4][43][49]). Although these qualitative studies have been focused in very different contexts (e.g. agile development, open source, etc.), they agree, and provide even more evidence, that motivation is highly directed by task design characteristics as well as by organizational characteristics and managerial practices.

Sharp et al. [44] produced a model of motivation for software engineering and compare this “new model” with the existing models that came out from the fifth aspect of the literature review. This new model, named MOCC, related software engineers characteristics, mediators, controllers, motivators, de-motivators, and external signs, in an attempt to create a comprehensive, “birds eye” view of motivation in software engineering. This research has been complemented and extended in other works ([22][45]). Although the MOCC model consolidates a wide range of aspects related to motivation in software engineering, most of the constructs related in the model still require operational definitions to support the development of empirical studies using the model. Besides, it lacks explanation on the complex interplay among motivational factors at the task, organization, and individual levels. These opportunities for new research are the central motivation of this work.

3. RESEARCH DESIGN

The general objective of this research is to answer the following twofold question: How the motivation of software engineers¹ in the workplace is affected by contextual and individual factors, and how motivation is perceived in terms of work-related behavior and outcomes? It is aimed at exploring specificities of organizational contexts, in order to develop insights and gain knowledge from the deep understanding of how individual software engineers interpret their experiences in the workplace, how these interpretations shape the meaning of motivation, and why certain combinations of contextual and individual factors lead to more or less motivated behavior.

Thus, this research was designed to be carried out in three phases, explained in depth in the following subsections.

¹ At this point, it is important to highlight that the way the practitioners in the software development field are referred in the literature have significantly changed in the last thirty years. Therefore, as has been done by Beecham et al (2008), we adopt the term “software engineer” (SEr) as a simplification to refer to any role directly related to the software development activity, and “Software Engineering” (SEring) to refer to the whole field.

3.1 Phase 1: Background knowledge building

This phase aims to (a) gather previous theoretical understanding of motivation as well as the state of art in motivation and related human factors research in the human and social sciences; and (b) consolidate a comprehensive set of existing evidence on motivation in the software engineering research field. The objective of this phase could be described as follows:

Analyze available previous literature work for the purpose of consolidating knowledge on what is known about the motivation of software engineers with respect to its antecedents, work outcomes and external signs from the point of view of the software engineers in the context of software engineering projects/organizations.

Methodological approaches

In 2004, Kitchenham et al. [26] introduced the concept of evidence-based software engineering (EBSE) as a promising approach to integrate academic research and industrial practice in software. Then, systematic literature reviews procedures, which are powerful at identifying and appraise available evidence regarding some research question, were adapted to software engineering research ([27][28][40]). Since then, it has been increasingly used in software engineering research as a method for conducting secondary research [13].

Beecham et al [5] carried out a mapping study on motivation of software engineers, which is a specific type of literature review aimed to identify all research related to a specific topic. The study sought for answers to the following questions:

RQ1: What are the characteristics of Software Engineers?

RQ2: What (de)motivates Software Engineers to be more (less) productive?

RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?

RQ4: What aspects of Software Engineering (de)motivate Software Engineers?

RQ5: What models of motivation exist in Software Engineering?

The guidelines developed by Kitchenham [27] were strictly followed to plan and execute the review, and its detailed protocol is published in [3]. Then, we decided, as a first step, to update the available data on motivation in software engineering, by carrying out the same review protocol, integrating and consolidating the results with the original study in order to build an up-to-date basis for further studies. Naturally, the same research questions guided our research in this phase.

Current Status

A comprehensive exhaustive search for primary studies was carried out, based on automated and manual search; 48 new studies were selected between 2006 and 2010, and were assessed regarding the quality of their evidence; data needed to answer the research question(s) were extracted and classified; and preliminary results were summarized, synthesized and reported in [15]. Our preliminary results suggested that the overall understanding of how software engineers are actually motivated does not seem to have significantly advanced in the last years, although the Open Source Software development, the Agile development practices, and the shortage of skilled human capital

may have boosted the interest of both industry and academy in this subject.

Moreover, this work revealed that many papers addressed Motivation using specific viewpoints and approaches that were not always carefully based on existing motivation theories. Besides, research adopted similar constructs with different names as well as different constructs with similar names, which may have been misinterpreted in our review. Therefore, we decided to carry out a data re-extraction from all papers of the original study and the update and re-analysis of, in order to consolidate, integrate and consistently synthesize their results, taking to account their different instances of motivation and other related theories. This work is still in progress.

Threats to Validity

The most common limitations in a literature review are the possible biases introduced in the selection process and inaccuracies of the data extraction. These are also the main possible limitations of this phase. We strongly based our work on the original study protocol and even though some adaptations were necessary, we were as careful as possible regarding the coverage of the review and also the comparability of our results with the Original Study. All steps of the review were carried out in pairs, conflicts in the selection process were solved either by a third party or in consensus meetings, and all reasons for inclusion and exclusion of studies at each stage were recorded, as recommended by Kitchenham and Charters [28].

The amount of published work on motivation in software engineering is still wispy, which may provide only a partial view of the sought potential answers. The problem of cultural bias is also relevant, since the USA still leads the amount of research carried out on motivation on software engineering, and western countries still holds the majority of software engineers studied. Finally, although this literature review may effectively identify motivators and its descriptors for software engineers, we cannot assure that this is a closed set, because it only brings to account those motivators previously studied.

3.2 Phase 2: Building local theories

This phase aims to develop context-dependent grounded theories on the motivation of software engineering people, in multiple distinct realities of software development. Therefore, its objective may be stated as follows:

Analyze software engineers' behavior for the purpose of designing grounded theories about the motivation of software engineers with respect to its antecedents, work outcomes and external signs from the point of view of the software engineers, project managers and directors in the context of specific software engineering projects/organizations.

Methodological approaches

In this phase, we are interested in understanding how individual software engineers interpret their experiences in the workplace, how these interpretations shape the meaning of motivation, and why certain combinations contextual and individual factors lead to more or less motivated behavior. Therefore, we address the following research questions:

How the motivation of software engineers in the workplace is affected by contextual and individual factors, and how motivation is perceived in terms of work-related behavior and outcomes?

As the methodological approach, we take a constructivist or interpretive philosophical perspective that “assumes that reality is socially constructed, (...), there are multiple realities, or interpretations, of a single event” [38]. Accordingly, we use a qualitative approach. According to Merriam ([38], apud Denzin and Lincoln, 2005), “qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them”. A case study is understood as “an in-depth description and analysis of a bounded system” [38]. We designed a multi-case research [53] to be carried out in different software organizations, following a single standard protocol, using the maximum variation sampling approach, consistent with the use of grounded theory [48]. We classify our case study as instrumental, since our goal is to understand the construct and build theories.

The difficulties in observing motivation, feelings and personal opinions about what constitute high and low motivated behavior, lead the decision of not using observation in this study. We therefore used: (a) interviews, which are effective to elicit information about things that cannot be observed [38]; (b) diary studies, which is a method of understanding participant behavior and intent *in situ* that minimizes the effects of observers or interviewers on participants [42]; complemented by the use of document analysis for data collection, which are important source of data for qualitative research because they are usually produced for reasons other than the research and therefore are not subject to the same limitations and biases.

Interview scripts and diary forms were carefully designed. A Term of Authorization and Commitment to the Research was also designed to meet ethical requirements of this type of research, and would grant the researchers access to facilities, to the participants, and to necessary documents. Additionally, it authorized the participants to use work hours for the interviews and diary studies. Each participant would be also required to sign an Informed Consent Form explaining the overall objective and importance of the research, which guaranteed confidentiality of the data provided, the anonymity of the participation, and the right to withdraw from the research at any moment. We planned to use the methods and techniques of grounded theory [48] to code, categorize, and synthesize data, towards the construction of a theory of motivation in each organization, separately. Relationships among categories would be built, leading to explanatory propositions. Finally, core categories would be chosen according to their general explanatory power, so a narrative could be created to describe the central story of each case.

Current Status

Four case studies have been carried out in four different organizations. The organizational contexts and the results of each case study are briefly described below.

- **Case I - A government organization:** situated in Recife-PE, Brazil. Its core mission is to provide Information Technology services to the State Government administration and also to the citizens. It is regulated under the laws and norms of the Brazilian public sector, which have specific characteristics that make it significantly different from private organizations. The organization is structured in 14 main unities distributed in different locations throughout the State. Its employees, including software engineers, are distributed in the main unities and also in over 60 other

public administration buildings. By the time this research was performed, the organization held 2,580 employees. The organization explicitly stimulated the adoption of open source software in the State administration, and there was one open source project being developed. Regarding development methods and practices, it used traditional, process-oriented methods, with command and control style of management in most software projects, although some small and isolated agile initiatives could also be found.

Brief results: The balance between Job Stability and Growth Needs emerged as the core factors related to the motivation in the organization. Unclear growth perspectives combined with priorities based on political instead of technical aspects directly affected the intention to leave the organization. More details of this case study are described in [16].

- **Case II - A private not-for-profit research and development organization:** The organization’s headquarters are located in the Porto Digital Science Park (<http://www.portodigital.com.br>), in Recife, Brazil. It operates in many different areas, such as Information Technology, Telecommunications, Industrial Automation, Solutions for the Public Sector, and Energy, by providing support services, workforce supply for third-parties, development of software and hardware products, software factory, product certification tests, and research and development of technological innovative products. The organization had a SW-CMMi level 2 certification and was targeting the SW-CMMi level 3 certification at the time of the development of the case study. The management processes broadly followed the PMBOK guide, and managers were certified Project Management Professionals (PMP), but some projects have already been adopting SCRUM agile management practices. At the time that this research was carried out, the organization had about 300 professionals, 85% part of the technical workforce and 15% allocated in administrative tasks. In this unity, there was no specific human resource management, and project managers were supposed to perform the activities related to human resources management.
Brief results: In this case, we concluded that task variety and technical challenges emerged as the main drivers of high motivation, while inequity and low self-efficacy (caused by poor estimations in the software process) emerged as the main sources of low motivation in the organization.
- **Case III - A small private software company:** formally established in 2006 by the initiative of five entrepreneurs from the Information Technology field, in Recife, Brazil. Its core mission is to support the development of people and organizations with software tools, by means of technical excellence and innovation. This company is specialized in software development for different platforms, with expertise in different programming languages (such as .NET Framework, Java family, LUA, and others). It focuses on the on-demand development of information systems, operating in areas such as management, finance, mining, health, and others. In addition, it also develops its own products. Its flagship product, a corporative social network, stands for intra-organizational innovation management. Currently, it serves national and international customers, usually medium and big companies. Internal products and

external projects significantly differ in terms of requirements management process and time pressure. The company follows an agile-like software development process. The organizational structure is flat, and the directors eventually act as part of the development teams. The directors themselves, who have software engineering background, instead of management, administer all organizational issues, including the Human Resource Management. At the time that the case study was carried out, the company was composed of 27 people, everyone younger than 30 years (directors included). Some of these people were in the organization for less than six months, while others had more than 3 years along with the team. As an organizational strategy, the company is closely tied to the academy, both physically (its location is near a University) and operationally, since its staff is composed of undergraduate students (trainees) as well as graduated students in software engineering.

Brief results: In this case study, Learning and Growth needs emerged as the strongest drivers of motivation, which in turn increase the Goal Commitment of engineers and create the conditions for better job performances.

- **Case IV – An IT department of a public university:** This department is accounted for the Information Technology services of a federal university in Recife-PE. It is responsible not only for the maintenance of the software system that holds all the valuable information of that organization (such as academic and patrimonial info), but also for the improvement of this system as well as the development of software to supply all the information needs of the organization. Its core product, named SIG@ - Academic Managerial Information System, was released in the early 2000's, and since then has been continuously evolved and adapted. It is a web-based system, written in Java, with about 840 functionalities, more than one million Lines of Code, and at the time this case study was carried out, its website received about four thousand hits by month. The department is mainly organized in three sectors: one responsible for the inception of new projects and products to improve the informational procedures in the university; another is exclusively responsible for the maintenance of the academic module of the SIG@ system; and a third one is responsible for the elaboration and development of the research module of the SIG@. Regarding the software development process, this department follows an agile approach based on SCRUM. Internal procedures are defined and continuously improved by a study group, which aims to make these internal processes adherent to the MPS.br model². The development process was already stable regarding the configuration management, project management, requirements management, portfolio management and quality assurance. Some initiatives were serving as pilot studies for procedures such as acquisition, measurement, validation and verification. Regarding the human management procedures, this department had 37 professionals, working under three different types of

contracts: eighteen public employees, eleven third-party workforce and eight internships. The former category are government employees, and therefore have the same rights as described in the case I. Third-party workforce are regular employees of another organization that is responsible for supplying workforce for many departments in the university. Therefore, they have a regular private contract with the third-party organization, although they were 100% allocated in the studied department. Interns are contracted under a standard educational internship contract, with (supposedly) less responsibilities and less work time in the organization.

Brief results: although the data collection has been finished in this case study, the data analysis and synthesis were not fully reviewed and concluded. Therefore, we are not able to give further details on the results of this case study.

The first three case studies have already been analyzed. Using a grounded theory procedure, we identified factors related to the software engineers' tasks, teams and organizational settings that affected motivation for each case, and proposed local theories of motivation. We also discussed how these theories could help to improve the motivation in each organization. However, we recognize that we may have missed some important details regarding the individual characteristics of the participants during the analysis, so we are currently considering a reanalysis in order to seek for more individual-related aspects that may mediate the motivation in each case.

Threats to validity

In this phase, the central problem is how to provide evidence that the findings are credible. To increase credibility, we used triangulation by having data collected from participants with different roles and by using multiple data collection techniques. We then used member checking. A long engagement time in data collection and analysis allowed the identification of contradicting evidences and complementary explanations. We also kept research diaries and process logs that can be used as audit trails by external reviewers. Moreover, we sampled the participants to achieve maximum variation since this would provide richer data and, consequently, a richer theory. Finally, we tried to provide a detailed description of the research method, context in which the research was performed, and the results themselves. However, the main limitation of this method is that the results are contextualized and, therefore, generalization to other contexts should not be carried out directly.

3.3 Phase 3: Theory proposition

The objective, in this phase, is to integrate the results of the case studies and the literature review, in order to identify more powerful components for the explanatory theory of motivation in software engineering.

Analyze the distinct theories of motivation in software engineering produced by the case studies for the purpose of identifying more elements that may help to explain the motivation of software engineers with respect to its individual and contextual settings from the point of view of the software engineers in the context of specific software engineering projects/organizations.

² MPS.br is a Brazilian model for software development process improvement, compatible with CMMi, developed by the Brazilian Association for Promoting the Software Export (<http://www.softex.br>).

Methodological approaches, Current Status and Threats to Validity

The main method that is planned to guide the research work in this phase is the meta-ethnography. Meta-ethnography is one of the several existing methods to understand and synthesize findings from multiple qualitative research concerning similar research questions [39]. The power of meta-ethnography lays in the possibility to identify concepts that may not have been explicitly identified in the original studies. These concepts may be identified when translating concepts from each case to another and similarities, conflicts or line arguments are identified. On the other hand, the critiques to meta-ethnographical research are mainly related to two issues: First, the interpretation of the author over the interpretation of other authors (third-order interpretations) may distance the synthesis from the actual data, adding more author-biases; second, it is claimed that synthesizing results from qualitative research presupposes that it is reasonable to generalize from individual studies, and some may not regard it as a legitimate approach. However, the idea of carrying out qualitative syntheses across qualitative studies is not directed towards the development of a general theory, but it is actually directed to adding even more details to the findings of the individual studies [9].

Noblit and Hare [39] describe a seven step process to guide the execution of meta-ethnographies: getting started, deciding what is relevant to the initial interest, reading the studies, determining how the studies are related, translating the studies in one another, synthesizing translations, and expressing the synthesis.

However, given the interplay that may exist among the factors related to individual motivation, static models may not be able to bring to account all the complexity existing in this context. System dynamics is a tool designed to map and communicate the dynamic interplay among a set of variables, so it may be useful in this step of the research.

“Although system dynamics models are mathematical representations of problems and policy alternatives, it is recognized that most of the information available to the modeler is not numerical in nature, but qualitative”[33].

Researchers have been investigating the interaction between qualitative approaches, such as grounded theory, to systems modeling ([29][33]), and have been achieved satisfactory results. Luna-Reyes and Andersen [33] also describe the guidelines for the modeling of a complex system. Therefore, in this phase, we must develop a research protocol that takes to account the seven steps of a meta-ethnography, and is able to support the modeling of a complex system for each case study, rewriting the central story of motivation of each case in terms of more detailed and systemic archetypes that describe motivation of the software engineers. The output of this phase may also be compared to the MOCC model [44].

4. DISCUSSION

4.1 Research limitations

Indeed, there are some threats to the general research validity, which are deeply discussed in this section. This section also describes how these threats have been addressed, and discuss the main project decisions that may limit the overall results of this research.

First, as discussed in Section 2, motivation is generally described as the **set of internal forces** that energize, channel, and sustain human behavior over time, towards a **goal**. In this sense, two important cut-points have indeed to me made to enable the operationalization of this research:

- **The goal:** even though our literature review results have not been fully published and peer reviewed, it has been showing us that the **goal** in motivation research in software engineering has been operationalized in many different forms, such as “choosing an organization to work”, “not leaving the organization”, “not leaving the profession”, “contributing to open source software”, among others. However, in this research, we are mainly interested in the factors that predict the software engineers’ willingness to apply effort in a task, in order to execute a better job and to achieve better outcomes.
- **The set of internal forces:** as discussed in Section 3, we designed a qualitative approach in order to complement the large amount of quantitative research that has been done in this area. However, collecting qualitative rich data about motivation may be as challenging as collecting quantitative objective data. Since motivation cannot be directly observable, our main data collection techniques were designed based on interviews and diary data. Therefore, because of the bunch of existing motivational theories, we evidenced that participants may confound the concept of motivation with other distinct (although nearly related) concepts, such as satisfaction, commitment, enthusiasm, among others. Moreover, while many researchers on motivation group intrinsic and extrinsic factors, we decided not to use this classification, since it is not straight-forward to distinct these types of factors [19]. In addition, there may be a dissonance between how people describe their thoughts or beliefs, and how their thoughts and beliefs actually are, and therefore how they actually act. This problem, called lack of *congruency* [2] may represent another challenge for our data analysis, although we have designed ways to triangulate source of the participants’ data.

Another relevant source of bias is the authors’ pre-formed opinion, which may contaminate the whole data analyses and syntheses, as well as the translations during the third-order interpretation. In order to tackle this issue we took two main strategies. First, the literature review and the case studies were carried out in teams, with at least one additional masters’ student involved in each isolated study, and all the protocols, data and results have been peer-reviewed in the research group. Second, the PhD student took a 10-day self-knowledge immersion course, in order to be able to expose his personal beliefs and opinions beforehand to the analysis of the case studies, so the bias could be not only avoided but also tracked in the research reports by external researchers.

Overall, this research does not mean to propose a general inter-cultural theory. As discussed in Section 3, we are aware that the results are contextualized and, therefore, generalization to other contexts should not be carried out directly. However, we expect that our findings can be reinterpreted (rather than reused) in other contexts, provided factors are carefully translated. With appropriate translations, propositions could be evaluated in the new contexts. Therefore, although the findings should not be assumed to be universally valid, the central tenets of the theory and the research method can assist others to reinterpret the theory

in specific contexts. Moreover, the case study protocol could also be used to carry out case studies in other even more different contexts and, through a large replication effort, the local theories could evolve to be even richer in the future, opening more opportunities for future research improvements. Finally, this research faces challenging time and budget requirements, since rich data in qualitative research usually take long cycles to be collected and analyzed, with not much help of automatized tools. The student has been enrolled to the PhD program since March 2010, and is supposed to finish the work until March 2014.

4.2 Planned next steps

The current status of each phase of this research has been discussed in Section 3. In summary, the systematic literature review produced preliminary results, and has been passed through a whole process of re-extraction and re-analysis; Regarding the four case studies, three of them have already been analyzed and local theories of motivation have been proposed, but we are currently considering a reanalysis in order to seek for individual-related aspects (e.g. personality) which have not been extensively investigated; and the protocol for the Phase 3 has not yet been designed. Nevertheless, Table 1 summarizes the numbers of scientific reports produced by now.

Table 1. Summary of scientific production

Type of Report	2010	2011	2012
Journal article		1	
Conference paper	2	2	2
Workshop paper	1		
Book	1		
Master dissertation		4	
Technical report		1	3
Total	4	8	4

Regarding the next steps, Table 2 summarizes the research schedule for the next three semesters. We also plan to carry out the Phase 3 in cooperation with prof. Helen Sharp, who is specialist in qualitative research as well as in motivation in software engineering, from the Open University, UK.

Table 2. Summary of scientific production

Phase/Activity	2012/2	2013/1	2013/2
<i>Phase 1</i>			
SLR Report	X		
<i>Phase 2</i>			
Case study IV: conclusion	X		
Re-analysis of the case studies	X	X	
<i>Phase 3</i>			
Planning / Execution		X	X
Final report			X

5. CONCLUSION

The present paper describes an agenda for a PhD project intended to develop a better understanding of motivation of software engineers. Our long term research objective is centered on understanding why some software engineers seem to be more motivated to perform their work than others, because motivation is closely tied to performance. We are also interested in explaining why different levels of motivation are found among employees that work in the same organizational context and perform similar tasks. In this paper, we present the main phases, methods, and threats to validity of the general research path, as well as the current status of the research project, together with the

planned next steps. This research is still in its initial stages towards the establishment of empirically based theories of motivation, which we believe that will assist managers and practitioners in general, in the difficult task of maintaining motivation in software development teams.

6. ACKNOWLEDGMENTS

Professor Fabio Q. B. da Silva holds a research grant from the Brazilian National Research Council (CNPq), process #314523/2009-0. This article was written while Prof. Fabio Silva was in a sabbatical leave at the University of Toronto, receiving a CAPES research grant process # 6441/10-6. A. César C. França is a doctoral student at the Center of Informatics of UFPE where he receives a scholarship CNPq, process #141156/2010-4. We would like to thank all software engineers, project managers, and the directors of the organization for their participation in this study. Finally, we would like to thank the Samsung Informatics Development Institute (SIDI) for partially fund this research.

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