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How do Work Motivation Aspects Impact Software Developer Turnover?

A Quantitative Study with Brazilian Developers

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**"HOW DO WORK MOTIVATION ASPECTS IMPACT SOFTWARE DEVELOPMENT: A
QUANTITATIVE STUDY WITH BRAZILIAN DEVELOPERS"**

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Resumo

Com o crescimento rápido do mercado para software, a necessidade de profissionais nas empresas de desenvolvimento está em alta, porém, há estudos que indicam uma alta taxa de rotatividade de profissionais, já que profissionais mudam de empresa em um curto período de tempo. Devido a esse fato, as empresas estão preocupadas em manter seus profissionais o maior tempo possível, evitando gastos com novas contratações, treinamentos e perda de bons profissionais, pois alguns profissionais de software possuem habilidades intelectuais especializadas, e para treinar outros com o mesmo propósito, pode levar bastante tempo até que o novato se torne produtivo. Além disso, também há estudos que evidenciam que a motivação possui influência no sucesso ou fracasso de projetos, do mesmo jeito que outros relacionam a motivação com a rotatividade de profissionais de software, de modo que os profissionais busquem empregos menos estressantes, mais significativos, com mais valorização e melhores condições de trabalho. Este estudo relaciona aspectos de motivação e rotatividade de profissionais em empresas de software no Brasil utilizando uma adaptação do modelo Job Characteristics Model (JCM) de Hackman e Oldham. Através de um questionário baseado no modelo, coletamos respostas de 102 profissionais de desenvolvimento de software no Brasil, que geraram resultados através de uma pontuação potencial motivacional (MPS). Desta forma, pudemos coletar dados de motivação dos profissionais sobre o emprego anterior. Os dados mostram que mais de 76% dos profissionais, exatamente 78 saíram do emprego anterior voluntariamente, sugerindo uma taxa alta de rotatividade de profissionais. Também conseguimos observar alguns aspectos de motivação mais críticos, observamos que 73% dos profissionais apresentaram exaustão elevada no emprego anterior, 71% possuíam baixa autonomia, e 69% sentiam baixa satisfação no trabalho. Esse estudo pode ajudar as companhias de software a entender quais são os problemas de motivação no desenvolvimento de software, visando melhorar o ambiente e cultura de trabalho para motivar os empregados, e assim, reduzir a taxa de rotatividade de profissionais.

Abstract

With the fast increase of the software market, the demand of professionals is also increasing, so there are studies that indicate a high rate of staff turnover, since many professionals move to other companies in a short time. Due to this reason, the companies are concerned to keep their professionals as long time as possible, avoiding costs with new hires, training and loss of good professionals, since some software professionals have specialized intellectual skills, and to train others for the same purpose, it may take a long time until the new hire becomes productive. In addition, also there are studies showing evidence that motivation has an influence on the success or failure of projects, as well as, others relate the motivation to staff turnover in software development, so the professionals look for jobs less stressful, more significant, with more appreciation and better working conditions. This study relates motivation aspects to staff turnover of software companies in Brazil, using an adaptation of the model Job Characteristics Model (JCM) of Hackman and Oldham. Through a survey instrument based on the model, we collected answers from 102 software development professionals in Brazil that generated results through motivational potential score (MPS). Thus, we could collect data of motivation of professionals over the last job. The data show that more than 76% of professionals, exactly 78 left the last job voluntarily, suggesting a high staff turnover rate. Also, we observed some most critical motivation aspects, we identified that 73% of the professionals presented high level of exhaustion in their last job, 71% had low Autonomy, and 69% felt low satisfaction in the job. This study can help software companies to understand which are the most motivation problems in software development to improve the work environment and culture to motivate employees, and so, reduce staff turnover rate.

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Lista de Símbolos

UFCG - *Universidade Federal de Campina Grande*

JCM - *Job Characteristics Model*

MOSD - *Models of Open Source Developer*

JDS - *Job Diagnostic Survey*

MPS - *Motivational Potential Score*

MFSE - *Models Focusing on Software Engineer Job Satisfaction*

UCC - *Locally calibrating Unified Code Count*

KMO - *Kaiser-Meyer-Olkin*

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Capítulo 1

Introduction

Software development is one area of the fastest increasing number of employment in the world today. According to recent studies, employment for software developers is expected to grow 24% from 2016 to 2026 in the U.S., much higher than the average for all occupations [1]. This fact happens because software is needed for automating several areas, such as computer factories, automobile industry, food industry and many others. So, there has been growing interest in the profession of software development in several position, including programmers.

In this area, human factors are very important. Like several areas, Software Engineering is not different, companies need humans to produce their software. In fact, software is the product of human intellect, then human factors are key to stimulate creativity and production, motivation encourages software engineers to produce their best abilities [2]. For software development having a creative nature and being characterized by possessing high levels of education and specific skills, as well as the ability to apply these skills to solve problems, the mental study of software professionals has impact on work. So, many evidences suggest that software developers go through considerable stress, by dealing with complexity through mind-absorbing tasks, even comparable to high-intensity jobs, like medical care [3; 4].

Similarly to many other areas, software development also presents characteristics that influence professionals deciding to stay a long time in the same job or to leave for another company; some these characteristics can related to motivation aspects. The motivation aspects influence are one of the reasons to staff turnover, including reasons such as job satisfaction, burnout, and other personal issues [5].

1.1 Problem

Software development companies have identified high staff turnover rate as shown in recent reports [6]. High turnover rate is a problem because this indicates that professionals do not stay much time in the same job, as companies show a low retention. Turnover possibly generates significant cost to companies, due to the time to find other professionals, training of new hires and time to adaptation of the new hires in the team. Besides that, the companies very likely lose professionals with potential [7]. The problems due to staff turnover can be several, like difficulty to manage, lack of team harmony and damages to project success [8].

It is believed that turnover is related to the motivation of software engineering professionals [9]. High turnover can cause problems like lower quality because of loss of expertise, lower productivity because newcomers may not be as productive as the developer they replace, it may take a long time until newcomers become really productive [10].

As a job that requires intensive creativity and resilience to intellectual challenges, software development needs motivated individuals, but to motivate professionals, we need to know which are the problems in the motivation before all. Motivation is an abstract factor, not easy to study. However, is possible to measure indirectly the motivational potential of the job by motivation aspects, such as Work Exhaustion, some Job Characteristics like Feedback, Autonomy, Skill Variety, as well as their Job Satisfaction, Workplace and the activity of developing software itself [11].

We identify a study having the most similar ideas, our study is about motivation on staff turnover, that already happened, while the work of Harrison McKnight et al. relates motivation aspect to turnover intention, a probability to change job [12].

There are a few studies measuring motivation of developers [13; 12; 14], but none of them relate them to turnover, in special, brazilian developers, the eighth biggest market in the world [15]. The following research questions for the study motivation and turnover for brazilian developers:

RQ1 - What is the relationship between motivation aspects and voluntary turnover with Brazilian software professionals?

RQ2 - What is the relationship between motivation aspects and personal demographic information (Job Position, Study Level, Age) in the last job?

RQ3 - What is the correlation between motivation aspects?

1.2 Contributions

In this work, we carry out a survey research work about staff turnover relating to the motivation aspects. For this, we performed a study based on a model of the psychology called Job Characteristic Model (JCM). We translated and adapted JCM to collect data about the last job of professionals and to analyze how motivated they were before they moved to another job.

Our study uses a web-based survey instrument sent to groups of software professionals located in different Brazilian companies to collect data, so we first analyzed sample using exploratory analysis to verify behavior of the data with support of graphs. After observing the behavior, we used another factorial descriptive analysis with support of statistical tests to validate our sample. Next we used inferential analysis to verify correlation among aspects. We gathered and analyzed evidence about motivation aspects in software development, in special their possible relationship with turnover, in a survey-based study with 102 developers who work for companies located in some states of Brazil (Pernambuco, Paraíba, São Paulo, Rio de Janeiro).

We identified that most staff turnover are voluntary, it means that the most professionals decided to change job by their own choice, and also we identify that the most critical motivation aspects are Work Exhaustion, Job Satisfaction and Autonomy having about 70% or more of software professionals with a negative or moderate score. This score means that professionals were exhausted, dissatisfied in the last job, besides they had a low autonomy. Looking for correlation between motivation aspects, the data shows weak correlations, all the aspects seem to be independent. As a secondary result, with our descriptive analysis, it is possible to know how the survey instrument is appropriate to this research, then the adaptation of JCM was systematically validated. The validation is a contribution to future work.

A deeper understanding of the motivating aspects in software teams certainly helps management, increase productivity, a more collaborative and healthier work environments. This research is intended to improve knowledge about the key factors in motivating developers to organizations, to create a comfortable place for software engineering employees and perhaps

reduce staff turnover. We show important issues that everyone in the software industry should pay attention to.

This document is structured as follows: Chapter 2 presents the concepts and models used in this work; Chapter 3 presents procedure and methods, Chapter 4 presents results and discussions, and Chapter 5 presents the conclusion.

Capítulo 2

Background

This research study is based on advancements in research about motivation and turnover. In this chapter, we present concepts we have used to perform this study. In following sections, we show some definitions regarding turnover, motivation and how these concepts have been applied in software development. Also, we describe the models and approaches that were applied in our study.

2.1 Turnover in Software Development

Turnover is a fact of frequent changes of human resources in companies, loss of professionals and replenishment by new hires [16]. Studies explain that general satisfaction, job content, and commitment are negatively related to staff turnover [17; 16; 8] at least. Since 1979 turnover is considered an important factor in the work psychology, as it showed by Mobley et al. that conceived a conceptual model of individual-level turnover behavior [18].

Software companies often present high turnover rates [12]. The constant loss of professionals generates some problems such as costs to the company, difficult to manage the team, less harmony of the team, impact on project success, and many others [8]. Beyond the problems when the company loses good professionals. According to study from the University of Southern California, software development environment faces an average of 90% personnel turnover in projects [19]. The data was generated after an analysis of 4 months from a Constructive Cost Model, a parametric cost estimation model that requires size, product, and personnel attributes as input. The cost model was calibrated by 16 organizations [19].

Software development is mostly made up by intellectual work that tends to concentrate specific knowledge in professionals, and learning is slow [20]. Then, turnover in software companies often generate problems with the activity of new hires, which negatively impact software quality [16], probably because the new hires are not allocated in important changes due to their low experience in specific knowledge [10; 20].

It is believed that there are many distinguished factors that possible influence staff turnover, such as salary, diversity of job as well as opportunities, on external problems, such as personal issues [7; 12]. This research focuses on human factors, which describe all aspects of human performance which interact with their environment, related to psychological aspects of human capability. [21]. Motivation is a human factor that we believe is as important as other factors. If companies improve the motivation aspects to employees, the companies possibly reduce their turnover rate, then retaining good professionals.

2.2 Job Motivation

Motivation has many definitions in psychology, although all have similar meanings. A brief definition is that motivation is an internal condition that activates behavior and gives it direction, sometimes described as a need or desire that energizes and directs to goals or behavior [22; 23].

Job Motivation is usually one of the most important factors to management, but also a challenge. In general, managers are prepared to plan strategies to organize work. However, the productive process of motivating professionals is a distinct and more complex challenge, since motivational issues are related to personal feelings of state of mind [24]. A number of research studies address work motivation [2; 25; 26; 24; 23].

Despite its importance, it is hard to measure motivation. It can not be calculated as a single metric, but must be divided into several aspects, such as autonomy, which expresses the desire to be self-directed, or feedback, which expresses the need to receive comments about the work done [27].

Each motivation aspect can respond as a part of the abstract measure of motivation, but each aspect measures different things and can infer distinguished conclusions [28]. In research motivation aspects are often treated in isolation; for example, a high score of autonomy

means that an individual is self-directed and can make some decisions without authorization of the supervisor, and that means a positive motivation for this context, not means that an individual has feedback from job [29].

2.2.1 Motivation in Software Development

Software production is carried out by professionals that spend time thinking and creating part by part of the software, it is possible to realize that the production resembles craft work. So, to encourage professionals, motivation has been studied in software engineering, in particular, Beecham et al. [30], França et al. [31], Hernandez et al. [32], and Magalhães et al. [33].

In those research studies, some aspects are often linked to motivated software developers, such as high work commitment that is the effort and concern to carry out the work activities, and high proactivity that is the desire to do work without anyone asking. Likewise, satisfied professionals present some characteristics like satisfaction with management that express a good sentiment about their supervisor, and nice work environment that expresses the pride to work with their team and stay at environment [25; 34].

In addition, a number of motivating and demotivating aspects has been observed as relevant to software developers, as showed by Araújo [34]. Among motivating aspects, she includes healthy relationships with management and other team members; good feedback from coaches; salary; constant self-development and learning opportunities; well-established position plans; and finally, task variety. On the other hand, the following aspects are often seen as demotivating to developers: low salary, not compatible to a heavy workload; poor working conditions; lack of resources, such as useful tools or practices; uninteresting or incoherent task assignment, or scarce feedback, given by bad management; or even extreme task complexity, whether too easy or too hard.

Also, the studies carried out by Beecham et al. [14] and França et al. [31], listed, in tables, a number of motivation-related factors in software development, namely motivational and de-motivational factors. These factors come from citations in existing studies, and they counted the number of times each factor was cited (see Tables 2.1 and 2.2).

Table 2.1: Motivational Factors

Factor	N° of Existing Studies
Working in successful company	3
Supportive management	20
Job security	12
Working with others/teamwork	26
Career path	24
Appropriate working conditions	6
Variety of work	19
Technically challenging work	15
Rewards and incentives	17
Trust/respect	10
Identify with the task	26
Sufficient resources	2
Development needs addressed	20
Feedback	13
Recognition	15
Autonomy	16
Work/life balance	9
Making a contribution	9
Empowerment/Responsibility	9
Sense of belonging	15
Equity	5

Table 2.2: De-motivational Factors

Factor	N° of Existing Studies
Poor working environment	10
Poor communication	6
Lack of relationship opportunities	4
Unrealistic goals	6
Lack of promotion opportunities	5
Poor quality software	3
Poor cultural fit	3
Uncompetitive pay	7
Poor management support	8
Lack of influence	4
Unfair reward system	3
Non interesting work	1
Inequity/Personal preferences	4
Risk	1
Stress/Pressure	7

2.3 Motivation Models

Models are a way to explore possible consequences of actions before executing the actions, often usual in social sciences [35]. Some models are applied in many fields of software engineering, such as a model to describe requirements [36], or software evolution [37], but this research employs models to describe motivation aspects.

Several motivation models have been proposed for different studies in software engineering. Sharp et al., for example, presents some models of motivation such as the Job Characteristics Model [38], Model focusing on Software Engineering Job Satisfaction [38], Models of Open Source Developer SE Motivation [38], among others. A representative model is JCM [39]; it has been widely adapted for researches [38; 40; 41]. So we selected this model, up on which we base our study relating motivation and turnover for brazilian software professionals.

2.4 Job Characteristics Model (JCM)

JCM is a validated model of work psychology developed by researchers J. Richard Hackman and Greg Oldham [42; 43]. It has been utilized for more than three decades in several areas to management of human resources, as support to analyze job motivation and effects on work outcomes [39; 44]. The JCM suggests that positive outcomes score will influence the employee and the company to have high motivation, high-quality performance, high job satisfaction, low absenteeism, and low staff turnover [45].

The model contains five core job dimensions that lead to critical psychological states in the individual: Skill Variety (the range of tasks performed), Task Identity (the ability to complete whole job from start to finish), Task Significance (the impact of the job on others), Autonomy (the ability to be self directed), and Feedback From Job (return of comment from job actions) [11]. To collect and study these aspects, it is necessary to calculate a motivational potential score (MPS) from a questionnaire named Job Diagnostic Survey (JDS), that is one component of the JCM (see Table 2.3). When MPS is showed as low index, demonstrating an individual growth necessity, motivation needs to be improved [40].

Table 2.3: Job Diagnostic Survey

Dimension	Questions
Skill Variety	<ol style="list-style-type: none"> 1. My job requires me to do many different things as work, using a variety of my skills and talents. 2. This job requires me to use a number of complex or high-level skills. 3. Overall, my tasks are not simple and repetitive. 4. My job requires that I make use of a wide range of my talents or abilities.
Task Identity	<ol style="list-style-type: none"> 1. This job is arranged so that I can usually do an entire piece of work from beginning to end, not just a small part of an overall piece of work. 2. This job generally provides me the chance to completely finish the pieces of work I begin. 3. My job usually involves a complete piece of work that has an obvious beginning and end.
Task Significance	<ol style="list-style-type: none"> 1. This job is one where a lot of other people, in this organization and other organizations, can be affected by how well my work gets done. 2. This job is important in that the results of my work can significantly affect other peoples' ability to do their work. 3. This job itself is very significant and important in that it facilitates or enables other peoples' work.
Autonomy	<ol style="list-style-type: none"> 1. In my work, I usually do not have to refer matters to my direct supervisor for a final decision. 2. Usually, my direct supervisor does not have to approve my decisions before I can take action. 3. Rather than asking my direct supervisor, I usually make my own decisions about what to do on my job. 4. I can usually do what I want on this job without consulting my direct supervisor.
Feedback From Job	<ol style="list-style-type: none"> 1. This job itself provides me information about my work performance. That is, the actual work itself provides clues about how well I am doing-aside from any feedback co-workers or supervisors may provide. 2. After I finish a task, I know whether I performed it well. 3. Just doing the work required by this job provides many chances for me to figure out how well I am doing.

The JCM can be adapted according to necessity, but all survey models need to be validated. Validation is important because changes can reduce the accuracy of the model, as it is necessary to verify all consequences of adaptation; it is carried out in several steps: revision of a specialist of the area (Software Engineering Researcher) that evaluates each question if it makes sense to current area; revision of a specialist in validation of the research tool to human (Psychology Researcher) that analyzes ambiguity of questions and if each question can respond the objective; application of the research tool to a small group to test and ask about problems; analysis of test results with descriptive and inferential statistics to analyze if survey is adequate to response all factor [46].

From the knowledge of this guiding model, Couger and Zawacki proposed in 1980 an enhancement of JCM, developing another Job Diagnostics Survey for Data Personnel JDS/DP. The JDS/DP has the same behavior, as the original survey, but adding new aspects [38]. Despite the JDS/DP to be an enhancement directed to software engineering, the original JDS is still used for many software related studies because it is simpler and generically facilitates adaptations.

Also, the JCM has been applied to turnover-related research. For instance, McKnight et al. [12] has an adapted questionnaire from JCM with a objective to respond the influence of motivation to turnover intention, desire to move on to another company, so performing a research tool that we can use as base, exactly what was necessary.

Capítulo 3

Methodology

This research is a survey based on a version of the Job Characteristics Model (JCM) by Hackman and Oldham[12]. Survey is a methodology that can help to investigate research questions related to people, which are hard to investigate by experiment or data collection only. This study uses a structured survey instrument based on a model to a quantitative analysis [47]. The standard survey instrument to this research is a component of JCM, named Job Diagnostic Survey (JDS), that is an instrument with objective to measure motivation aspects through group of questions.

Our aim is to study how motivated were software professionals in their last job, and if their decision about leaving the last job voluntarily has some relationship with motivation aspects. In this chapter, we explain and demonstrate how we performed our study and how we analyzed the results of the survey. We present the research questions, describe the context of our research, demonstrate the procedure of analysis and describe the analysis method.

3.1 Research Questions

In this work, we intend to study the motivation aspects of software development professionals and how strongly are they linked with the voluntary turnover. The research methodology of this study is quantitative, using an adapted survey based on the instrument JDS to collect and analyze data, which were analyzed to respond our research questions. Following we describe each research question in more detail.

3.1.1 RQ1: What is the relationship between motivation aspects and voluntary turnover with Brazilian software professionals?

The objective in answering RQ1 is to identify the most strongly related motivation aspects in voluntary turnover (Skill Variety, Task Identity, Job Significance, Autonomy, Job Feedback, Work Exhaustion and Job Satisfaction). The result that answers this research question is the most important goal of this dissertation.

3.1.2 RQ2: What is the relationship between motivation aspects and personal demographic information (Job Position, Study Level, Age) in the last job?

To answer research question RQ2, we need to analyze the behavior of all motivation aspects (Skill Variety, Task Identity, Job Significance, Autonomy, Job Feedback, Work Exhaustion and Job Satisfaction) compared with collected demographic data (Job Position, Study Level, and Age). The idea is to analyze the distribution of motivation aspects in terms of groupings.

3.1.3 RQ3: What is the correlation between motivation aspects?

In RQ3 we measure the correlation rates with Spearman rho index [48] between the answers (score) for each motivation aspects.

3.2 Study Context

This research was carried out with software developers working in Brazil, either in public and private companies or as autonomous developers. In order to be part of the study, the participant must have worked in at least two jobs, because the questions are directed to professionals who have already moved to another job. All questions of the survey apply only to their last job. We consider, then, actual turnover; all professionals in our sample have already moved to another job.

Our sample is composed of professionals working mainly in software development teams (developer, tester, or manager). The choice of the person profile was made with an

objective to analyze differences between these groups, and to find out how much software professionals were motivated in their last job and relate it to turnover.

In our survey instrument, all questions are in portuguese, and the participants must be working in Brazil. The invitation of participants was made by sending a message with description and access link of the questionnaire to two online groups of software developers, four mailing lists, and to about 40 directed people, who served as a hub to pass on the survey to colleagues (snowball sampling), as a convenience sample. Snowball sampling is a research technique that recruits participants by other recruited participants for a study [49].

3.3 Study Procedure

This research is a survey based on the instrument JDS from the JCM, and to adapt JDS in this study, we made some changes. The original JDS covers five job dimensions that are called Job Characteristics, but we chose to cover two additional areas: Job Satisfaction and Work Exhaustion [11], as showed in Table 3.1. Another major change is that the standard JDS asks about the current job of professionals, and this study asks about their last job (the one they have left for the current job).

With a standard research instrument, it is necessary to adapt JDS to this research, and also as this research is made in Brazilian companies, it was translated to portuguese, requiring validation of the survey instrument, also it is necessary a new validation. It was made all necessary changes generating a new adapted questionnaire to this research (see Appendix A), and after we have made a validation of our model (Section 3.4.2).

Table 3.1: Our Motivation Aspects

Job Characteristics	<p>Skill Variety, represents the capacity to use several abilities in work.</p> <p>Task Identity, represents a full understanding to complete the work.</p> <p>Job Significance, means how important is the work to other people.</p> <p>Autonomy, represents the ability to be self directed.</p> <p>Job Feedback, shows return of information about work.</p>
Work Exhaustion	High level of stress at job, burnout.
Job Satisfaction	Feeling of pleasurable or positive emotional state resulting from the job experiences.

Figure 3.1 shows the new model with all connected aspects. This representative figure describes that the model has five Job Characteristics, and another two aspects: Work Exhaustion and Job Satisfaction.

We chose these motivation aspects because they are mostly related to human factors and turnover [12; 50; 51; 52], and also, due to an already existing validated survey to adapt. All the aspects are a group about motivation. Job Characteristics come from the original JCM (its five dimensions [11]). Work Exhaustion and Job Satisfaction were selected from a research about motivation and turnover intention of McKnight et al. [12].



Figure 3.1: Motivation Aspects Model

Data collection was performed through online Google Forms sent to professionals in Brazil¹. The survey was applied, before, to a small sample of about 15 participants, who were asked to provide feedback about the items. After correcting the problems (difficulty to understand questions, very similar questions, wrong interpretation), we applied to the entire sample. To analyze the sample, initially we use exploratory data analysis [53] to verify behavior of the data. After observing the behavior, we use another factorial objective analysis [54] with support of statistical tests.

The survey instrument has 24 items (Appendix A), with each question corresponding to a motivation aspect: Work Exhaustion, Job Satisfaction, Job Significance, Task Identity, Skill Variety, Autonomy, and Feedback. Each aspect includes three or four corresponding questions, and these questions were mixed when the instrument was actually applied, the order of questions are independent of group, so the participants are not influenced by the group organization, reducing grouping bias. By splitting all questions by the respective motivation aspect, there are seven groups; in Table 3.2 we can see which questions are related to each aspect.

Table 3.2: Questions of the Motivation Aspects

Motivation Aspect	Corresponding Questions
Work Exhaustion	1, 2, 3, 4
Job Satisfaction	5, 7, 9
Autonomy	6, 8, 10, 12
Job Feedback	11, 13, 15
Job Significance	14, 16, 19
Task Identity	17, 21, 23
Skill Variety	18, 20, 22, 24

The answers to questions are presented in reversed scale, values from 1 to 7, 1 being the most positive and 7 the most negative. The scale was selected from the related study of

¹https://docs.google.com/forms/d/e/1FAIpQLSc18xP4_hAlvF82wPPHufqaFET4MFSGTrK0dGRIt1eq01nXQQ/viewform?usp=sf_link

McKnight et al. [12]. We classify an answer as negative when the index of scale is higher than 4, moderate when equals 4, and positive when equals or less than 3 [55; 12], as showed in the following example.

I felt emotionally burned out in my last job:

- 1 = never;
- 2 = a few times a year or less, almost never;
- 3 = once a month or less, rarely;
- 4 = a few times a month, sometimes;
- 5 = once a week, rather often;
- 6 = a few times a week, nearly all the time;
- 7 = daily.

Another part of our survey was to collect additional information, such as voluntary turnover and demographic data. Voluntary turnover is when a professional decide to move on to another company by his/her own reasons, as well as the not voluntary turnover is when a professional leave the company as being laid off for a given reason. The question about turnover has a more objective answer (voluntary turnover, not voluntary turnover). Demographic data are informations about personal characteristics, such as Job Position, Study Level, and Age. Our survey instrument has one question to each of those.

Our analysis begins with a behavior analysis, showing data behavior through graphs and discussions. Next we use a descriptive analysis to verify the adequacy of our survey, before applying inferential analysis to correlate motivation aspects.

The survey instrument (Appendix A), was applied for evaluation by the Ethics Committee of UFCG (see Appendix B), as our study includes human responses. The data collection started in October 2017 ending in December 2017, but the survey form is open, and it is still able to receive responses. We expect to collect more results for future studies.

3.4 Analysis Method

Our data analysis was performed with the objective to answer the research questions and make a survey validation. In this section, we describe all used methods to analysis, and after describing the validation in details.

3.4.1 Methods Regarding the Research Questions

Descriptive and inferential statistics are applied, in our study, for analyzing and answering the research questions, demonstrating the percentage of voluntary turnover, each motivation aspects rate (negative, moderate, or positive), the relationship between personal information to motivation aspects, and also to calculate the correlation among motivation aspects.

To analyze our sample with the objective to answer research questions, we initially need to demonstrate the turnover rate (voluntary or not voluntary) using descriptive statistics. Then, we can make our data analysis in all sample that has a turnover voluntary. Also, we have made the grouping of corresponding questions to each aspect, then we calculate the average of grouped questions, that generated indexes named motivational potential score (MPS) about every seven aspects (Skill Variety, Task Identity, Job Significance, Autonomy, Job Feedback, Work Exhaustion and Job Satisfaction). As our scale is reversed and has seven points, we divide as MPS lower than three is positive; MPS equals four is moderate; MPS higher than four is negative.

Lastly, we analyzed the correlation among motivation aspects, using a Plot Correlation Matrix backed by the Spearman rho index [48]. We then, generated a matrix demonstrating all p-values to aspect by aspect [56].

To perform our analysis, we used RStudio as our analytical tool for the R language. The RStudio brings some facilities to compile code and use important analysis packages, such as ggplot2 [57] that is used to build several types of graphs, and likert [58] package that is used in factorial analysis to our validation, psych [59] that bring function of Kaiser-Meyer-Olkin measure of sampling adequacy, and ggrepel [60] that we used to show grouping of items with factorial plot graph. Another easiness from RStudio is to publish code generating graphs and information as a site, just using the plug-in Rpubs. We shared our data analysis through Rpubs in <http://rpubs.com/wallison/310216>.

3.4.2 Survey Validation

Survey validation is necessary because we have made changes in the original survey JDS to adapt it to our research, such as the addition of two aspects (Work Exhaustion and Job Satisfaction), translation to Portuguese, and adaptation of questions for considering the last

job (not the current job). Then, the changes can affect the survey accuracy. To perform the validation, we carried out two revisions and analyzed results using descriptive statistics and factorial analysis [54].

Concerning formal revision, two types have been performed for our survey instrument: the first by a specialist of software engineering (Software Engineering Researcher) that analyzes questions to verify if each question makes sense to the software engineering work, and the second revision is made by a specialist in surveys (Psychology Researcher) that analyzes if questions can answer the corresponding motivation aspect [46].

From the revisions, we proceeded to a pilot application of the survey, and then used descriptive and factorial analysis to statistically evaluate the questions. Initially, we have made the application of the survey to a small group (about 15 professionals), asking about possible problems in the questions. Finally, with the corrected survey instrument, it was applied to the entire sample.

With the results, as our survey instrument is answered using a Likert scale, we verified the trend of answers to the questions. To verify and demonstrate this measure, we use plots of Likert package as support [61], which show the percentage of questions to each value of scale (from 1 to 7). By verifying the trend of answers, we can analyze if each question seems to respond the respective motivation aspect or the question has a bias to the same value ever.

So, in our descriptive analysis of the survey instrument, we realized that survey questions have some trends in two items: 12 and 14. The item 12 demonstrates that most of the professionals answered the item as higher than three, with more than 80% of the participants (see Figure 3.2). And about item 14, almost 80% of the participants answered the question as less or equal than three. Item 12 refers to autonomy, and 14 refers to job significance. The survey has only two trends, this result demonstrate a good behavior, because it means that the questions have not bias in general.

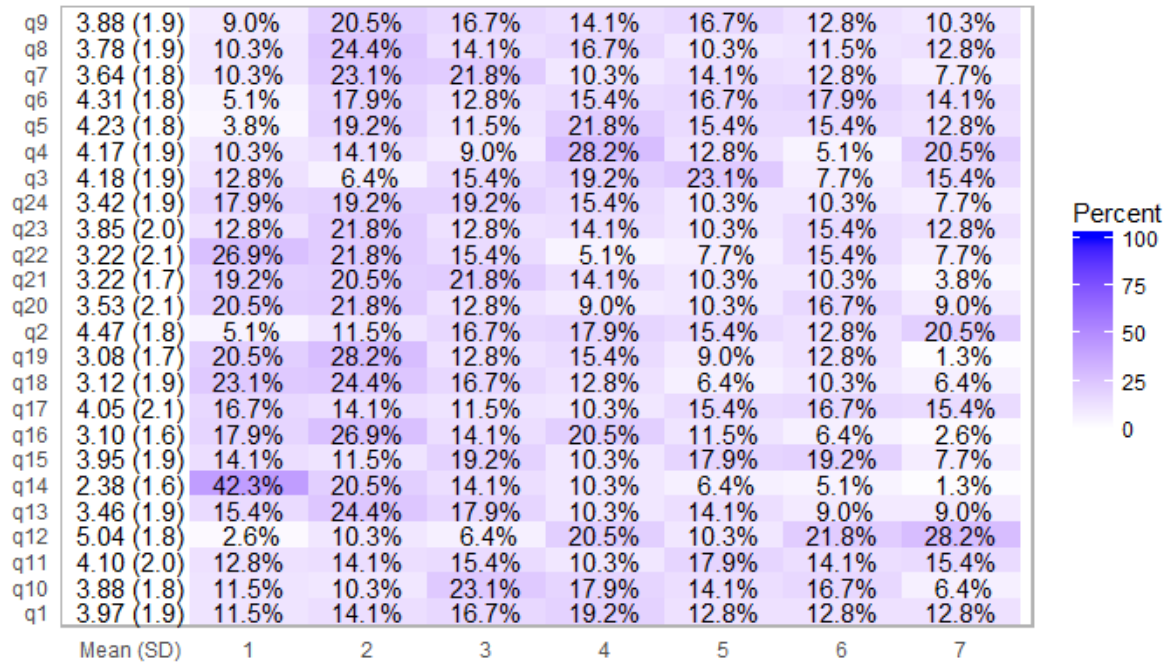


Figure 3.2: Descriptive Plot Questions

After verifying trend of the answer in the survey, we need to analyze the questions adequacy. This analysis tests the accuracy of answers to questions, so Kaiser-Meyer-Olkin is used to show the adequacy of questions results generating a value of adequacy to each question [62; 63].

Kaiser-Meyer-Olkin scale for sampling adequacy:

- Values between 0.00 to 0.49 are unacceptable.
- Values between 0.50 to 0.59 are miserable.
- Values between 0.60 to 0.69 are weak;
- Values between 0.70 to 0.79 are middling;
- Values between 0.80 to 0.89 are meritorious;
- Values between 0.90 to 1.00 are marvelous.

As shown in Figure 3.3 we have many middling indexes of KMO, some meritorious and some weak. There are some weak indexes maybe by the reduced sample number. So in general, we have adequate questions.


```

Kaiser-Meyer-Olkin factor adequacy
Call: KMO(r = resultsCor)
Overall MSA = 0.74
MSA for each item =
  q1  q2  q3  q4  q5  q6  q7  q8  q9  q10 q11 q12 q13 q14 q15 q16 q17 q18 q19 q20 q21 q22 q23 q24
0.66 0.69 0.75 0.76 0.80 0.81 0.77 0.60 0.80 0.62 0.62 0.68 0.85 0.63 0.78 0.69 0.72 0.79 0.76 0.79 0.72 0.79 0.77 0.76

```

Figure 3.3: KMO results

As factorial analysis, we use the functions of Principal Components Analysis [64], whose demonstrates factorial loads. The loads represent the correlation between the item and the principal component grouping all items in a factor. The Factor analysis can demonstrate the principal components represented by Standard Deviation, Proportion of Variance and Cumulative Proportion. The results of factor analysis contribute to identify the question groups and to verify if the grouping in factors is adequate, corresponding to our aspects. In Figure 3.4 we can see that the most of variations are acceptable because have values less than 2, and Cumulative Proportion presents a good distribution.

```

Importance of components%:
      PC1  PC2  PC3  PC4  PC5  PC6  PC7  PC8  PC9  PC10  PC11  PC12  PC13
PC14  PC15
Standard deviation  4.8105 3.5182 2.83910 2.45032 2.25244 1.96035 1.93132 1.80474 1.69422 1.47367 1.41510 1.3173 1.28782
1.1465 1.11889
Proportion of Variance 0.2747 0.1469 0.09568 0.07127 0.06022 0.04562 0.04428 0.03866 0.03407 0.02578 0.02377 0.0206 0.01969
0.0156 0.01486
Cumulative Proportion 0.2747 0.4216 0.51730 0.58857 0.64879 0.69441 0.73869 0.77735 0.81142 0.83720 0.86097 0.8816 0.90126
0.9169 0.93172
      PC16  PC17  PC18  PC19  PC20  PC21  PC22  PC23  PC24
Standard deviation  1.06136 0.97864 0.95307 0.80606 0.73193 0.70953 0.69529 0.5801 0.50045
Proportion of Variance 0.01337 0.01137 0.01078 0.00771 0.00636 0.00598 0.00574 0.0040 0.00297
Cumulative Proportion 0.94510 0.95646 0.96725 0.97496 0.98132 0.98729 0.99303 0.9970 1.00000

```

Figure 3.4: Principal Components Analysis

To evaluate the internal consistency of results from survey application, we use the function of Cronbach's Alpha [65]. The Cronbach's Alpha more acceptable as good consistency is between 0.8 and 0.9. In Figure 3.5 we can see that all items have alpha equals 0.87, so the alpha has a good value of reliability to our sample.

```

Reliability analysis
Call: psych::alpha(x = results[, 3:26])

raw_alpha std.alpha G6(smc) average_r S/N ase mean sd
0.87      0.87      0.94      0.22 6.9 0.021 3.8 0.95

lower alpha upper      95% confidence boundaries
0.83 0.87 0.91

Reliability if an item is dropped:
raw_alpha std.alpha G6(smc) average_r S/N alpha se
q1      0.87      0.87      0.94      0.22 6.6 0.021
q2      0.88      0.88      0.94      0.23 7.0 0.020
q3      0.87      0.87      0.94      0.22 6.6 0.021
q4      0.87      0.87      0.94      0.22 6.5 0.022
q5      0.87      0.87      0.94      0.23 6.8 0.021
q6      0.87      0.87      0.94      0.23 6.7 0.021
q7      0.87      0.87      0.94      0.23 6.7 0.021
q8      0.87      0.87      0.94      0.23 6.8 0.021
q9      0.86      0.86      0.94      0.21 6.3 0.023
q10     0.87      0.87      0.94      0.23 6.7 0.021
q11     0.87      0.87      0.94      0.23 6.9 0.021
q12     0.88      0.88      0.94      0.23 7.0 0.020
q13     0.86      0.86      0.94      0.22 6.4 0.022
q14     0.87      0.87      0.94      0.23 6.7 0.021
q15     0.87      0.87      0.94      0.22 6.4 0.022
q16     0.87      0.87      0.94      0.23 6.8 0.021
q17     0.87      0.87      0.94      0.22 6.6 0.022
q18     0.87      0.87      0.94      0.22 6.5 0.022
q19     0.87      0.87      0.94      0.22 6.5 0.022
q20     0.87      0.87      0.94      0.22 6.6 0.022
q21     0.87      0.86      0.94      0.22 6.4 0.022
q22     0.87      0.87      0.94      0.22 6.5 0.022
q23     0.87      0.87      0.94      0.22 6.6 0.022
q24     0.87      0.87      0.94      0.22 6.5 0.022

```

Figure 3.5: Cronbach's Alpha

As a conclusion, we can realize that our survey instrument, in general, presents good adequacy. So, the answers really have a good relationship with motivation aspects, and the analysis to respond our research questions is more trustworthy.

Capítulo 4

Results and Discussions

We collected data from a sample with 102 participants, from different companies in several states in Brazil (São Paulo, Pernambuco, Paraíba, Rio de Janeiro, and others), and most answered that left their job voluntary. We sent invitations to professionals explaining that the requirement to participate of the survey is to have worked in at least two companies of software development, so the first question ask them if decision to move to other company was voluntary or not. The Figure 4.1a shows that 76.5% of professionals of software development have a voluntary turnover, corresponding to 78 participants. This result of turnover is already very significant, because it follows the idea seen in related works that software engineering presents a high voluntary turnover rate [6]. All research questions are analyzed over voluntary turnover participants, so, we have 78 participants in our sample asked about motivation aspects in their last job.

We have collected some demographic data to group the 78 professionals (Job Position, Study Level, Age). Figure 4.1b in graph of Job Position shows that the most of participants are Developers with 56.4%, followed by 34.6% of Testers, and 9% of Managers. Figure 4.1c in graph of Study Level shows that the most of professionals are graduate as 43.6% of participants, or have master's degree as 30.8%. And also, Figure 4.1d in graph of Age shows that most of participants have age between 25 and 30 years old, as 56.4% of participants.

We have answers from 24 questions, each question corresponds to a motivation aspect, in which a set of questions defines a motivation aspect. To classify each aspect, we calculate a motivational potential score (MPS) from the average of the related questions. So we can analyze and identify significant information in the motivation aspects.



Figure 4.1: Most Important Motivation Aspects

4.1 Research Question 1

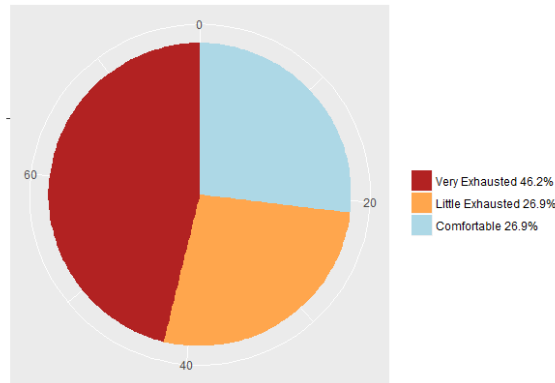
The following aspects seem most critical for professionals leaving the job, having less than 40% of positive MPS: Work Exhaustion, Job Satisfaction, Autonomy, Job Feedback, and Task Identity.

The graph of Work Exhaustion in Figure 4.2a shows that 46.2% of professionals were Very Exhausted, 26.9% were Little Exhausted, and 26.9% were comfortable. Most participants (72%) answered they felt exhausted in their last job, or at least uncomfortable about the work load. For psychology, the work exhaustion (tired out) is a problem in job motivation, and sometimes make the professional to look for a better place to work [66].

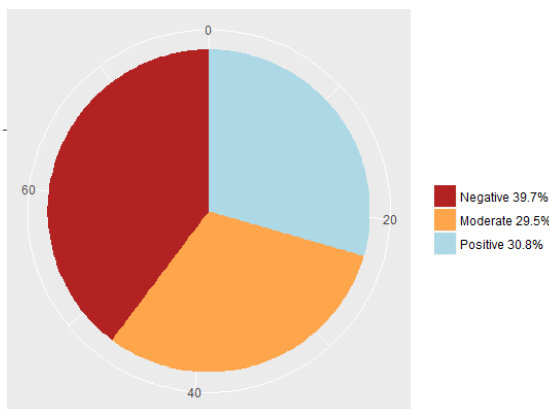
Regarding Job Satisfaction (a good feeling or positive emotions from job experience), in

Figure 4.2b the graph shows that 39.7% of participants have a negative MPS, 29.5% have moderate, and 30.8% of participants have a positive MPS. Most professionals (69.2%) were not so satisfied in their last job, or demonstrate that have dissatisfaction with their activities o job position. These results suggest that Job Satisfaction presents a strong relationship with turnover. Negative or moderate MPS is a sign that professionals of software development are not satisfied with the way they worked, with the position they held, or not satisfied with the company.

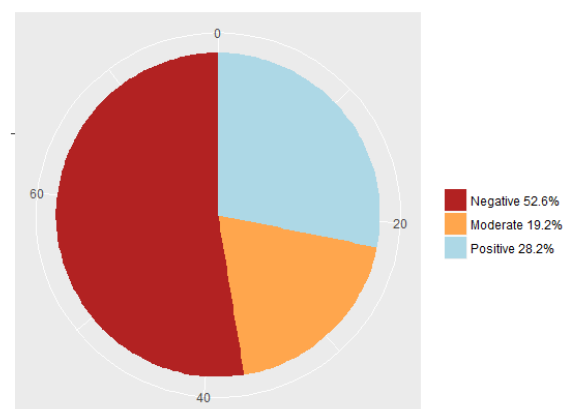
Similarly, regarding autonomy (desire to be self-directed, which is related to independence in work), negative results were observed with most participants, in Figure 4.2c the graph presents 52.6% of negative MPS, 19.2% of moderate, and 28.2% positive. Most professionals lacked autonomy in their last job. This motivation aspect demonstrates more negative MPS than all other aspects, the professionals in majority had problems about autonomy. Autonomy can have more relationship with turnover rate.



(a) Work Exhaustion



(b) Job Satisfaction



(c) Autonomy

Figure 4.2: Most Important Motivation Aspects

The first three motivation aspects above seem to have most problems to voluntary turnover. On the other hand, there are others aspects that demonstrate a moderate relationship with turnover. In the graph of Job Feedback Figure 4.3a we can see 43.6% of negative MPS, 17.9% moderate, and 38.5% positive. Most professionals had no much feedback in their last job, they have not received a return from their activities. There are some reasons to feedback importance [67], as professionals need to know how they are doing in the work to keep learning, it is an opportunity to give a direction to the professionals to improve their skills.

The graphic in Figure 4.3b of Task Identity (a full completion of work, necessity to finish activities from beginning to end receiving some outcome) presents 37.2% of negative MPS, 26.9% of moderate, and 35.9% positive. Most professionals were not satisfied with their activities in the last job. Task Identity represents a full completion, and identifiable piece

of work, activities from beginning to end that generate a visible result [40]. So, this result suggests that software engineering still requires partitioned activities with few visible results, as tasks like refactoring of a piece of the code, the professionals do not feel so good doing only activities like that all time.

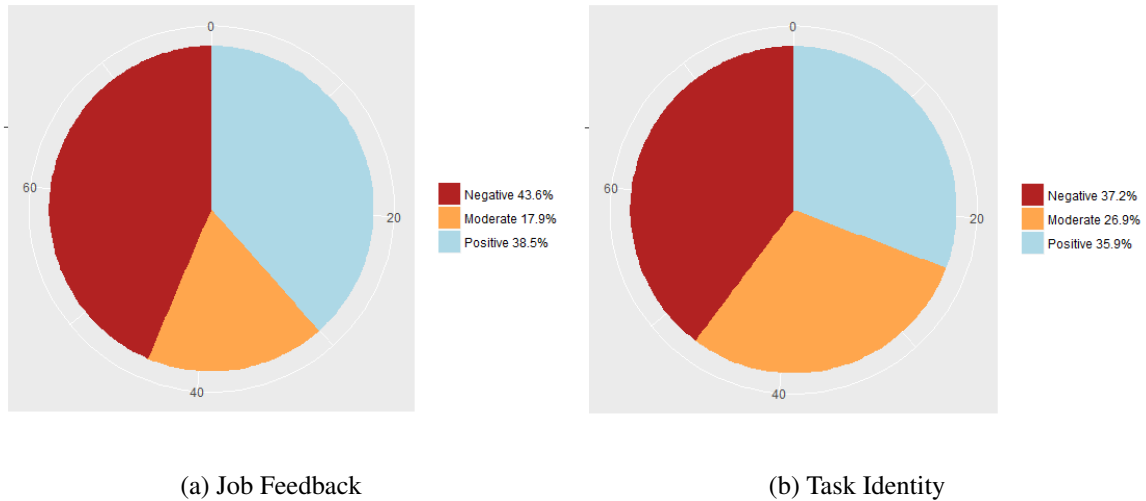


Figure 4.3: Job Feedback and Task Identity

There are two motivation aspects that have the positive MPS as the majority, that are: Job Significance and Skill Variety. We can observe in Figure 4.4a that Job Significance has 20.5% of negative MPS, 17.9% of Moderate, and 61.5% of positive. Job Significance does not seem to be most critical in software development, probably has a weak relationship with staffs turnover.

Also, it is possible to see in Figure 4.4b that aspect Skill Variety has 30.8% of negative MPS, 16.7% moderate, and 52.6% of positive. The aspect Skill Variety also seems to have a weak relationship with staff turnover, but has more negative values then Job Significance. These two motivation aspects have fewer problems than others, but still need to be improved in software development. Approximately 40% of professionals were working in activities with few significant or insignificant, and working in activities with few variety, monotonous.

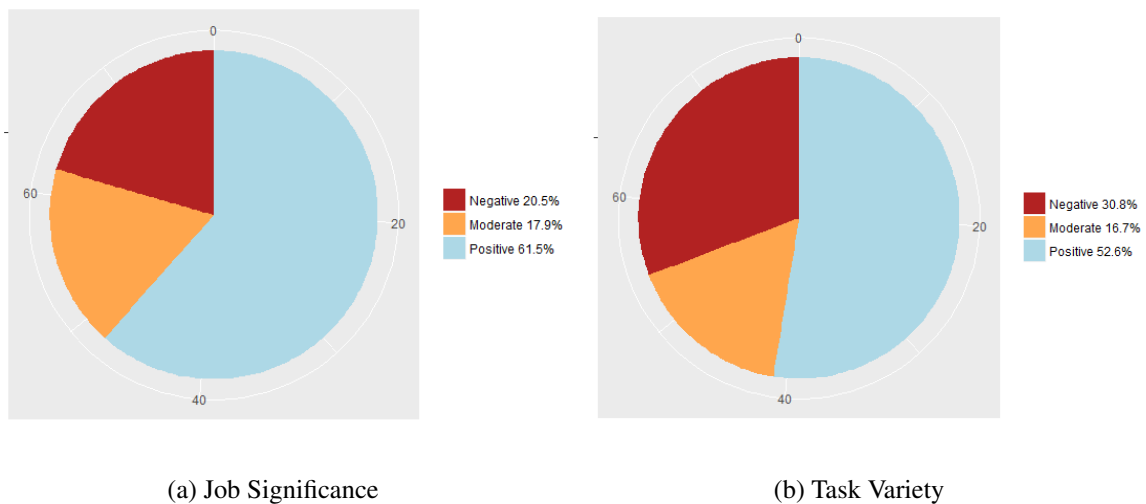


Figure 4.4: Job Significance and Skill Variety

4.2 Research Question 2

As an answer to RQ2, data of motivation and demographic data, we analyze the results considering the groups established by the demographic data, job position, the study level, or the age, which presents common characteristics and trend to some aspects, namely Work Exhaustion, Job Satisfaction, Autonomy, Job Feedback, Job Significance, Task Identity, Skill Variety.

We start the analysis of the results in Figure 4.5 corresponding to each motivation aspect to Job Position. It is possible to identify some trends in the job position; for instance manager has some differences in motivation aspects. The graphs show more negative trends to Manager like Job Satisfaction, Autonomy, Job Feedback, and Task Identity. On the other hand, Manager has more positive trends in Skill Variety and Job Significance.

Managers suffer most pressure, feel burnout and does not have much autonomy of decisions, probably due to having to organize the team and the priority of activities. As also expected, Manager is a job position that has less feedback and many partitioned activities. And as a positive result, Manager execute more different activities having used more skills, and the work of the Manager seems more significant than other job positions. These positives results demonstrate that in management, exists more activities to do and this activities have major impacts. Results do not allow us to reason about trend to turnover for managers,

if compared to other positions, this can be a good investigation for future works.

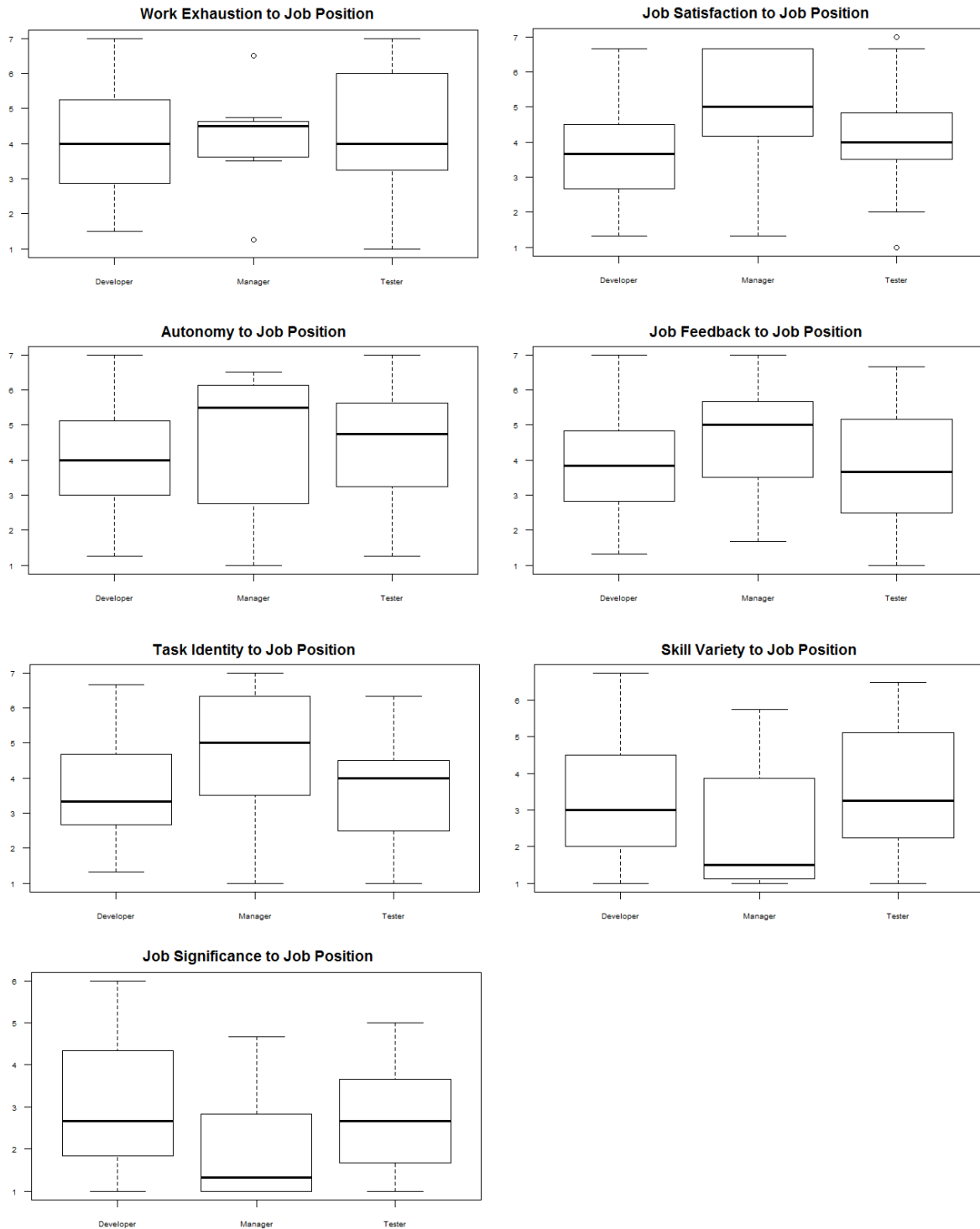


Figure 4.5: Motivation Aspects to Job Position

Also, we observed the Study Level to motivation aspects, noticing a few trends (see Figure 4.6). Doctorate Degree shows having more problems, but this piece of sample is too

small to infer anything. Undergraduate shows that this level has fewer pressure in Work Exhaustion, better Job Feedback, higher Job Significance, better Task Identity, and higher Skill Variety, maybe because many of them are in internships and have fewer responsibilities and more attention from supervisors, likewise they can give more importance to their activities, just because they are learning more.

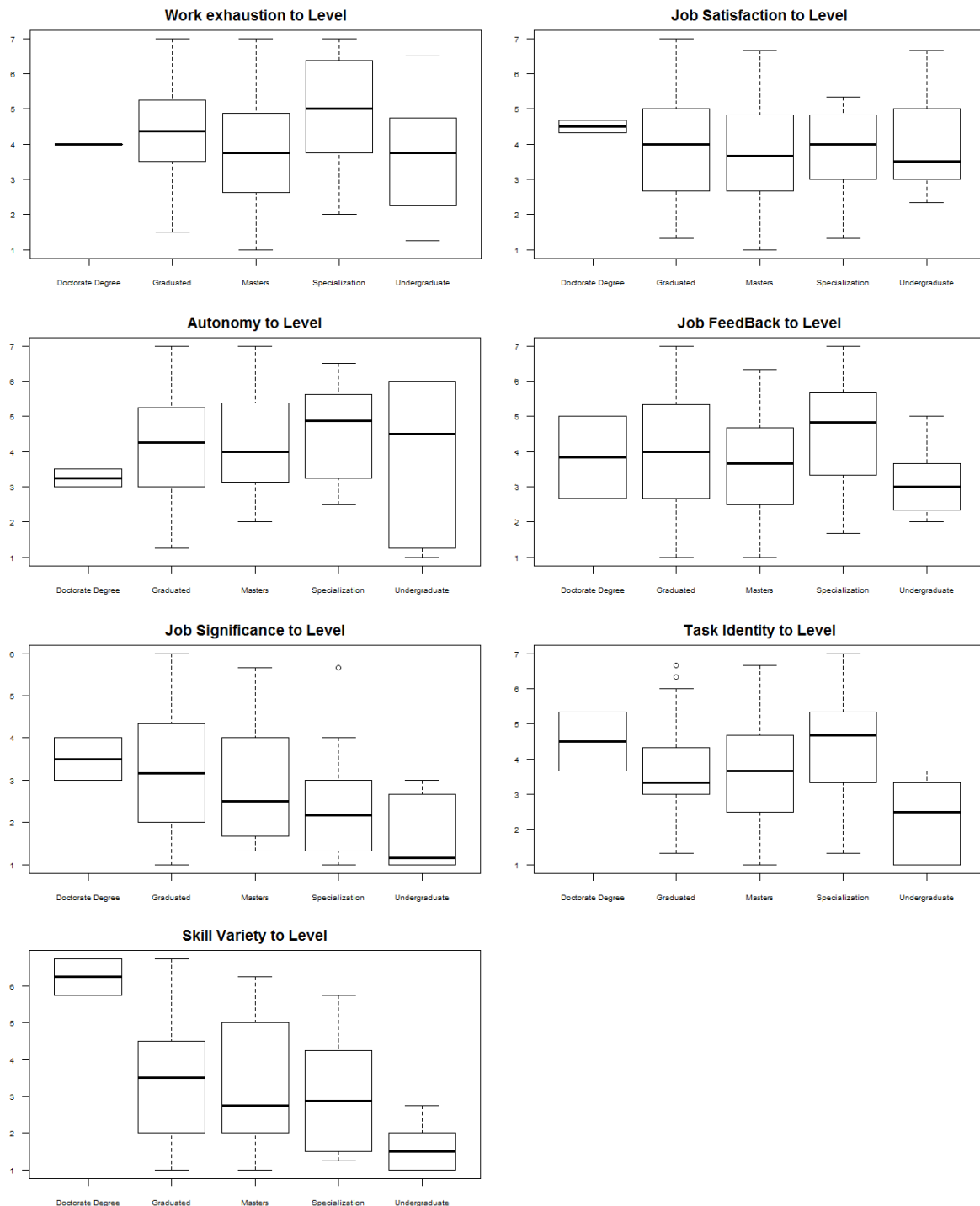


Figure 4.6: Motivation Aspects to Study Level

As other demographics data, we have analyzed motivation aspects with Age of professionals. Looking to Figure 4.8 we can analyze if age has any relationship with motivation aspects. All aspects do not seem have trends about age, except the variance of values in almost all aspect.

A correlation graph can be better to verify this behavior. We use a Sample Correlation Matrix with Spearman rho test [48] to compare overage of motivation aspects to age. Spearman rho test is an option to verify relationship between items, in special when we are using Likert scale since it is non-parametric. In Figure 4.7, we can see all correlation values about motivation aspects and age, and we realize that the age has many weak inverse correlations, the inverse correlation mean that when age increase, the aspect has better index, but the confidence coefficient is so lower to infer something. Then, according results, the age do not have relationship with motivation aspects.

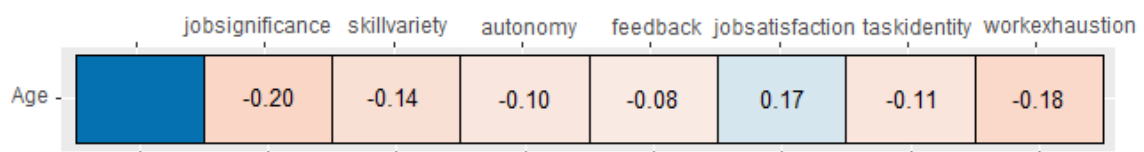


Figure 4.7: Correlation between Motivation Aspects and Age

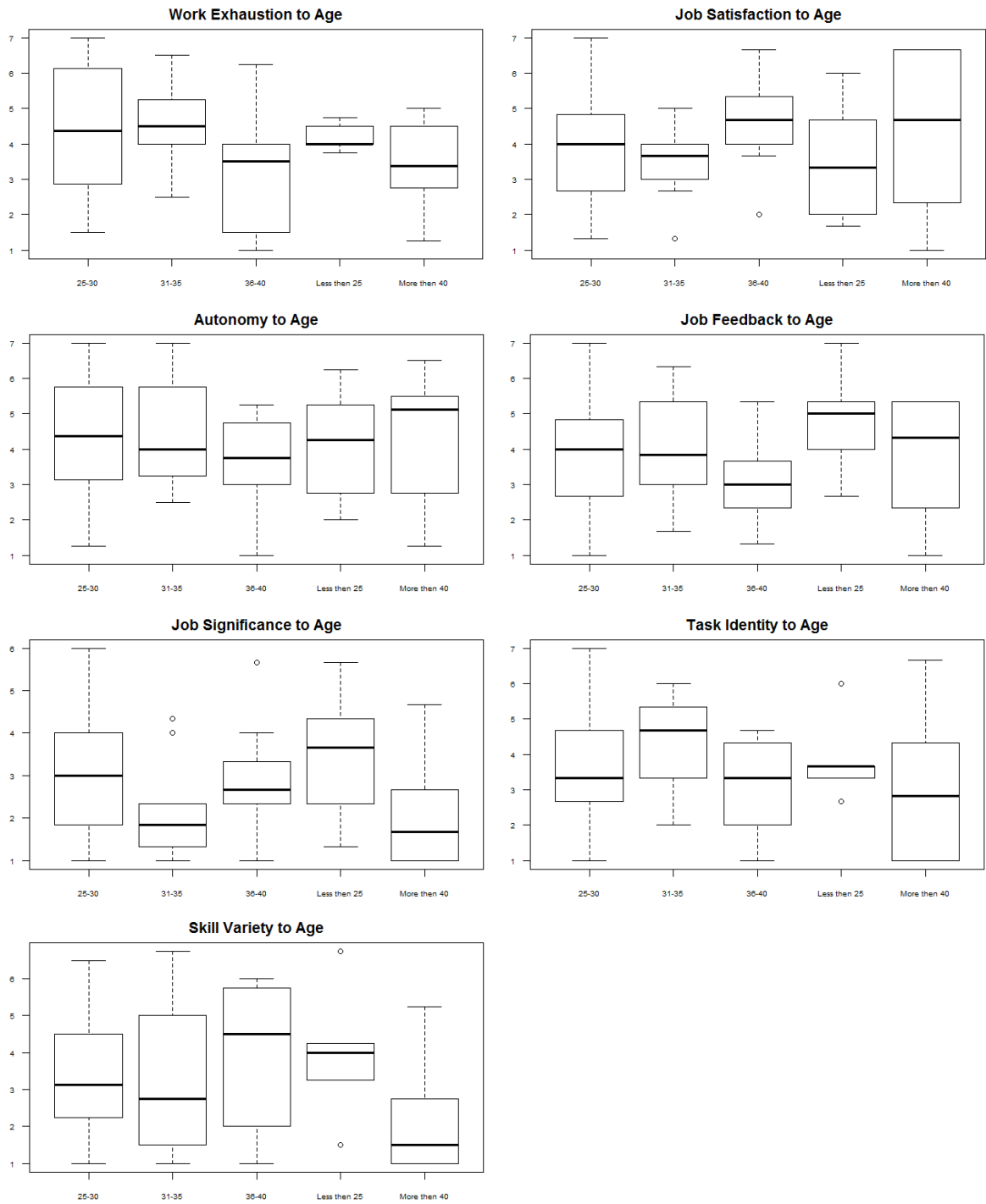


Figure 4.8: Motivation Aspects to Age

4.3 Research Question 3

We perform a Sample Correlation Matrix, using Spearman rho [48] with average of each aspect grouping corresponding questions. There are only positive correlations in Figure 4.9, with range 0.03 to 0.58. The most significant correlations are as follows: the most positive correlation (0.58) between Job Significance and Skill Variety, that seems when the professional executes many different activities, his job expresses more importance; positive correlation (from 0.41 to 0.51) between Task Identity and Feedback, seems feedback is more frequently when the tasks have a complete outcome, Task Identity and Skill Variety demonstrate complete outcome is related with more skill in executing, and Feedback and Skill Variety demonstrate that feedback is more frequently for individual executing more different skills in activities; and a positive correlation of others below 0.38.

No strong correlations are observed in general. Correlations between survey items are not significant, we have only possibly correlation mentioned above. Maybe a bigger sample helps to understand if the motivation aspects really have no correlation, it is an idea to future improvement to this research.

workexhaustion	0.03	0.03	0.18	0.26*	0.37***	0.38***	
taskidentity	0.34**	0.42***	0.28*	0.51***	0.37***		
jobsatisfaction	0.22	0.33**	0.17	0.41***			
feedback	0.26*	0.43***	0.25*				
autonomy	0.05	0.14					
skillvariety	0.58***						
jobsignificance							
	jobsignificance	skillvariety	autonomy	feedback	jobsatisfaction	taskidentity	workexhaustion

Figure 4.9: Inferential Correlation

4.4 Threats to validity

As an external threat, the collected information from the sample was limited, since our sample has 78 participants with voluntary turnover. Maybe this sample is not enough to have more conclusions with more details in analysis of motivation aspects and relationship with voluntary turnover. The data could have stronger statements with a larger sample. To minimize this threat, we picked a diverse range of software companies in different regions in Brazil using an online survey. As another external threat, we did not compare professionals that left the company with professionals that stay, so, we can not calculate the exactly impact of motivation aspects.

Regarding internal threats, the participant may not have been precisely true in their answers. There are several psychological reasons for that, as the fear of saying something that is considered wrong behavior at work. In order to minimize this threat, we explained the anonymity of answers and did not collect any personal data of the participants. Also, we did a research commitment term having approval of the UFCG Ethics Committee. Also, as internal threats, the survey instrument can be not better to collection, so we did a survey validation to minimize this problem. In addition, maybe the participants were not well selected, companies do not had a good representation of most professionals.

In terms of construct validity, the survey questions may not have caught the proper concept of motivation aspects. In order to reduce this threat, we used an already validated survey model. Some questions may be difficult to interpret, or even confusing to the respondent. So, we have performed a pilot application with 15 professionals before to apply real sample, receiving previous feedback about possible problem in the questions and correcting it.

Capítulo 5

Conclusion

In this research work, we gathered and analyzed evidence about motivation aspects in software development, in special their possible relationship with voluntary turnover, by a survey-based study with 102 developers located in Brazil.

The sample showed that the most turnover rate is voluntary, the data contains 78 participants with a voluntary turnover, exactly 76.5%, a suggestion of the high voluntary turnover in software engineering. The most critical motivation aspects are Work Exhaustion, Job Satisfaction, Autonomy, Feedback, Task Identity, showing higher than 60% of negative or moderate motivation potential score. Among the five most critical motivation aspects, we emphasize the three most apparent: Work Exhaustion, Job Satisfaction and Autonomy having 70% or more of negative or moderate motivation potential score.

Regarding Work Exhaustion, 46.2% of professionals felt very exhausted, and 26.9% felt little exhausted. Most professionals were feeling stressed in the last job. This aspect has more evidenced relationship with turnover rate, since burnout professionals tend to look for a better place to work.

Job Satisfaction has 39.7% of negative MPS, and 29.5% moderate answers. This result indicates that most professionals were not satisfied in their last job. This aspect demonstrates a relationship with turnover, as negative or moderate motivation potential score shows signals that professionals of software development are not satisfied with their activities, with their position, or not satisfied with the company.

Also, Autonomy demonstrates having a strong relationship with turnover rate, with 52.6% of negative, and 19.2% of moderate motivation potential score. The majority of res-

pondents did not feel in the control of their own choices. The Autonomy presented highest percentage of negative score, showing that software processes could be hindering freedom and creativity.

Other important results are the relationship between motivation aspects and demographic data. We found for instance some relationships about Job Position: manager seems to feel the burden of greater responsibilities, less autonomy, less job feedback, and has more partitioned activities, that are not activities from beginning to end. Beyond problems, managers also showed some good trends, such as more different activities having to use more skills, and more significant work.

In its turn, the Study Level presents a weak relationship with motivation aspects. Undergraduate seems to have less pressure than others, an hypothesis is because many of them are in internships. There are no more conclusions about it because the data has no equivalent quantities to all study levels.

We looked for correlation among motivation aspects, but the data shows weak correlations, all the aspects have some positive correlations but it is weak and not enough to affirm something. The highest correlation we found was between Job Significance and Skill Variety, with a correlation coefficient (statistically significant, $p\text{-value} > 0.9$) equals to 0.58. The motivation aspects seem to be independent in general.

The results contribute to the companies consider which motivation aspects might be the most successful in avoiding key developers moving to other jobs, or to a different area of expertise. Scientific evidence on this matter certainly puts companies in the direction to motivate professionals and reduce turnover rate. With our descriptive and factorial analysis is possible to know how the survey instrument is appropriate to this research, the model was correctly validated. The validated survey instrument is a good contribution to future work.

5.1 Related Work

The literature review is important to find theories, models, concepts, methods, and ideas. As our study is about motivation and turnover in software development, we need to apply concepts and models of psychology, and some guides about how to perform a motivation study in software engineering. In this section, we presents some related work to our study,

separating in two subsections.

5.1.1 Motivation in Software Development

A related work bring to us national culture as important impact on the motivation of software developers[68], software companies should follow the sensitivity of culture to deal with motivational factors that affect software developers. It justifies our choice to use a sample of brazilian developers, since these results can be compared with other developers in other cultures.

Going a little deeper, we also found a study showing an analyze personality types of software engineers, arguing they are a unique group of individuals[69]. Although software development attracts people from all psychological types, certain traits are clearly more represented than others in this area. Interests and personality types can play a role in selecting a career, but they cannot predict the success of the individual.

It is very important to understand the value of motivation to the success of projects, as well as Verner et al. explain that motivation is considered to be the single largest contributing factor to developer productivity, and also suggests that low motivation is an important factor in project failure [26]. The paper investigates the relationship between team motivation and project outcome. They further identify some motivational and cultural factors that must be considered by project management.

As a basic for organizing our study, the work of França et al.[70], presents an empirical study of motivation in software engineering. The authors build explanatory theories of motivation from a number of software organizations, and also integrate these local theories towards a comprehensive understanding of the role of motivation in the effectiveness of individuals and teams in which they work. Similarly, Beecham et al. [38] study motivation models in software engineering, providing a new motivation model based on crossings of existing models.

About models motivation and application in software engineering, Cleyton et al. [33] can describe some models and how can we use. The most interesting model to us is JCM because it seems more similar with human factors in general [41].

5.1.2 Turnover in Software Teams

The work of Sarah Beecham et al. [71] performs a systematic literature review on turnover in software teams, including papers about motivation problems, motivation model of psychology and software engineering, turnover of professionals, and research structure.

A relevant work about motivation and turnover intention is the work of Mcknigh et al. [12], as they perform a study about influence of motivation characteristics to turnover intention, using as standard model Job Characteristics Model (JCM). This work adapts JCM adding more characteristics of job, such as Work Exhaustion, Job Satisfaction, Workplace Characteristics. Mcknigh et al. conclude that most important characteristics influencing turnover intention are Workplace, Work Exhaustion, and Job Satisfaction. We included some adaptations of this work to our research, such as studied motivation aspects, and survey instrument as base to our new adapted instrument.

The work of Foucault et al. [16] presents evidence that constant changes of human resources in companies, staff turnover, generates problems with the activities of new hires, like negatively impact in software quality. Their results reports 80% of turnover in open-source project, and their impacts on software quality. Also, Hall et al. [8] suggest that the constant loss of professionals generates some problems such as costs to the company, difficult to manage the team, less harmony of the team, and impact on project success.

As problems when the company loses good professionals, Hira et al. [19] show a study, executed in the University of Southern California, presenting an average of 90% personnel turnover in software projects. The data have generated after 4 months of analysis from a Constructive Cost Model, that requires size, product, and personnel attributes as input. The cost model was calibrated by 16 organizations, the result represents tables with actual turnover in projects and estimation of expected turnover in some years.

5.2 Future Work

As future work, we intend to split the idea of turnover to career length expectancy into other variables (years left, years actually worked, etc.) to identify how long is the career of software developers, relating these data to motivation aspects. Also, intend to interview former developers at other career contexts (retired, or already in a diverse career) that can

bring more explanation and help to understand the reason to have left software development job.

We also need more representative samples seeking partnership with software companies, collaborating with informations to make better environment and increase retention of employees. The sample could be separate by region in Brazil, or cross-country to compare if the location can influence the relationship between motivation and turnover.

Furthermore, we intend to compare career length data in software development with other engineering-related careers, using data from related research from other areas, such as the studies of McKnight et al. [12], Robles et al. [9], and Hall et al. [8]. Another possible study is to make comparison between software developers that moved to another job and software developer that still stay in the job, measuring score of motivation in last and new job.

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Apêndice A

Turnover Questionnaire

A.1 Exaustão do trabalho

Medida de Escala:

- 1 = nunca;
- 2 = algumas vezes por ano ou menos, quase nunca;
- 3 = uma vez por mês ou menos, raramente;
- 4 = algumas vezes por mês, as vezes;
- 5 = uma vez por semana, bastante frequente;
- 6 = algumas vezes por semana, quase todo tempo;
- 7 = diariamente.

Perguntas:

1 - Sentia-me emocionalmente exausto no emprego anterior. (pressão exagerada, problemas interpessoais, etc.)

2 - Sentia-me exausto no final do dia.

3 - Sentia-me cansado quando levantava de manhã e tinha que enfrentar outro dia no emprego.

4 - Sentia-me esgotado do emprego anterior.

A.2 Satisfação e Características do trabalho

Medida de Escala:

- 1 = concordo plenamente;
- 7 = discordo totalmente.

A.2.1 Satisfação do trabalho

- 1 - De maneira geral, eu me sentia satisfeito com o emprego anterior.
- 2 - No geral, eu me sentia satisfeito com o tipo de trabalho que exercia no emprego anterior.
- 3 - Na maior parte do tempo, eu me sentia satisfeito com o meu cargo.

A.2.2 Autonomia

- 1 - No meu antigo emprego, eu geralmente não tinha que encaminhar questões para o meu supervisor direto para uma decisão final.
- 2 - Geralmente, meu supervisor direto não tinha que aprovar minhas decisões antes que eu pudesse agir. Ao invés de perguntar ao meu supervisor, eu costumava tomar minhas próprias decisões sobre o que fazer no meu trabalho.
- 3 - Ao invés de perguntar ao meu supervisor, eu costumava tomar minhas próprias decisões sobre o que fazer no meu trabalho.
- 4 - Eu costumava fazer o que eu quisesse no trabalho anterior sem consultar o meu supervisor.

A.2.3 Feedback do trabalho

- 1 - No meu emprego anterior eu recebia informações sobre o meu desempenho. Os próprios resultados mostrava a qualidade do trabalho, além de alguns outros feedbacks de colegas de trabalho ou supervisores.
- 2 - Depois que eu terminava uma tarefa, eu sabia se eu a tinha feito bem.
- 3 - Apenas fazendo as atividades exigidas pelo emprego anterior, eu tinha muitas chances de descobrir a qualidade do meu trabalho.

A.2.4 Importância do trabalho

1 - No antigo emprego, várias pessoas, da organização e em outras organizações, podiam ser afetadas pela qualidade do resultado do meu trabalho.

2 - Meu antigo emprego era importante na medida em que os resultados do meu trabalho poderiam afetar significativamente a capacidade de outras pessoas de fazer seu trabalho.

3 - Meu antigo emprego em si era muito significativo e importante na medida em que facilitava ou permitia o trabalho de outras pessoas.

A.2.5 Identidade da tarefa

1 - Meu antigo emprego era organizado de modo que eu podia geralmente fazer um trabalho inteiro do começo ao fim, não apenas uma pequena parte de um trabalho.

2 - Meu antigo emprego geralmente me dava a chance de terminar completamente as partes de um trabalho que eu tinha começado.

3 - Meu antigo emprego geralmente envolvia um trabalho completo que tem um começo e fim óbvios.

A.2.6 Variedade de habilidades

1 - Meu antigo emprego exigia que eu desempenhasse muitas tarefas diferentes, usando várias das minhas habilidades e talentos.

2 - Meu antigo emprego exigia que eu usasse uma série de habilidades complexas ou de conhecimento aprofundado.

3 - No geral, minhas tarefas não eram simples e repetitivas.

4 - Meu antigo emprego exigia que eu fizesse uso de uma ampla gama de talentos ou habilidades. (criatividade, raciocínio, etc.)

Apêndice B

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

B.1 Informações para o(a) participante voluntário(a):

Você está convidado(a) a responder este questionário anônimo que faz parte da coleta de dados da pesquisa ESTUDO DE MOTIVAÇÃO E MUDANÇA DE EMPREGO NA ENGENHARIA DE SOFTWARE NO BRASIL, sob responsabilidade dos pesquisadores em Ciência da Computação da UFCG Mestrando Wallison Fernando da Silva, Prof. Tiago Massoni - Universidade Federal de Campina Grande e Profa. Georgia de Oliveira Moura - Faculdade Maurício de Nassau - Campina Grande-PB, aprovada pelo Comitê de Ética do HU-UFCG sob o parecer número 79932217.3.0000.5182. Sua participação é voluntária, o que significa que você poderá desistir a qualquer momento, retirando seu consentimento, sem que isso lhe traga nenhum prejuízo ou penalidade.

O objetivo dessa pesquisa é identificar o quanto pessoas que atuam nas atividade de desenvolvimento de software sentiam-se motivadas com o emprego anterior, o último emprego antes do atual. Com isso, tentar entender o contexto que faz o profissional mudar de emprego voluntariamente. Caso decida aceitar o convite, você irá responder um questionário de forma individual. O único risco oferecido diz respeito ao fato de você poder ficar inibido ou constrangido em responder alguma questão que não saiba a resposta, porém, tal fato não lhe trará nenhum prejuízo. Todas as informações obtidas serão sigilosas e seu nome não será identificado em nenhum momento. Os dados serão guardados em local seguro e a divulgação

dos resultados será feita de forma a não identificar os voluntários. Em qualquer momento, se você sofrer algum dano comprovadamente decorrente desta pesquisa, você terá direito a indenização. Você poderá imprimir esta página, servindo de cópia do Termo e toda a dúvida que você tiver a respeito desta pesquisa, poderá perguntar diretamente para Wallison Fernando da Silva, Tiago Massoni ou Georgia de Oliveira, pelos e-mails w.fernando.20@gmail.com, tiagomassoni@gmail.com e georgiaio@hotmail.com ou direto no Comitê de Ética em Pesquisa com Seres Humanos - CEP/ HUAC. Rua: Dr. Carlos Chagas, s/n, São José. Campina Grande- PB. Telefone: (83) 2101-5545.