Pós-Graduação em Ciência da Computação

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JOB ROTATION IN SOFTWARE ENGINEERING: Theory and Practice

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Tese de Doutorado apresentada ao Programa de Pós-Graduação em Ciência da Computação da Universidade Federal de Pernambuco, como requisito parcial para a obtenção do título de Doutor em Ciência da Computação.

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Orientador: Prof. Dr. Fabio Queda Bueno da Silva

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Orientador: Prof. Dr. Fabio Queda Bueno da Silva

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To the little dreamer boy from the rural Community of St Anthony.

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Life is easy if you got faith, says the lyrics of the song. But it can be even easier when you are also surrounded by amazing people. I just keep thinking about how lucky I am for having the best collection of amazing people around me. So, I’m thankful to all my friends for exist in this world, and especially for being around while I was walking this path throght the PhD. Thank you, to those from long date, who were there when everything started, Celina, Paulo, Emanuelle, Ivo. Thank you, to those who are abroad, but who cared about it, and asked about it, and somehow made themselves closer even in phisical distance, Nathalie, Rachel, Alice, Adam, Stubby, and Raheem. Thank you, to those who recently become part of my life, but that almost instantly become essential, my Babe, my Baby and Ma Baby (Moisés, Nestor and Marina), Vitor, Ciça, Flavia, you are resposible for all the good moments that kept me from losing my mind. In addition, I’m thankful to all of those that were optimistic about my journey and those that were happy for my accomplishments over time. “Don’t make friends who are comfortable to be with. Make friends who will force you to lever yourself up.” – Thomas J. Watson

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ABSTRACT

Job rotation has been proposed as a managerial practice to be applied in the organizational environment to reduce job monotony, boredom, and exhaustion resulting from job simplification, specialization, and repetition. The scientific literature distinguishes between job-to-job and project-to-project rotations. Despite the potential benefits and its actual use by software companies, software engineering research did not accumulate an extensive body of scientific knowledge about benefits and limitations of job rotation in software engineering practice. In fact, there is a known knowledge gap regarding how practitioners can apply this practice in software industry. This research aims to identify and discuss evidence about project-to-project (P2P) job rotation in software companies, seeking to understand its benefits and limitations, in order to build a model that could guide research and practice towards the use of this managerial practice in software development environments. A mix-method research strategy was applied to collect, analyze, and synthesize empirical evidence in order to build and validate a consistent model that could be applied to guide industry practice. This research identified evidence from multiple sources and from different data types (qualitative and quantitative) about the use, benefits and limitations of rotation in software engineering practice. An amount of 25 factors (benefits and limitations) of such rotations in software engineering were identified and discussed. Different research methods yielded complementary evidence that could be used to inform practitioners about the effects of this managerial practice in software professionals' work. Finally, a managerial model was build and its comprehensiveness was checked in order to be applied in software companies in the process of plan, execute and evaluate job rotations. Before this research, evidence related to job rotations in Software Engineering was restricted to studies that did not investigate this phenomenon as their primary goals. Now, relevant novel evidence and significant findings based on practice were added to the body of knowledge about this specific topic, supporting researchers into the development of future research about the theme, and guiding practitioners into the improvement industry practice.

Keywords: Software Engineering. Job Rotation. Software Team.

RESUMO

Job Rotation, ou rotação do trabalho em Português, é uma prática gerencial proposta para ser aplicada em organizações buscando reduzir a monotonia no trabalho e a exaustão causada em indivíduos que desenvolvem trabalhos simplificados, especializados e por vezes, repetitivos. A literatura cientifica distingue dois tipos de rotação de trabalho que podem existir, a rotação de indivíduos entre departamentos da empresa, e a rotação de indivíduos entre diferentes projetos. Apesar dos benefícios desta prática, e do seu uso na indústria de software, a literatura da área de Engenharia de Software não produziu um conjunto suficiente de evidências científicas sobre os efeitos desta pratica no trabalho dos engenheiros de software. Esta pesquisa tem o objetivo de entender e discutir a prática de rotação de trabalho de profissionais entre projetos de software, buscando apontar benefícios e limitações desta prática, visando o desenvolvimento de um modelo teórico que possa guiar pesquisadores e profissionais no uso eficiente deste recurso gerencial. Uma estratégia de métodos de pesquisa mistos foi utilizada nesta pesquisa, visando coletar, analisar e sintetizar dados sobre o uso, as vantagens e as desvantagens da prática de rotação de trabalho em empresas de software. Foram identificados 25 fatores distintos que podem ser influenciados pela prática de rotação do trabalho e que tem efeitos diretos no trabalho dos engenheiros de software. O uso de métodos empíricos variados demonstraram evidências complementares que podem ser usadas para informar e guiar profissionais da indústria. Além disso, um modelo foi construído com base nesses resultados, e sua consistência foi verificada buscando avaliar sua usabilidade para planejar, realizar e avaliar rotações de trabalho entre projetos de software. Antes do desenvolvimento dessa pesquisa, evidências sobre a rotação do trabalho na Engenharia de Software estava restrita a trabalhos que não tiveram como objetivo principal investigar esta prática. Agora, novas evidências relevantes e resultados significativos advindos da prática industrial foram reunidos para serem utilizado como suporte para novas pesquisas, e principalmente para guiar profissionais da área no uso prático desta técnica gerencial.

Keywords: Engenharia de Software. Rotação do Trabalho. Equipes de Software.

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1 INTRODUCTION

For decades, the research on human resource management has investigated issues related to how the work is performed in organizations, as researchers proposed and discussed methods, practices and approaches to improve individual performance (BELIASI and SKLIKAS, 2013). In this scenario, Viteles (1950) proposed one of the first theories about work design in the early 1950s. According to this theory, “work design” can be defined as the different ways in which a given work or task can be designed, assigned to individuals and/or teams, and performed (VITELES, 1950; MORGESON and HUMPHREY, 2008). In general, following these authors, work design means the existence of processes and outcomes that encapsulate how the work is structured, organized, experienced, and legalized, including techniques to modify this structure, such as job simplification, job rotation, job enlargement, job enrichment, among others.

Job Rotation is one of the techniques applied to modify the way the work is structured. This practice is defined by Woods (1995) as “the systematic movement of employees from job to job, or project to project, within an organization, as a manner to achieve various different human resources objectives”, which means that the movement of individuals, among teams, projects or along the company, makes feasible the change the way work is defined, assigned and developed, or in other words, increase the possibility of modify the work design of organizations. Job rotation has being applied in several companies over the globe in many types of contexts and scenarios in order to modify their work design while increase task variety, and reduce the monotony, boredom and fatigue, resultant from job simplification, specialization, and repetition at work (COYNE, 2011).

The use of job rotation and its impacts on organizations and on individuals have raised attention from academic researchers as well. During the last decades, studies have been performed in different research fields to discuss the effects of job rotation, as a managerial practice, and its negative and positive influences on several characteristics and outcomes related to the work, such as satisfaction,

motivation, conflicts, and turnover (CAMPION, CHERASKIN and STEVENS, 1994; RICHARDSON et al., 2003). During the same period, human factors have become of great interest for Software Engineering research and practice as well, due to the fact that software development process depends on human-centered activities. Therefore, individual characteristics and behavioral aspects can have direct impact on the effectiveness of individual and teams at work, and consequently software quality (PIRZADEH, 2010).

Despite of this increase in the research regarding human factors in Software Engineering, only few studies have produced evidence regarding work design techniques, such as job rotation, and its effects in software engineers and software companies (FÆGRI, DYBÅ, DINGSØYR, 2010). This scenario raise concerns, since both types of job rotation defined by Woods (1995) can be applied in software companies, often, depending on the organizational needs. For instance, in job-to-job (J2J) rotation, individuals are rotated between different jobs in the company, to perform activities with distinct natures and/or not directly related to the software development process, such as, a software developer that can be rotated to customer support department to increase knowledge redundancy at the organizational level (FÆGRI, DYBÅ, DINGSØYR, 2010). In project-to-project (P2P) rotation, individuals are moved between projects of similar nature (e.g. two software development projects or two different products), keeping the same technical role (e.g., a developer working with java in a project moved to work with C++ in other) or changing this role (e.g. a requirement analyst moved to a different project to work on acceptance testing) (SANTOS et al., 2016).

Considering the use of this practice in software companies and it's potential impact on software development, there is an actual need for fulfill the gap of knowledge regarding job rotation in Software Engineering research and practice. Therefore, the general goal of this research is to understand how job rotation affects software engineers at work, by searching for answers to the following research questions:

RQ1. How does the practice of job rotation affect software engineers at work?

RQ1.1 What are its benefits?

RQ1.2 What are its limitations?

RQ2. How this practice can be applied in software companies in order to improve software development?

In particular, this research is focused on P2P rotations, that is, the scenario in which professional software engineers are rotated among different projects in the same software organization, which means two different projects focused on the development of two different software products or software solutions.

From this introduction, the remainder of this document is organized as follows. Chapter 2 presents the theoretical background that supports this work. Chapter 3 describes the methodological approach used to collect and analyze data required to achieve the study goals. Chapter 4 presents the findings obtained in this research, which are discussed as the results are presented. Finally, Chapter 5 presents implications for research and practice, conclusions, and directions for future research.

2 THEORETICAL BACKGROUND

The interest for comprehending and improving how work is defined and performed can be observed since the beginning of the 20th century, when Taylor (1911) proposed a theory focused on simplification and specialization of work as an attempt to maximize workers' efficiency and productivity in organizations' mass production. Since then, the work scenario in general has changed, especially because of the nature of jobs in different types of companies around the world. However, Work Design has been established as one of the main concepts regarding how the work is conceived, assigned across organizational levels, and structured into tasks performed by individuals or teams (TORRACO, 2005; GRANT, FIRED and JUILLERAT, 2011).

Over the years, different theories, approaches and models were developed, in order to improve efficiency and productivity in the workplace, depending on specific characteristics of each job (TORRACO, 2005). This means that the study on work design and its related topics is usually context dependent, since outcomes observed in one specific research field or in one specific type of company or organization might not be completely applicable in other contexts.

In particular, considering the dynamics and the nature of work in software companies, the study on work design and its relation with managerial techniques, such as job rotation, is relevant because the way how the work is structured can affect several organizational aspects in such companies, and consequently, it can influence several work outcomes, such as, performance and motivation, which might affect software development afterwards (da SILVA et al., 2016).

In fact, job rotation is a relevant topic to be explored in Software Engineering for at least two reasons. Firstly, job rotation is one of the main techniques to be applied in order to dynamically modify the work design in a company, since the way the tasks are conceived, assigned and structured are frequently modified at each rotation. Therefore, the dynamics of job rotation cope with the dynamics involved in the software development process. Secondly, the

rotation of software professionals is a common practice in software companies, especially considering that these professionals are frequently switching between different projects or tasks during the software development life cycle. Therefore, in order to improve the use of such managerial practice, the study of job rotation is an important topic for Software Engineering.

2.1 JOB ROTATION: CONCEPTS AND HISTORICAL BACKGROUND

Since the 1950's, job rotation has been proposed as a practice to be applied in the organizational environment (VITELES, 1950; COYNE, 2011). The literature presents many definitions to describe this practice focused on distinct approaches to achieve the desired organizational goals.

2.1.1 Definitions of Job Rotation

A search for the general literature about job rotation retrieved descriptions about two general types of job rotation. A group of authors focused their definition on job-to-job (J2J) rotations. For instance, Coyne (2011) described job rotation as the purposeful and organized movement of staff within and across organizational areas to enhance both the success of the company and the employability of staff. Kuijer et al. (2004) stated that job rotation is a regular alternation between different jobs within an organization, based on a scheme or spontaneously based on the workers' personal needs. Richardson et al. (2003) defined job rotation as a reciprocal exchange of staff between two or more areas for a predetermined period.

On the other hand, other authors made explicit reference to project-to-project (P2P) rotations or rotation of employees in the development of different types of products, in which individuals are moved among these projects or teams but keep the type of job or role that they were performing before the rotation. In this group, Soderquist and Prastacos (2002), Alei and Shahrezaei (2015) and Brady et al. (2005) presented job rotation as a practice that allows individuals or group of individuals to be moved from team to team and from project to project within the same organizational area. In software engineering, this would be equivalent to

moving engineers from one software development team to another team in the same company.

Including both types of rotations, Woods (1995) defines job rotation as “the systematic movement of employees from job to job or project to project within an organization during the development of a task, as an approach to achieve many different human resources objectives, such as staffing jobs, orienting new employees, preventing job boredom or burnout, rewarding employees, enhancing career development, and exposing employees to diverse environments”. In this study, Wood’s characterization was applied as the conceptual definition to guide the research, since both types of rotation can be applied in the context of Software Engineering.

2.1.2 Effects of Job Rotation in Different Types of Organizations

Besides the fact that job rotation has several definitions, typically depending on the research field in which the practice is investigated, the literature presents different and sometimes conflicting discussions about the impacts of this practice both to the employees and to the organization. By performing a broad traditional literature review looking for articles addressing the impact or effect of job rotation on several work-related factors, 12 studies were found in distinct fields such as business, automotive industry and nursing. None of the studies addressed software engineering or software organizations. Five studies addressed P2P rotations and seven studied J2J rotations.

Table 1 summarizes this review, which was used to build the initial conceptual framework of this research and guide empirical studies. In this review, the results of one study were constantly compared to results from another to raise the theoretical level and sharpen construct definitions, as recommended by Eisenhardt (1989). In Table 1 studies are identified from [1] to [12] and the complete reference list is presented in Appendix 2.

Table 1 - Job Rotations in Different Research Fields

Factors	Correlation with Factor		Impact of Factor on Work	Benefit/Limitation
	J2J	P2P		
Organizational Factors				
Organizational Commitment	+[3] +[9]	+[5]	+	Benefit
Organizational Understanding	+[10] +[12]		+	Benefit
Innovation	+[12]		+	Benefit
Learning Costs	+[3]		–	Limitation
Communication	+[3]+ [10]	+[11]	+	Benefit
Time Consuming	+[10]	+[11]	–	Limitation
Team Factors				
Knowledge Exchange	+[12]	+[11]	+	Benefit
Knowledge Transfer		+[11]	+	Benefit
Work Process and Workflow	–[3]		+	Limitation
Work Characteristics				
Task Characteristics				
Task Variety	+[3] +[10] – [6]	+[7]	+	Benefit/Limitation (J2J) | Benefit (P2P)
Task Autonomy	–[6]		+	Limitation
Knowledge Characteristics				
Acquisition of Knowledge	+[10]	+[7] +[2]	+	Benefit
Specialization	–[6]		+/–	Benefit/Limitation
Social Characteristics				
Social interaction	+[8]	+[7]	+	Benefit
Outcomes				
Individual Outcomes				
Motivation	–[3]+ [10]	+[7]	+	Benefit/Limitation (J2J) | Benefit (P2P)
Job satisfaction	–[3]	+[5]	+	Limitation (J2J) | Benefit (P2P)
Career Development	+[10]	+[1]	+	Benefit
Job Outcomes and Correlates				
Exhaustion	–[6]		–	Benefit
Professional Efficacy	–[6]		+	Limitation
Productivity	–[3]		+	Limitation
Cognitive Effort	+[9]+ [4]		–	Limitation
Workload	+[3] +[4]		–	Limitation

For each of the 12 studies, the complete manuscript was read in an information extraction process that searched for: a) definitions of job rotation; b) applicability of this practice considering the research field; c) benefits and limitations of this practice. This review process revealed that the identified studies pointed out work-related factors that were correlated with the use of job rotation (first column of Table 1). The studies demonstrated direct and inverse correlations. Direct correlations (shown as a + sign in the second column of Table 1) indicate that the use of job rotation was related to the increase of the factor. For instance, Kaymaza (2010) [7] found that the use of P2P rotations was directly related to an increase in task variety and individual motivation. Inverse correlations (shown as a – sign in the second column of Table 1) indicate that the use of rotations was related to a decrease on the factor. For instance, Hsieh and Chao (2004) [6] showed that the use of J2J rotation was correlated with a decrease in job specialization.

The studies also presented analysis on the impact of the factor on the work of individuals or organizational effectiveness. For instance, Soderquist and Prastacos (2002) [11] found that P2P rotations were time-consuming, which was considered as negatively affecting the work of individuals and, ultimately, organizational effectiveness. Other factors, such as motivation, job satisfaction, and innovation were considered as positively affecting the work. The third column in Table 1 indicates when the factor positively (+) or negatively (–) impacted the work.

Therefore, benefits and limitations of P2P rotations (fourth column of Table 1) were defined by combining the correlation of job rotation with the factor (second column of Table 1) and the impact of the factor on the work (third column of Table 1), as follows:

- + correlation and + impact is a Benefit: job rotation potentially increases a factor that has a positive impact on the work;
- – correlation and – impact is a Benefit: job rotation potentially decreases a factor that has a negative impact on the work;
- + correlation and – impact is a Limitation: job rotation potentially increases a factor that has a negative impact on the work;
- – correlation and + impact is a Limitation: job rotation potentially decreases a factor that has a positive impact on the work;

In two situations, the identification of benefits or limitations needed some care. First, studies did not always agree on the potential influence of job rotations on certain factors. For instance, job satisfaction was negatively correlated in one study of J2J rotations (CAMPION, CHERASKIN and STEVENS, 1994) [3] and positively correlated in one study of P2P rotations (HO et al, 2009) [5]. In such cases, job rotation was found to be a benefit in some studies and limitation in others. These contradictory findings were acknowledged by indicating this in the fourth column of Table 1 as Benefit/Limitation.

A second situation resulted from the study of Hsieh and Chao (2004) [6], where the researchers found that the impact of the factor job specialization on individuals was dependent on the individual's attitude toward specialization, i.e.,

certain individuals prefer to become specialists in a narrow set of tasks or skills (high job specialization) whereas other individuals prefer to work on a broad range of tasks and use broad set of skills (low job specialization). Therefore, the impact of this factor on the work of individuals can be both positive or negative depending on individual characteristics. Therefore, this factor has a +/- impact sign in the third column of Table 1 and a Benefit/Limitation value in the fourth column.

The above rationale was applied throughout the rest of this research, in particular in the construction of the summary tables throughout Chapter 4. Further, to make the presentation of this review consistent with the results synthesized in this research, the work related factors identified were grouped into four categories:

- **Organizational Factors**: those related to organizational wide and managerial aspects not directly related to a project team or an individual.
- **Team Factors**: factors that are related to team characteristics and team level processes.
- **Work Characteristics**: these characteristics broadly refer to the different ways in which a given work can be structured, assigned to individuals and/or teams, and performed. To organize work characteristics, we used the factor structure presented in the WDQ model (MORGESON and HUMPHREY, 2006). It defines three categories of characteristics: (1) Task Characteristics, “concerned with how the work itself is accomplished and the range and nature of tasks associated with a particular job”; (2) Knowledge Characteristics: “reflect the kinds of knowledge, skill, and ability demands that are placed on an individual as a function of what is done on the job”; (3) Social Characteristics: group together the social and interactional aspects of the work reflecting "the fact that work is performed within a broader social environment”.
- **Outcomes**: as it is common in work characteristics models (MORGESON and HUMPHREY, 2006), the term (work) Outcomes refers to factors related to what turns out from performing some work either as tangible factors, such as productivity or subjective, or less tangible ones such as motivation and burnout.

In summary, regarding factors at the organizational and team level, it seems that job rotation was capable of achieving several organizational and team goals, in particular in the context of J2J rotations, although some limitations were found concerning learning costs, being time consuming, and disrupting workflow. Further, no contradictory evidence was found between P2P and J2J rotations.

Concerning work characteristics and outcomes, there is a less uniform scenario to be observed. In the J2J context, studies found contradictory evidence about the correlation of job rotation and task variety and motivation. For these two factors, there is a divergence among studies regarding whether J2J rotation offers benefits or limitations in practice. Similar contradictions among the studies of P2P rotations were not found. However, J2J and P2P studies do not agree with respect to the correlations of rotations with job satisfaction and individual motivation. P2P rotations were positively correlated with these factors whereas J2J rotations correlated negatively. These discrepancies could be explained by the potential effects of J2J on other factors, such as increase of cognitive effort and workload, and a decrease of task variety and task autonomy, which are likely to affect motivation and satisfaction.

Discussions regarding J2J and P2P rotations were presented in this section in order to provide a broader view of the theme and to present the rationale applied to characterize benefits and limitations of job rotation along the whole research, although the main scenario investigated is P2P rotations. Therefore, findings from the software engineering context synthesized in this research were compared, in Chapter 4, only with the evidence from the literature in other fields, related to P2P rotation.

2.2 Job Rotation in Software Engineering

As observed before, both types of rotations described by Woods (1995) can be observed in software companies. However, before the beginning of this PhD research, only one study focused on investigating the practice of job rotation in software development was found in the literature. In this study, Faegri, Dyba and

Dingsøyr (2010) described job rotation as a broadly known approach to increase knowledge redundancy, but emphasized the lack of empirical evidence about the introduction and adoption of this practice in software development.

Their study aimed to explore benefits and challenges to improve knowledge redundancy among developers using job rotation. By applying an action research approach, during a period of eighteen weeks, they observed and collected data from nine developers being rotated from their software development tasks to customer support activities. The results suggests that although there were strong indications of increasing knowledge redundancy, the benefits obtained were not sufficient to justify the practice of rotation of developers, is this case, regarding learning about different products in the customer support department (FAEGRI, DYBA and DINGSØYR, 2010).

Further, a set of studies relating job rotation practices with software engineering were also identified. However, differently from the research performed by Faegri, Dyba and Dingsøyr (2010), the main goals of these studies were not to investigate aspects around the practice of job rotation. The researchers only pointed out evidence about the influence of this practice on members of software development teams observed during their studies. Considering this scenario, a systematic literature review was designed and performed in this research seeking to collected and interpret all evidence about the practice of job rotation in software engineering available in the literature by searching relevant online engines and repositories. The results of this systematic review are presented in Chapter 4.2.

3 RESEARCH DESIGN AND METHODS

This chapter describes the research strategy followed to answer the research questions. In summary, a mix-method research strategy combining different empirical studies was applied to gather and analyze data from multiple sources. Therefore, in order to collect as much evidence as possible, a systematic literature review, two qualitative industrial case studies, and a quantitative survey-based research were performed resulting in an extensive amount of information from the literature and from practitioners from software industry. The research phases and their main results are summarized in Figure 1, and described below.

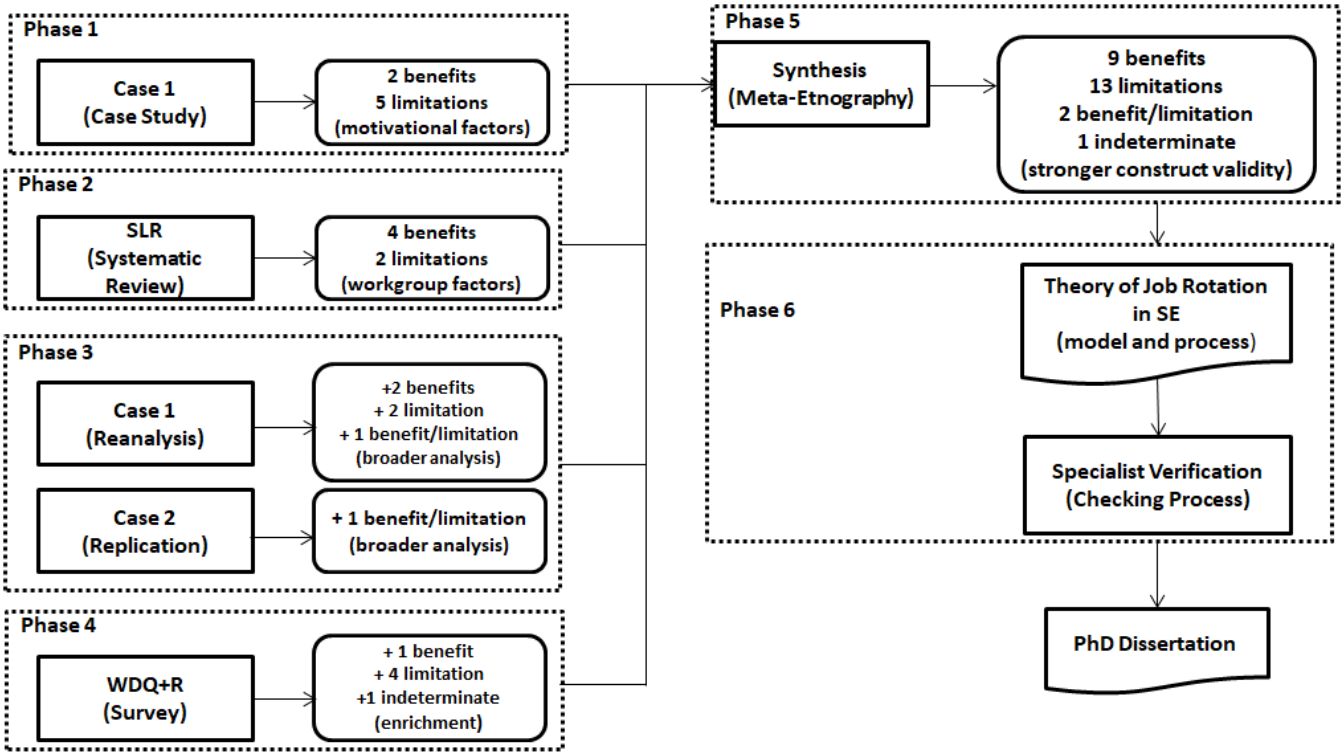


Figure 1. Research Phases

Phase 1 – The first study performed in this research was an industrial case study (Case 1), performed in 2014 and it is the lead study of a Master Dissertation (SANTOS, 2015). The main goal was to investigate the potential effects of P2P rotations on motivation and satisfaction of software engineers by collecting

perceptions of practitioners working in an organization that uses rotations systematically. Therefore, the analysis was focused on pre-formed codes from a theory of motivation and job satisfaction of software engineers (FRANÇA, 2014; FRANÇA, da SILVA, and SHARP, 2015), even though data that potentially covered other factors were collected. This analysis identified two benefits and five limitations of job rotation. Santos et al. (2016) published the full analysis of Case 1, presenting a preliminary model about the interacting effects of benefits and limitations of P2P rotations.

Phase 2 – Following the first study, a systematic literature review (SLR) was performed and covered previous studies published until 2014. Santos, da Silva and Magalhães (2016) published the results of the SLR, an analysis of 17 unique studies published in 18 articles, addressing both J2J (7 studies) and P2P rotations (11 studies). The set of 11 studies that addressed P2P rotations presented four benefits and two limitations. The intersection of the results from Case 1 and the SLR was very small, with only one benefit in common and no common limitation. This small intersection can be attributed to the focus of the analysis of Case 1 on motivational factors and also to the fact that no study identified in the SLR investigated P2P as its primary goal. This scenario evidenced the need to perform a reanalysis of Case 1 data, looking for a broader set of factors, and to extend the finding of the SLR by producing evidence with the development of more primary studies.

Phase 3 – In the next step, two studies that produced complementary results were developed. First, the data collected in Case 1 was reanalyzed (Case 1 – Reanalysis), meaning to identify benefits and limitations not directly related to motivation or satisfaction of software engineers, and therefore, not observed or considered before. Through this reanalysis three new benefits and three new limitations that were found neither in Case 1 nor in the SLR were identified. Second, a replication of Case 1 (Case 2 – Replication) was performed, in which two different projects in the same software company, and 14 new participants that were not involved in Case 1 were interviewed to collect new data. The same data analysis technique was applied looking for a broader set of benefits and limitations. Case 2 –

Replication resulted in one new benefit and one new limitation. In addition, strength of the evidence collected before was increased. These results were published in Santos et al., 2017.

Phase 4 – Since the application of similar research methods based on a qualitative approach were producing low variation of data until this point, a quantitative study was performed to collect information from software engineers working in 39 different companies, using the Work Design Questionnaire (WDQ) to assess how P2P rotations correlate with several work characteristics and outcomes. Existing measures were applied to assess work characteristics (MORGESON, HUMPHREY, 2006), together with measures for job burnout (MASLACH, JACKSON and LEITER, 1996), in addition to role conflict and role ambiguity (RIZZO, HOUSE and LIRTZMAN, 1976). A list of items to measure job rotation was created and combined with existing measures for job interchangeability (Van de Ven and Ferry, 1980). As a result, one new benefit and five new limitations were revealed. Most importantly, this method was efficient in demonstrate important existing variables not as a result of the rotation, but in one step before, in the process of planning and configuring the rotation. These results were published in Santos et al., 2019.

Phase 5 – Techniques from meta-ethnography (DA SILVA et al., 2013; NOBLIT and HARE, 1988) were applied in this phase in order to synthesize the findings of the previous four phases. In summary, this stage consisted in an extensive analysis of the scientific literature of Software Engineering, work design and organizational psychology to refine the meanings of the factors identified in the previous phases to construct an extensive body of knowledge about the benefits and limitations of job rotation in the context of Software Engineering. In this process, a total of 26 work-related factors direct or indirect affected by job rotations were identified and described. So far, this is the most extensive body of knowledge regarding this practice developed in the software engineering context to inform industry practice and to help to improve managerial processes.

Phase 6 – Finally, the conclusion of this work was the construction of a model that could guide practitioners during the process of planning, executing and evaluating job rotations among software projects. This model was developed and designed

using the factors, the correlations obtained in the survey and the interactions gathered in the five previous phases of this research. The proposed model explains the impact of job rotation in the software engineering practice and can be applied to guide software managers to use this practice. The closure in this research was the execution of a fourth qualitative study, a specialist verification, which was developed and performed in a small scale when compared to cases 1 and 2. In this phase, a senior software manager who works at an international software company and who applies P2P rotation of software engineers as managerial practice analyzed the model consistency and its possible uses.

In summary, the studies performed in all six phases were successfully applied to fulfill the main goal of this research. The following sections present the details of each method applied.

3.1 CASE STUDY I

Case Study 1 was performed in 2014 and it is the main result of a Master Dissertation (Santos, 2015). Its methodological process and results are presented in this research for completeness matters, and also, in order to highlight the evolutionary process of this research that started by refining the results of the Master Dissertation.

Yin (2003) defines the case study research method “as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used”. The existing literature on research methodology usually describes a case study as a feasible approach to investigate contemporary real-life phenomenon through detailed contextual analysis. Which means that this method allows investigation and understanding of complex issues.

Consistently with the nature of the problem and the investigated phenomenon, in this research the case study was performed by following the method proposed by Eisenhardt (1989) to build theories from case study research.

During Case 1, the main goal was to investigate the potential effects of P2P rotations on motivation and satisfaction of software engineers that worked in an organization that uses rotations systematically. To achieve this goal, the following methodological steps were followed.

3.1.1 Getting Started

The first step was focused on the definition of the general research question and the case study design. A broad literature review was performed searching for:

- Definitions of job rotation to provide a better grounding of this construct;
- Studies regarding the impacts of job rotation in different research areas;
- Studies investigating job rotation in the context of software engineering.

This step was important to precisely define job rotation and the research questions, to identify potentially important variables to be observed in the field, and to increase construct and external validity during data analysis and synthesis.

3.1.2 Selecting the Case

The second step was the purposeful sampling of the case to be investigated. To that, a well-established mature software company was selected, in which:

- The job rotation practice was performed consistently with the chosen definition, namely, Woods (1995) regarding project-to-project rotations;
- Job rotation was systematically applied as a managerial practice throughout the entire organization (all projects and teams);
- The application of this practice was known to all current employees and also to potentially new employees during recruiting and selection;
- There was a large number of projects running at the same time (over 50, in this case), of varying size, scope, duration, team size, etc.;
- It was possible to have full access to all data and individuals necessary for the investigation.

Following these requirements, a large software organization located in Recife, Brazil, was selected. In this company, members of software teams were

frequently rotated amongst software projects, during the development process, depending on business needs. At this point, it is important to state that each project reflects the development of a particular software product, which means that software project and software product can be synonym in this investigation and that each project has a well-defined team composed of different software engineers working on it, e.g., developers, analysts, testers, tech leaders, managers, and others, depending on the product.

3.1.3 Crafting Instruments

As recommended in the literature (EISENHARDT, 1989; YIN, 2003), multiple data collection methods were applied in this research: interviews, document analysis, and questionnaires. No observations were used because the perceptions and feelings about the phenomenon that were under investigation are difficult (even impossible) to observe. Therefore, it was difficult to pinpoint when and what to observe.

Semi-structured interviews were performed with two groups of participants (using different interview scripts): a) the senior managers of the company, to collect data about the organizational context, and to characterize job rotation in the company; b) software project managers and software team members, to obtain information about their experience with job rotations. Both interview scripts followed the six types of questions described by Merriam (2004) and are presented in Appendix IV.

The validation of the interview scripts was accessed by conducting pilot interviews with a group of five professionals of different companies, who had prior experience with P2P rotations. Minor adjustments were applied to the scripts, such as the phrasing of some questions and also the estimated time of required to perform the actual interviews.

3.1.4 Entering the Field

Consistently with the qualitative research approach, two projects in the organization portfolio were purposively sampled, looking for maximum variation of

information. One project with a great incidence of rotations and other one with a more stable team were chosen. This diversity allowed the understanding of distinct perceptions about the benefits and challenges of job rotation.

Then, a sampled of participants from each of the two projects were invited to participate of the case study. To that, different types of professionals, in different roles (developers, testers, team leaders, and project managers) were considered, in order to achieve good variation. Further, variety of gender was appraised, along with time within the organization, education level, and age. Finally, individuals with different perspectives about the rotations were selected, e.g., participants who had been rotated at least once and individuals who had never been rotated, but experienced the indirect effect of this practice on the team.

Interviews occurred in the organization's facilities and were performed by an interviewer and supported by a second researcher (that took notes to support the process of data analysis). All interviews were recorded producing 9 hours of audio and over 190 pages of transcriptions. Further, documents provided by the human resources department of the company was accessed and the information was applied to triangulate the data collect directly from the participants in the interviews. These documents were related to: the values and principles of human resource management in the company, managerial practices of the organization, the characteristics of the projects in which the participants of this study were allocated, and data about the personal and individual profile of participants, including performance evaluation information.

3.1.5 Data Analysis

The objective of qualitative analysis was to consolidate, reduce, and interpret data obtained from various sources, and make sense of them (SEAMAN, 1999). It involved labeling and coding all data in order to identify similarities and differences to describe the phenomenon under study. Data analysis was performed in parallel with data collection, in incremental and iterative steps, as recommended by Merriam (2009) and Seaman (1999).

Processing qualitative data often begins during the early stages of data collection. According to Merriam (2009), it is recommended performing data collection, data analysis, and reporting simultaneously, because ongoing findings can affect the data being collected, and how they are collected, in order to obtain better performance from the researcher and, consequently, lead to richer results. Usually, qualitative data analysis includes (STRAUSS and CORBIN, 2008):

- Coding and categorization of the information obtained at the data collection step (interviews, observation, field notes, etc.);
- Definition of concepts to characterize the defined categories;
- Linking and combination of concepts;
- Elaboration and report of a scheme from the emerging understanding obtained.

Frequently, the data analysis process is conducted by applying the coding approach defined by Strauss and Corbin (2008) to construct grounded theory, in which the collected data are submitted to three phases of coding:

- Open Coding: According to Strauss and Corbin (2008) this is the moment when “the data are broken down into discrete parts, closely examined, compared for similarities and differences, and questions are asked about the phenomenon reflected in the data”. In other words, each line, sentence and paragraph is analyzed in order to identify the concepts, their properties and dimensions to define codes, that is, to label chunks of data that posteriorly are grouped into representative categories.
- Axial Coding: This phase consists in intense analysis around the defined categories in order to find relationships by making connections between a category and its subcategories or other categories (STRAUSS; CORBIN, 2008). Axial coding is an inductive and deductive process, focused in emphasizing causal relationships amongst data.
- Selective Coding: The final stage of data analysis is to set the main story underlined in the investigation through the identification of the core category that gathers all the data analyzed. Strauss and Corbin (2008) proper define

selective coding as "the process of selecting the central or core category, systematically relating it to other categories". Thus, through selective coding, the categories are integrated and developed into a theory.

In this process, coding techniques to code, categorize, and synthesize data were applied, towards the construction of a central story that explains the effects of job rotation in this organization. Initially, all audio from the interviews was verbatim transcribed. Data analysis began with open coding of the transcripts. Post-formed codes were constructed as the coding progressed by attaching particular pieces of the text (Figure 2). Then, the codes arising from each interview were constantly compared to codes in the same interview and from other interviews. From the constant comparisons of the codes, they were grouped into categories that represent factors affected by job rotation (Figure 3). As the process of data analysis progressed, relationships among categories were built (Figure 4).

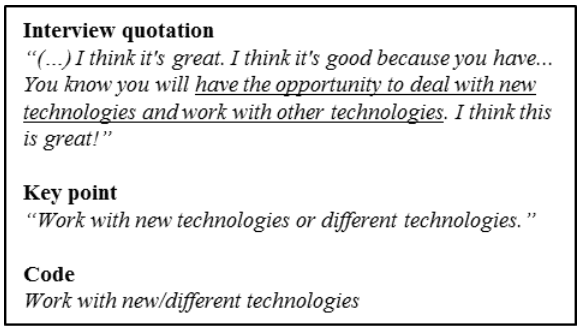


Figure 2. Open Coding: Building Codes

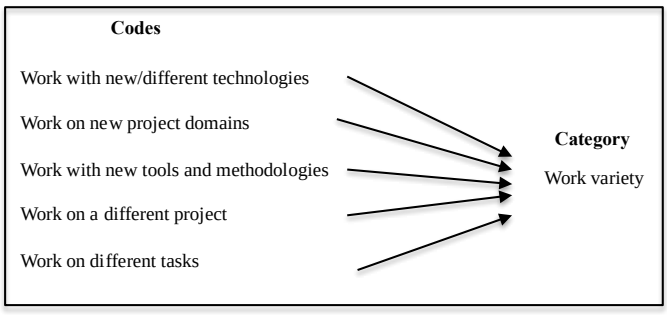


Figure 3. Building Categories

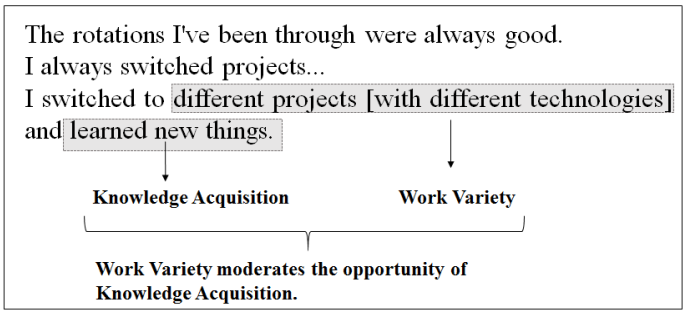


Figure 4. Axial Coding: Building Relationships

Finally, core categories were chosen according to their general explanatory power, propositions emerged, and a narrative was created to describe the central story of the case.

3.1.6 Enfolding Literature

Following the guidelines of Eisenhardt (1989), after completing the data analysis, a literature analysis was performed to sharpen construct definitions and generalizability, and raise theoretical level, by contrasting and comparing the case study results with the findings from the literature review. Throughout the iterations of data collection and analysis, theoretical saturation was checked and data collection stopped when the results from new interviews and document analysis were adding no significantly new information. At this point, results were consolidated and member checking techniques were applied to validate these findings, improving accuracy, credibility, and internal validity of our interpretations (HARPER and COLE, 2012; KREFTING, 1991).

3.1.7 Member Checking

The Member checking is a quality control process, largely associated with qualitative research, applied to improve accuracy, credibility, and validity of what was interpreted form the qualitative data collected in the interviews, diaries or observations (HARPER and COLE, 2012). The effort for this step is to measure how well the researcher understood the participants' viewpoints about the phenomenon under study and whether the conclusions are representative and complete (KREFTING, 1991), commonly using two approaches:

- A second interview with individuals who participated of the research;
- An interview with a small group of individuals similar to those who participated before.

Both cases require that researchers conduct an interactive presentation of their findings. In this process, a 15 minutes session was performed with five participants of the study (each at a time) following a simple protocol. Firstly, the general results of the study were presented to the participants. Then, a

questionnaire was applied to evaluate the level of agreement of the participants with the interpretation of the data (Appendix V). Most participants completely agreed with the interpretations and those that partially agreed were probed for suggestions for improvement in each specific item. These improvements were analyzed with other participants and added to the final results of the case.

To finalize the member checking, an activity to verify consistency (raising internal validity) and theoretical saturation was developed. In this step, the consolidated results were presented to a group of 32 project managers and 2 senior managers of the organization (Case 1), who validated the results and did not add new information to the findings. At this point, the general conclusion was that the results provided an accurate interpretation of the investigated phenomenon in this organization and the case study were successfully ended.

3.1.8 Ethics

This study followed the norms of Resolution 466/12 – CNS-MS of the Brazilian National Health Council that regulates research with human subjects. The company signed a Term of Authorization and the researchers signed a Non-disclosure Agreement (covering access to sensitive information). Both documents granted the researchers access to facilities, to the participants, and to necessary documentation. They also authorized the participants to use work hours for the interviews. This formalization reduced the possibility of participants concealing information that they would consider sensitive.

Before the interviews, each participant signed an Informed Consent Form that explained the overall objective and relevance of the research, guaranteed data confidentiality, the anonymity of the participation, the non-obligatory nature of the participation, and the right to withdraw from the research at any moment. All invited individuals freely agreed to participate and no participant withdrew from the research.

3.1.9 Case Study Report

The report of this case study included all the relevant snapshots obtained from the data to support the conclusions, such as, citations, narratives, anonymous quotations of participants, research instruments and details of the procedure, as the guidelines suggest, in order to provide clear understanding about the found evidence and also allow researchers to perform replications and further investigations in similar contexts.

In summary, the case study was an efficient method to collect and interpret impressions of professional software engineers about the effects of job rotation in their work, regarding the motivation as satisfaction of such professionals. The findings suggest the need for a balance between the positive effects on work variety and learning opportunities, and negative effects on cognitive workload and performance in order to maintain the levels of motivation and satisfaction at work. These results are fully presented Chapter 0

3.2 SYSTEMATIC LITERATURE REVIEW

Secondary studies aim to synthesize results from several different primary studies, such as case studies, experiments, surveys, action research and ethnographies, which are performed in order to access or understand a given phenomenon (KITCHENHAM and CHARTERS, 2007). In this context, Conventional systematic reviews aggregate results from a specific problem and are applied to address relational research questions. On the other hand, systematic mapping studies are a particular type of systematic review with a broader view of primary studies usually applied to answer descriptive questions on specific topics (da SILVA et al., 2011).

The use of secondary studies in Software Engineering allows researchers to collect and analyze evidence from several different aspects of software development, with the purpose of integrating experimental results, and its

application can emphasize the detection of general practical problems and research gaps to guide future research (KITCHENHAM, DYBÅ and JØRGENSEN, 2004).

In this research phase, the conceptual work on systematic literature review (PETTICREW and ROBERTS, 2006) along with the guidelines for performing a systematic review in software engineering (KITCHENHAM and CHARTERS, 2007) were applied, by executing the following steps.

3.2.1 Data Sources and Search Process

An automatic search was performed in five search engines and indexing systems (Table 2) using a search string based on the general terms extracted from the general research question and also based on synonyms for job rotation found in the literature, as presented in Figure 5. The automated search process performed in July 2015 retrieved over 4,000 papers.

The set of synonyms for job rotation added to the search string, together with the use of just one term to specify the research field (software), increased the sensitivity of the search, thus increasing coverage. However, it also decreased its precision, i.e., the amount of non-relevant studies found in the automatic search that were excluded in the following phases of this process.

Table 2 - Automatic Sources

Search Engine	Link
ACM Digital Library	http://dl.acm.org/
IEEEXplore	http://www.ieeexplore.ieee.org/Xplore
Scopus	http://www.scopus.com/home.url
Science Direct	http://www.sciencedirect.com/
Springer	http://www.springer.com.br/

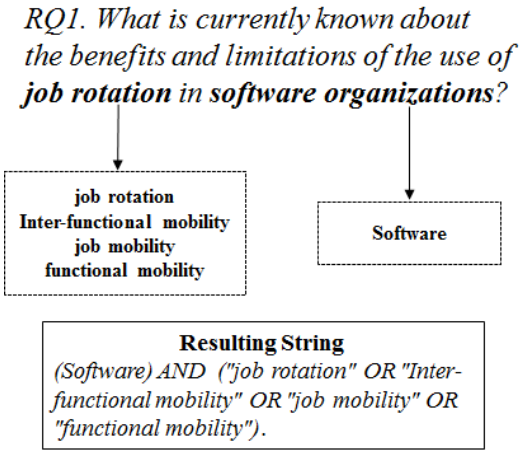


Figure 5. Search String

3.1.2 Inclusion and Exclusion Criteria

From the initial set 4,035 papers, studies were selected when presenting concepts, theories, guidelines, discussions, lessons learned, and experience reports about the practice of job rotation in the Software Engineering field (inclusion criteria). Papers were excluded when fell in any of the eight exclusion criteria:

(1) Written in any language but English;

(2) Not accessible on the Web;

(3) Invited papers, keynote speeches, workshop reports, books, theses, and dissertation;

(4) Incomplete documents, drafts, presentation slides, and extended abstracts;

(5) Addressing other areas besides computer science (e.g. business and management, social science, health-care, and others);

(6) Studies only citing or only referencing papers about job rotation, but not addressing job rotation in their findings;

(7) Addressing topics of computer science that were clearly not related to software engineering (e.g. database systems, human–computer interaction, computer networks, artificial intelligence, etc.);

(8) Papers that do not present any type of findings or discussions about the practice of job rotation in the context of software engineering.

3.1.3 Data Selection

The pre-selection of papers was based on the analysis of the full text of all papers retrieved by the automated search. Two researchers, working independently, excluded those that met any of the exclusion criteria (1) to (6). Sixty-three potentially relevant studies were pre-selected and the vast majority of papers were excluded in this phase, especially due to the exclusion criteria (5) and (6).

In the selection phase, each researcher applied the exclusion criteria (7) and (8), and the inclusion criteria on the full text of the 63 remaining papers. This process excluded studies addressing topics of computer science different from Software Engineering. Duplicates were excluded in this phase. When a study had been published in more than one journal or conference, all versions were reviewed for the purpose of data extraction. However, in this case, the first publication was used in all time-based analysis. Data selection finished with 18 papers, reporting 17 unique studies.

Disagreements between the two researchers during both pre-selection and selection phases were solved in a consensus meeting, which could involve the presence of a third researcher to solve these disagreements. Figure 6 summarizes the process of search and selection of papers.

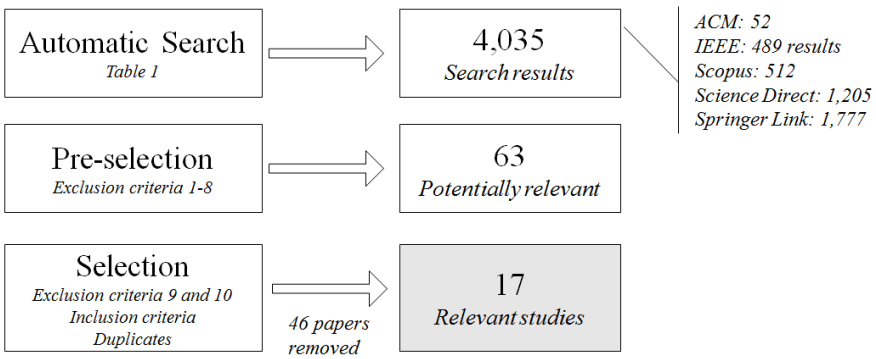


Figure 6. Search and Selection Processes

3.1.4 Data Extraction

An extraction form implemented in MS Excel™ guided data extraction. In this step, two researchers, working independently, analyzed each paper in order to fill the form with information as described on Table 3. The process with two researchers working in the data extraction is meant to improve the accuracy of the extraction process and, therefore, the reliability of the results. Similar to data selection, conflicts of extraction were discussed and solved in a consensus meeting, which involved a third researcher.

Table 3 - Data Extraction Form

Data	Description
Title	Title of the paper
Year	Year of publication of the paper
Publisher	Type of publication: journal or conference
Country	Country where the authors are located
Study Goal	Main objective of the research analyzed
Study Method	The research method
Data Collection	Instruments to collect data used in the study
Unit of Analysis	Type of participants of the study
Job Rotation	Definition used by authors to define job rotation
Motivation	Main application of the practice of job rotation
Benefits	Benefits of job rotation in software organizations
Limitations	Limitations of job rotation in software organizations

3.1.5 Data Synthesis

The following steps were applied to synthesize data:

- Identifying Factors: Qualitative coding techniques (STRAUSS and CORBIN, 2008) were applied to identify factors related to job rotation in each study. The findings between studies were compared to make sure they were addressing the same construct. This is an analysis similar to open coding in qualitative research.
- Grouping Factors: similar to the use of axial coding in qualitative analysis, codes representing factors were compared and grouped in three levels related to the: organization, workgroup and processes, and the individual. Further the individual level were split in factors associated to motivation, the job design itself, job satisfaction, and to outcomes associated to job burnout

and productivity. This phase applied a constant crosschecking process with work on motivation and satisfaction (FRANÇA, 2014), job design (MORGESON and HUMPHREY, 2006), and job burnout (MASLACH, JACKSON and LEITER, 1996).

- Creating Propositions: finally, using selective coding techniques, the analysis of factors and categories were performed, in order to find relationships among them, and to present these relationships as propositions.

3.1.6 Summary of results

In summary, this review identified 18 empirical papers presenting evidence of 17 distinct studies about job rotation in software engineering and synthesized evidence that could inform research and practice about the effects of this practice. There are two papers reporting the same study, however with different level of details, both were included in the SLR due to temporal information. These results are presented in Chapter 4.2.

3.3 CASE STUDY EXTENSION AND CASE STUDY REPLICATION

This stage consisted of two parts, an analysis extension of the data collected in the first case study (Case 1 – Reanalysis) and a replication of the study (Case 2 - Replication). The extension was based in a new process of analysis on the transcriptions of all interviews performed in Case 1. However, differently from the first stage, this analysis focused on identifying all types of factors related to the work of software engineers, not only those related to motivation and satisfaction.

Further, a replication of a study can be defined as “the repetition of an experiment, either as closely following the original experiment as possible, or with a deliberate change to one or several of the original experiment’s parameters, in order to achieve, or ensure, greater validity in software engineering research” (ALMQVIST, 2006). In this particular phase, the replication logic described by Yin (2003) was applied. Thus, the replication of the case study was performed in the first half of 2016, in the same software company where Case 1 was developed, and

using the same protocol and steps presented in Chapter 3.1. However, in this case, data was collected from a different set of software projects and from different professionals.

3.4 SURVEY-BASED RESEARCH

This phase was based in the application of a questionnaire to collect quantitative data from professional software engineers about their perceptions of the characteristics of their work and how these characteristics are related to job rotation. The main objective was the investigation of correlations among work characteristics, work outcomes, and two dimensions of job rotation: rotation intensity and job interchangeability. In this process, the definitions presented in the guidelines of Pfleeger and Kitchenhan (2001) to perform cross-sectional surveys in Software Engineering were followed. In general, this type of research can be applied to collect information about a specific topic in one fixed point in time and the information collected can provide a snapshot of the context under study.

Following the above cited guidelines, the study was designed following this set of methodological steps: Setting Objectives, Design and Evaluation of Questionnaire, Data Collection, and Data Analysis, as described below.

3.4.1 Setting Objectives

The main objective of this phase was investigate the correlations among work design factors and the practice of job rotation seeking to understand the effects of this practice on the factors related to software engineers' work by applying a quantitative method. The quantitative approach can be relevant to identify correlations not revealed before in the previous qualitative studies, and also it could allow comparisons with the previous findings.

3.4.2 *Designing and Evaluating the Questionnaire*

The questionnaire was built using tested measures and existing instruments to facilitate comparisons with related work and increase reliability, as

discussed in the guidelines (PFLEEGER and KITCHENHAN, 2001). The only exception for the use of existing instruments was in one of the measures for job rotation, for which an instrument was developed containing three items to evaluate the degree/frequency of rotation experienced by professionals (Rotation Intensity), based on the script for interviews validated in the previous case studies.

Thus, job characteristics were measured using the Work Design Questionnaire (WDQ) (MORGESON and HUMPHREY, 2006). Further, to evaluate work outcomes, existing measures for satisfaction and job burnout were applied. Satisfaction was measured using the Michigan Organizational Assessment Package, while the Maslach Burnout Inventory - General Survey (MASLACH, JACKSON and LEITER, 1996) were applied to assess Job Burnout. This inventory is composed of 16 items and measures three dimensions of job burnout: exhaustion (5 items), cynicism (5 items), and professional efficacy (6 items). Role conflict and ambiguity were also measured in this phase, by accessing two correlation variables used by Hsieh and Chao (2004) and obtained from the Role Stress Assessment of Rizzo et al. (1970).

Regarding job rotation, two sets of items were adopted to assess two dimensions of this practice. The first is related to the degree of rotation that the individual experiences in his/her job, which was named Rotation Intensity (RI). For this dimension, a new instrument was created with three response items based on the interview script of the case studies previously performed. The second dimension is related to how easy or difficult it is to rotate individuals in a job or task. For this dimension, the Van de Ven and Ferry (1980) Job Interchangeability measure (JI) was applied. This measure was also used by Hsieh and Chao (2004).

To build the complete questionnaire for this phase of the research, Portuguese validated versions of each instrument were accessed. These versions were validated in previous studies performed in different research fields. As recommended in the guidelines, a pilot study was performed to validate the complete instrument. This pilot was performed with 16 participants, among software engineering professionals and researchers. Results of the pilot test were used to

clarify the wording of some sentences in the context of software engineering, when necessary.

Next step was to test the reliability and construct validity of all factors presented in the questionnaire on a sample of 77 professional software engineers and the results were published by da Silva et al. (2016). The validated instrument was applied in this current study and it is presented in Appendix VI. Further, all individual and original instruments are available in each of the cited studies (MORGESON and HUMPHREY, 2006; MASLACH, JACKSON and LEITER, 1996; HSIEH and CHAO, 2004; RIZZO et al., 1970; VAN DE VEN and FERRY, 1980. Table 4 presents the validation of measures obtained from the sample of this study.

Table 4 - Means, Standard Deviations, and Reliability

Construct	*M*	*SD*	*α*
Task Characteristics			
Work scheduling autonomy	3,69	0,79	0.70
Decision-making autonomy	3,61	0,8	0.77
Work methods autonomy	3,66	0,78	0.76
Task variety	3,96	0,74	0.82
Significance	3,96	0,82	0.80
Task identity	3,82	0,75	0.72
Feedback from job	3,39	0,92	0.83
Knowledge characteristics			
Job complexity	3,61	0,74	0.62
Information Processing	4,18	0,59	0.66
Problem solving	3,85	0,66	0.55
Skill variety	4,11	0,71	0.84
Specialization	3,93	0,65	0.67
Social characteristics			
Social support	3,89	0,71	0.78
Initiated interdependence	3,51	0,85	0.71
Received interdependence	3,43	0,81	0.66
Interaction outside organization	3,11	1,14	0.86
Feedback from others	3,17	0,97	0.81
Job Rotation			0.66
Rotation Intensity	2,67	0.77	0.52
Job Interchangeability	2.87	0.76	0.52
Outcomes and Correlates			
Job Burnout	2,05	0.59	0.85
Role Conflict	2,47	0.76	0.78
Role Ambiguity	2,06	0.70	0.88
Satisfaction	4,19	0.79	0.78

3.4.3 Procedure and Sample

Two strategies were applied to increase the number and diversity of respondents in this phase. First, the same strategy used by Morgenson and Humphrey (2006) in the development of the WDQ was applied. A group of postgraduate students (master and doctoral levels) who were attending a course on empirical methods in software engineering at the Federal University of Pernambuco were invited to participate in the data collection as part of their training in data collection techniques. Each participant from a class of 20 students was assigned with the task of applying the questionnaire on five software engineer professionals in different companies. No restriction was imposed on the companies, but they were required to identify professionals with a minimum of five years of experience.

Diversity in the professional and academic background of the group of students helped to reach 39 distinct commercial software companies located in three different cities in Brazil. The questionnaire was applied using an online form, and the link to the instrument was sent only to the invitees. Over 100 emails were sent with the survey to distinct professionals following the invitations performed by the students. As a result, a total of 89 valid answers was collected, that is, an 89% response rate.

Parallel to this, the questionnaire was sent to software engineers working in a software company located in Recife, Brazil. At the time of data collection, the company had over 120 employees, of which 75 individuals were working in activities directly related to software development in more than 16 simultaneous projects. The link with the questionnaire was sent to all the individuals directly working with software development, and answers were obtained from 36 individuals (48% response rate). All answers were complete and, thus, used for data analysis.

3.4.4 Data Analysis

The data analysis process was similar to those applied by Morgeson and Humphrey (2006) and da Silva et al. (2016) using Spearman’s ρ correlation. Thus, all scales were considered to be interval, supported by the argument of Carifio and

Perla (2007) about Likert scales and Likert response items. The efforts were directed to understand how the work design factors were co-related to the items that measured the two dimensions of job rotation presented in the questionnaire.

3.4.5 Summary of Results

By the end this phase, the sample was composed of 126 individuals. Although the sample strategy does not allow a statistical generalization to a well-defined population, the results support analytical generalization and hypothesis building that can be used to inform practice and guide future research. The results of this phase are presented in Chapter 4.4.

3.5 SYNTHESIZING EVIDENCE FROM MULTIPLE SOURCES

The fifth phase of this research consisted on a meta-ethnography synthesis (DA SILVA et al., 2013; NOBLIT and HARE, 1988) performed to consolidate the results produced in the case studies, the SLR and the survey, as described below:

- **Deciding what is relevant for the synthesis**: Methodologically, the studies that would be included in the synthesis were selected. In this case, the case study and its extension and replication, the SLR and the quantitative study are part of this stage in the meta-ethnographic synthesis.
- **Reading the Studies**: This phase involved carefully analysis of the findings from each study to identify the key concepts addressed in the studies through repeated reading and noting of the main concepts observed.
- **Determining how the studies are related**: In this phase, the relationships between the different studies were observed and their findings were put together and compared.
- **Translating the studies into one another and raising theoretical level**: During this phase, the concepts of one study were translated into the concepts of another, considering studies as analogies, i.e. findings in one study are identical to findings in the other studies, which also consider non-similarities, for instance, when two different individuals consider two different

effects in the same factor, e.g., the effect is consider negative for one and positive for another. An adequate translation preserves the meanings of concepts in each study, while compares the meanings of concepts from one study with those from the others. In general, concepts from the studies can compare with each other in three ways: (i) they are directly comparable as reciprocal translations; (ii) they may contradict or stand in opposition to one another as refutational translations; (iii) taken together they may represent a line-of-argument. In this synthesis, only cases of reciprocal translations were found.

Table 4 present an example of how the translation of the concepts related to Task Variety and Skill Variety was built.

Table 5 - Meta-Synthesis Process

Case 1	SLR – SwEng (P2P)	Case 1 (Extension)	Case 1I (Replication)	Concept from Literature	Synthesis of the Concept
Work Variety "(...) It's really good (job rotation) because one can **work with several different things**." [PB-IN11] "(...) I think this is great (job rotation)! I think it's good because you know you'll have the opportunity to **work with new and different technologies**." [PA-IN02] "…, **there is no other thing (task) for me to do**? I'm doing this for such a long time'…" [PB-IN08]	**Task Variety** "Job rotation may help to increase the **variety** and challenge of IS development **work**." [JOB11] "Job rotation strategies could accommodate the different individual aspirations related to task variety." [JOB08]	**Work Variety (T)** "I would be like, 'man, **there is no other thing (task) for me to do**? I'm doing this for such a long time'…" [PB-IN08]	**Work Variety (T)** (...) **I can't work for too long doing the same thing**. So, I need to be moving (job rotation). [PD-IN26]	**Task Variety** "Task variety refers to the degree to which a job requires employees to perform a wide range of tasks on the job. As such, it is similar to notions of task enlargement discussed in the literature" (MORGESON AND HUMPHREY, 2008).	**Task Variety** In software engineering, Task Variety refers to the scenario in which software engineers can perform a wide range of tasks. Thus, Task Variety is related to the role performed in the project. For instance, a developer that is assigned to perform tests activities or an analyst that also team leader.
		Work Variety (S) "(…) Good (job rotation). Especially if this rotation allows you to **work with a different technology**. [PA-IN04] "**I don't want** to spend the rest of my life **working with computer graphics** (same technology always)." [PB-IN12]	**Work Variety (S)** "(...) (job rotation) allows one to **know different types of projects, different types of technologies** ... [PD-IN27]	**Skill Variety** "Skill variety reflects the extent to which a job requires an individual to use a variety of different skills to complete the work" (MORGESON AND HUMPHREY, 2008.	**Skill Variety** In software engineering, skill variety refers to the diversity of different skills that the software development process requires from professionals. Thus, Skill Variety is related to the variety of technology or process related issues. For instance, the ability to work with backend and with interfaces, or the ability to fit in different domains using new technologies.

From left to right, columns 1-4 present the concepts extracted from each study used in the synthesis (in this case, work or task variety was identified in all four studies). The fifth column presents the concept definition from the literature. In the example, the concepts of Task Variety and Skill Variety were extracted from the work of Morgeson and Humphrey (2008). The sixth column shows the synthesis of the concept that aggregates the results of all studies, after checked for consistency with the concept definitions from the literature (column 5).

In this process, Case 1 and SLR identified concepts related to Work or Task Variety. Comparing these two studies showed that the concepts were similar and, thus, supported synthesis through reciprocal translation. As results from Case 1 – Extension and Case 2 – Replication, which provided richer qualitative information, were added, it was possible to noticed that participants were describing two different types of variety. First, some participants referred to variety related to performing different software engineering tasks, such as requirement analysis and coding, which is consistent with the interpretations of Task/Work Variety from Case 1 and SLR (labeled Work Varity (T) where T stands for Task). Second, participants also referred to variety related to use of different skills and technologies and to work on different application domains (labeled Work Variety (S) where S stands for Skill). The quantitative study did not provide any type of evidence about this factor.

At this point of the synthesis, the literature about work design was checked in order to set definitions of work characteristics that would explain these two types of variety. The study of Morgeson and Humphrey (2008) consolidated over 50 years of research on work design and their model distinguishes Task Variety (a task characteristic of the work) from Skill Variety (a knowledge characteristic of the work). The definitions of these two concepts, presented in the fifth column, are consistent with the two types of variety described by the participants. Therefore, Skill Variety was added to the list of factors related to job rotation.

Definitions for each factor synthesized from the five studies were built, while the definitions from the literature (column 5) were checked and compared with the coding of the concepts resulting from the studies (columns 1-4), enabling the definition of concepts that synthesizes the findings in column 6.

Finally, the interaction among job rotation and the final list factors, along with their impact on the work of software engineers, was used to develop a model that could be used in practice to plan, conduct and evaluate the use of job rotations in software companies. The use of such scheme might be effective to enable the use of this practice in software industry, in order to maximize its positive effects and avoid its problems and limitations depending on each specific scenario. This scheme was validated in a new qualitative study (Specialist Verification) planned and performed in a small scale, if compared to Cases 1 and 2, but yet, effective enough to check the proposed model.

3.6 SPECIALIST VERIFICATION

In this phase, an experienced software manager who systematically planned and performed project-to-project rotation in a large company was invited to participate. This interviewee did not participated in any of the previous phases of this research. His company had a partnership with an international mobile phones company to develop and test new products, while maintained current products already launched. By the time of data collection, the company had over 70 professionals, working in different projects, whereas each project represented a different product, and the software manager who participated in phase was in charge of all rotations.

In general, the Specialist Verification phase consisted in a 1 hour interview where the process of project-to-project rotations was debated, the results of such rotations were explored and cases of success and failures were discussed. This interview was conducted in two parts:

- Part 1: The participant commented about his work, considering how a rotation is planned, executed and evaluated. While he spoke about his experience, he was asked to describe a complete rotation from its beginning to the end, highlighting reasons to performing it, pointing out variables to be considerate, and commenting what work-related factors the rotations might affect. While the interview evolved and the participant commented the

process of job rotation in software teams, the model was checked in order to visualize its coverage, and the coverage of the theoretical background developed in this research, by comparing it with the examples that the participant provided.

- Part 2: After comparing the real situations commented in the interview with the general scheme and checking the existence of all factors and relations identified in this research, the final model built in this work was revealed to the interviewee and he was asked to evaluate the scheme, in terms of completeness, ease of use, and relevance to his context.

The interview was recorded and the results of the coding process, including descriptive quotations, are presented in Chapter 4.5.

3.7 THREATS TO VALIDITY

Regarding threats to validity, an interpretative epistemological perspective was carried, as discussed by Merriam and Tisdell (2016). In this perspective, construct validity is related to the precise and clear-cut definition of constructs that is consistent with the meanings assigned by the research participants. In this research, this notion of validity extends to the consistent meaning of the constructs across the different studies, where comparisons among the concepts meanings in each study and definitions from the literature were carried out through the meta-ethnographic translations.

Considering Internal validity, or credibility, maximum variation of information was accessed by collecting data from participants in different projects, with different roles, and with different perspectives regarding rotations. Further, regarding the case studies results, member checking techniques were applied to ensure that the interpretations in the results were consistent with those from the participants and whenever the meaning assigned by the participants differed from the literature, these interpretation were double-checked until a consistent definition was reached.

A limitation of this research is the fact that all studies were developed in the context of Brazilian software organizations, which means that different cultural practices and issues might have influenced the results. The Systematic Literature Review was used to mitigate this threat by adding evidence from other countries and different types of organizational context. Nevertheless, generalization of results to a large population cannot be claimed in a positivist perspective. Instead, consistent with the interpretative perspective, the use of multiple sources of data and research methods supported good analytical generalization. In this sense, researcher and practitioners can learn from these results and decide to what extent the findings can be applied or transferred to other contexts.

4 RESULTS AND DISCUSSIONS

This chapter presents the findings of each individual study, followed by the results of the meta-ethnographic synthesis, the construction of the model and the specialist verification process. These results were obtained, consolidated and published over time. The results of the specialist verification were not yet published, as this was the last phase of this research. In summary, Case Study 1 was previously performed for a Master Dissertation (SANTOS, 2015) and posteriorly its results were refined and published (SANTOS et al., 2016), then added the present research. Following Case1, the systematic literature review was performed and posteriorly published (SANTOS, da SILVA and MAGALHÃES, 2016). Then, Case 1 – Reanalysis and Case 2 – Replication were developed and published in Santos et al. (2017). Finally, results from the Survey-Based Research were recently presented to the research community (SANTOS et al., 2019). In conclusion, each study provided an input to the next phase and the consolidation of the whole group of studies enabled the developed of the model proposed in this research.

4.1 CASE STUDY 1

Case 1 was performed in a Brazilian software company, founded in 1996. By the time of the case study, the company had just over 500 employees of which about 70% worked directly in software development. The company executed an average of 50 projects concurrently in various business areas, and it had a typical hierarchical organizational structure. Software development division was headed by the Chief Operation Officer (COO) and supported by a Project Management Officer (PMO). Both COO and PMO were in charge of resource allocation for all projects and also job rotation, with support from the Human Resources department.

The results of this case can be divided in two distinct but interrelated parts. In the first part, project and human resources managers were interviewed and documents were accessed in order to determine and characterized a P2P rotation

in the context of software companies. As stated in the early stage of this research, both types of rotation can be used in software companies. However, literature presented wispy evidence about how such rotations, especially those performed among teams and projects/products. Therefore, the first contribution of this research was a general characterization of job rotation in software engineering.

4.1.1 Characterizing Project-to-Project Job Rotation in Software Projects

To characterize P2P rotations in software companies a group of project and human resources managers that have deployed P2P rotations were interviewed to understand how rotations worked in practice in software development projects. The information collected in the interviews was contrasted with documents about previous rotations provided by the company, and then, compared and contrasted with definitions from the literature. Following this, the characterization was built considering five elements, described below and illustrated in Figure 7.

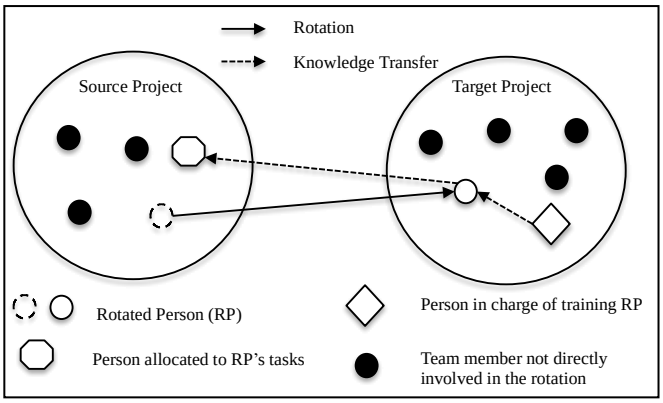


Figure 7. Illustration of a P2P Rotation

Definition – P2P job rotation is defined as the practice of moving one professional from one software project (the "source project") to another project (the "target project) within the organization. In most situations, the role (software engineer, test engineer, team leader, software architect, etc.) performed by the rotated person remains the same. However, this role could change under various circumstances, e.g., when a test engineer changes to the role of a software engineer to fulfill a resource need in the target project.

Agents – individuals in the organization who participate directly in one rotation: (MCR) manager in charge of the rotation; refers to the senior or project manager that implements the rotation; (RP) the rotated person that moves from source to target project in a rotation; (RPH) the rotated person host is the individual (or group of individuals) in charge of training RP in target project; (RPR) the rotated person replacement is the individual (or group of individuals) assuming RP's tasks in source project.

Triggers – a P2P rotation is triggered by three reasons: (1) target project needs: when the target project requires more manpower (quantity) or different set of skills (diversity); (2) source project needs: when the performance or skills of the rotated person is not compatible with the requirements of the source project and the person is rotated to a target project with more compatible performance or skill requirements (in such cases, the source project would potentially become a target project due to trigger 1); (3) individual request: an individual manifests the desire to change projects. Triggers 1 and 2 are related to organizational needs whereas trigger 3 addresses individual motivation and satisfaction needs.

Tasks – several tasks are directly related to the rotation. They are temporary and not directly related to the end tasks of the project. In fact, they support the rotation and create new workload on project managers and some team members at target and source project. These tasks are mostly planned and supervised by MCR: identifying the trigger, agents, source, and target project involved in the rotation; communicating the rotation to agents, source, and target project, potentially including projects' clients; actually moving the RP to target project; assigning tasks to RPH to train RP in the new project, if needed; assigning tasks to RPR to assume RP's tasks in source project, if needed.

Moment of rotation – a rotation can occur at any moment while the project is under execution.

This initial characterization helps to distinguish P2P rotations from other types of resource allocation. For instance, when a project finishes it is natural that the members of the project are allocated to new projects. Therefore, this research

do not consider this re-allocation as a P2P rotation because several potential impacts (negative and positive) of rotation do not occur in this type of re-allocation. Further, this characterization also identifies agents that might have different perceptions of benefits and limitations of rotations, which becomes important when analyzing the research findings. This initial characterization is important as an input to be modified and improved in the final model resulting from this research.

4.1.2 Effects on the Motivation and Satisfaction of Software Engineers

After characterizing job rotation in software companies, based on the experience of experienced software project managers and human resources analysts, the next step in this case study was to collect data from software engineers, that is, the professionals that actually experience the effects of this practice. Thus, the effects of P2P rotations were investigated from the perception of two groups of software engineers sampled from two software projects from the company portfolio. At this point, it is important to state that each project represents a software product under development. The participants of this study were samples from the two projects characterized as follows:

- Project A – this team was developing a web-based system for a multinational logistics company. At the time of data collection, the project was running for 2.5 years. The project team was composed of 13 professionals. An amount of 7 individuals participate in this study: one project manager, four software engineers, one test engineer, and one technical team leader were interviewed in this research. Project A used an Agile process based on SCRUM.
- Project B – this team was developing a 3D visualizer for a multinational printer company. This was an innovation project with the objective of creating and implementing new products. An amount of 7 individuals participate in this study: one project manager, four software engineers, one test engineer, and a technical team leader were interviewed in this research. Project B also used an Agile process based on SCRUM.

From each of the two projects, participants were purposively selected in order to achieve a large variation in data collection, as summarized in Table 6.

Table 6 - Profile of Participants

Projects	PA	PB
Team Roles	4: Software engineers 1: Test engineer 1: Team Leader 1: Project Manager	4: Software engineer 1: Test engineer 1: Team Leader 1: Project Manager
Genders	6: Males 1: Female	6: Males 1: Female
Ages	3: < 25 3: 26 – 35 1: > 36	1: < 25 4: 26 – 35 2: > 36
Education	3: Undergraduates 1: Technician 2: B.Sc. 1: M.Sc.	1: Undergraduates 3: B.Sc. 3: M.Sc.
Time in the job	1: < 3 years 4: 3 – 5 years 2: > 6 years	2: < 3 years 3: 3 – 5 years 2: > 6 years
Experience with rotation	3: Never rotated 2: Rotated 1 or 2 times 2: Rotated > 3 times	1: Never rotated 4: Rotated 1 or 2 times 2: Rotated > 3 times

Considering the impacts of job rotation in their work, the participants reported work related factors that were directly affected by job rotation according to their perceptions. As most of the factors were converging in direction of recent theories of motivation and satisfaction of software engineers, the data was analyzed through the lenses of such theories. Hence, the analysis considered mostly the potential effects of job rotation on work factors related to motivation and satisfaction, along with the perception of participants regarding the importance or impact of each factor on their work. The list of work-related factor affected by job rotation and identified in this phase of the study is summarized in Table 7 and discussed below.

Table 7 - Benefits and Limitations – Case 1

Factor	Effect of job rotation on factor	Impact of factor on the work	Benefit/Limitation
Work Variety	+	+	Benefit
Knowledge Acquisition	+	+	Benefit
Knowledge Transfer	+	-	Limitation
Well-defined Work	-	+	Limitation

Feedback	-	+	Limitation
Performance	-	+	Limitation
Workload	+	-	Limitation

Job rotation provided software engineers the opportunity to work with a wide diversity of projects and technologies. Therefore, job rotation helped to create a working environment that is rich in *Work Variety*, which was positively valued by software engineers:

"(...) It is very good because one is going to work with several different stuff."

Participants also perceived the lack of variety at work as being negative, reinforcing the positive value of Work Variety:

"… I can't stay in the same project for long."

Job rotation also created opportunity for the rotated person (RP) to acquire new knowledge (*Knowledge Acquisition)*, both technical and business related, increasing professional experience and skills regarding technologies, process, tools, business domains, etc. Knowledge acquisition was also perceived as positive for the job, emphasizing the constantly changing nature of the technologies and practices in software engineering:

"(...) I think it is good because you know you will have the opportunity to learn."

A rotation could happen at any point in the life cycle of a project. Therefore, individuals could be transferred to a new project before completing their assignments in the source project. Two effects of this characteristic of the job rotation practice were identified. First, participants emphasized that when they were rotated and left unfinished assignment, they still had to perform some activities in their previous project, mostly to transfer knowledge about their prior tasks:

"You will keep supporting the previous project. So you will have to help that person on what you were doing"

Job rotation, thus, creates the need for *Knowledge Transfe***r** and the RP perceived no positive effect on her work. A second effect of rotating a person before the end of the project or the person's assignments was the perception that they were not developing a *Well-defined Work*. Participants emphasized that they liked to perform complete tasks, i.e., from start to end, before moving to another project:

"I would not say it [job rotation] would be good. Because it is good when you do something and finish it".

"During the on-going project, if I'm moved, then I would be mad, because I'll get that feeling that my work remains unfinished."

Participants felt that job rotations could negatively impact the *Feedback* provided by managers and team leaders about their performance. They felt that managers and team leaders did not have enough information about their performance or capabilities at work because they were frequently moving between projects, as emphasized by this participant:

"... There are some guys who had to wait too much time to get a good feedback because they were always switching between projects".

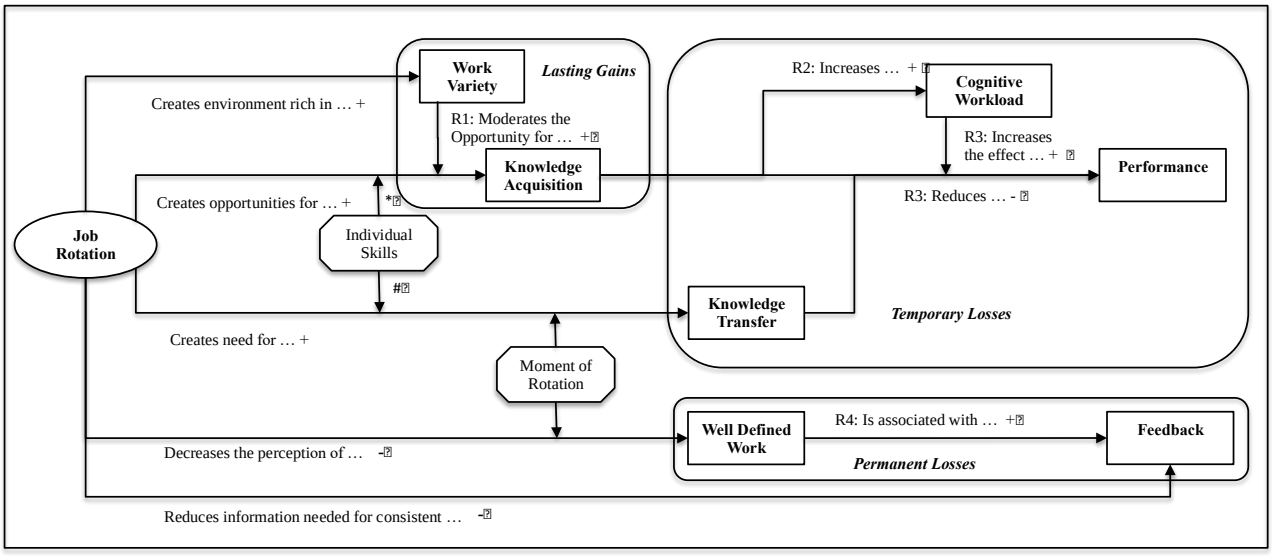
Finally, participants pointed out that job rotation had a potential negative impact on the *Performance* of all three individuals directly involved in the rotation (RP, RPH, and RPR). Therefore, job rotation had a potential negative effect on performance, as seen in the following quotes:

"It is always traumatic [job rotation]. You end up having loss of performance" [point of view of the RP].

The evidence found in this phase supported the contention that there are several complex interacting effects among the factors potentially influenced by P2P rotations. In particular, a tension must be managed. On one hand, there might exist short term loses of performance due to increase of workload on the agents involved in the rotations. On the other hand, the increase in work variety and knowledge acquisition tend to produce long-term gains to those involved. Therefore, the central

element that seems to balance this tension is the amount of variety that is included in the rotation. Too much variety will increase the short-term negative effects and potentially lead to job burnout, whereas too little variety will not reap the long-term motivational benefits.

Based on these observations an initial model was developed, as presented below in Figure 8. Although it explains a great amount of the complex process of planning and performing rotation, there is still the problem related to how to understand the interaction among factors in order to balance the tension observed in this process. Therefore, more data needed to be collected in order to improve the preliminary model and enlarge the body of knowledge in order to improve industry practice.



* Rotated Person (RP) # Person allocated to RP's tasks

Figure 8. Effects of Job Rotation in Software Engineers Work - Initial Scheme

4.2 SYSTEMATIC LITERATURE REVIEW

The SLR was performed in order to identify evidence regarding how job rotation affected the work of software engineers in practice. As stated before, the literature presented only one paper discussing job rotation in software companies.

Nevertheless, different from this research, the study was developed in the context of J2J rotations. However, the literature on software engineering is vast enough to hold further information about this theme, even when the main goal of the studies is not job rotation itself. Therefore, a SLR was efficient to identify such evidence published in the software engineering literature over the years. Thus, through the process of SLR 18 research papers, reporting 17 studies, published between 1997 and 2014 were identified, as shown in Table 8.

Table 8 - Summary of Selected Papers

Year	Study Ref.	Source	Process Type
1997	[JOB02]	Conference	Traditional
2001	[JOB17]	Conference	Traditional
2003	[JOB03]	Journal	N.D.
2004	[JOB05]	Journal	Traditional
2004	[JOB11]	Journal	N.D.
2007	[JOB16]	Journal	N.D.
2008	[JOB12]	Conference	N.D.
2009	[JOB06-JOB07]	Conference	Agile
2009	[JOB14]	Journal	Agile
2010	[JOB10]	Conference	Both
2010	[JOB18]	Journal	N.D.
2011	[JOB13]	Conference	Agile
2012	[JOB08]	Conference	Traditional
2012	[JOB09]	Conference	N.D.
2012	[JOB01]	Conference	N.D.
2013	[JOB04]	Journal	Both
2013	[JOB15]	Conference	Agile

N.D.: Not described in the study.

Appendix III presents the reference list including these articles, using the label [JOBnn]. These studies have no direct link among them and no cross references were found among the papers. It was possible to observe that even when the researchers came from the same country and in, some specific cases, from the same organization, the studies and their results have no connection.

As expected, most studies were not focused on job rotation as the main topic or goal of the research, with an exception of one study reported in two papers [JOB06-JOB07]. The remaining studies presented and discussed benefits and limitations of job rotation obtained as collateral or secondary results while other topics were being explored as their main goal. No explicit definition of job rotation or

a classification was provided in the primary studies. Therefore, to classify the studies the operationalization of the practice was analyzed and compared with the definition of Woods (1995), namely, job-to-job rotation (J2J) or project-to-project rotation (P2P), which also can represent the rotation among the development of different software products. Thus, the papers were classified in two categories, whether their focus was on J2J or P2P rotations (Table 9).

Table 9 - Classification of studies according to the type of job rotation

Type of Rotation	Study Reference
J2J	[JOB04], [JOB05], [JOB06-JOB07], [JOB10], [JOB16], [JOB18]
P2P	[JOB01], [JOB02], [JOB03], [JOB08], [JOB09], [JOB11], [JOB12], [JOB13], [JOB14], [JOB15], [JOB17]

Of the first results obtained in this SRL demonstrated that one-third of studies (6/17) were performed in a context where the rotation of software engineers occurred between software development operations and a different department in the same organization (J2J). This means that the individuals who worked in software development were rotated to other organizational areas to perform jobs different from those they were performing before, to achieve several organizational objectives, such as understanding about the business or the organizational structure and dynamics.

The remaining papers (11/17) reported studies of P2P rotations. In these cases, individuals were rotated to projects with different types, sizes, and even locations to collaborate with different teams. This type of rotation occurred in two ways:

- The rotated individual kept the same task or a similar task performed in the previous project;
- The rotated individual was assigned to a different task. For instance, developers being rotated to perform software requirements analysis or testing.

Considering the specific scenario of P2P rotations, which is the scope of research study, Table 10 summarizes the motivations or goals for the use of P2P rotations as described in the primary studies.

Table 10 - Goals for the use to job rotation

Goal	Studies about P2P Rotations
More Effective Communication	[JOB01], [JOB03], [JOB12],[JOB15], [JOB17]
Knowledge Exchange/Transfer	[JOB09], [JOB12],[JOB13], [JOB14],
Task Variety	[JOB02], [JOB08], [JOB11]

Nearly half of the studies mentioned that one of the goals of P2P rotations was to enhance or facilitated *More Effective [Enterprise-wide] Communication*. In this case, job rotation could be used to develop inter-team communication, enabling and stimulating the formal or informal contact among individuals that worked in different projects (or products). This would, in term, create and improve networking among individuals across the organization and consequently provide support for knowledge exchange and social interactions among individuals, which are motivation and satisfaction related factors. As a potential secondary effect, software teams could become more flexible and adaptable to change. An example of evidence is presented below:

"Job rotation …, may be an effective way of maintaining this vital link [among individuals]." [JOB17]

To increase or facilitate *Knowledge Exchange/Transfer* was another effect reported as a goal in just over a third of the studies. The exchange of technical knowledge resulting from P2P rotations supports the sharing of understanding about practices, artefacts, and tools among people from different projects, both in local and in distributed teams. The following excerpt from [JOB09] illustrates this goal:

"(…) proposes that job rotation be enforced from one project team to another and states that part of the knowledge and experience acquired from a prior project team may be transported to the new team." [JOB09]

Finally, the use of job rotation to increase *Task Variety* was observed in three studies. Task variety is a work design factor by which individuals are assigned a diversity of different activities. In the context of software companies, it means that job rotations could allow software team members to work in different software engineering tasks, such as requirements, development, or testing, increasing competencies and job experience, as demonstrated below:

"Job rotation strategies could accommodate the different individual aspirations related to task variety." [JOB08]

Further, the primary studies obtained in the SLR were analyzed to understand the effect of job rotation as positive or negative, regarding to observe benefits of limitations of P2P rotations. Table 11 summarizes this evidence. Below, there is a description of each of the benefits, which are also compared with the goals reported above. In this analysis, three situations were identified: (1) goal and benefits matched, (2) goal was not achieved, and (3) a benefit was achieved without being an explicitly stated goal (side effect).

Table 11 - Benefits and Limitations of P2P rotations – SLR

Factor	Effect of job rotation on factor	Impact of factor on the work	Benefit/Limitation
Organizational Level			
Communication (*new*)	+[JOB01]+[JOB03] +[JOB12]+[JOB17]	+	Benefit
Difficult to Plan (*new*)	+[JOB15]	-	Limitation
Time Consuming (*new*)	+[JOB09]	-	Limitation
Workgroup and Work Process Level			
Knowledge Exchange (*new*)	+[JOB09]+[JOB12] + [JOB13]	+	Benefit
Team Flexibility (*new*)	+[JOB14] +[JOB15]	+	Benefit
Individual Level			
Task Variety (Case 1)	+[JOB02]+[JOB08] +[JOB11]	+	Benefit

The SLR demonstrated that the most cited benefit of job rotation was to support or enable *More Effective Communication* among individuals, improving networking and the relationships among employees. This is consistent with the goals stated in the studies. Effective communication is a benefit itself and also an

essential enabler of other benefits such as knowledge exchange. Among the studies that reported *More Effective Communication* as one of the goals for the use of job rotation, only the study reported by [JOB15] did not report the benefit.

The support for *Knowledge Exchange/Transfer* and the creation of *Task Variety* were the second most cited benefits, in three studies. Regarding the use of *Knowledge Exchange/Transfer*, the study reported in [JOB14] did not report the benefit although it was stated as a goal. The creation of *Task Variety* was reported as a benefit by the three studies that also stated this factor as a goal with the use of job rotation.

Only two studies did not report the achievement of their stated goals. These studies, reported in [JOB14] and [JOB15], cited the increase in *Team Flexibility* as the observed benefit of the use of job rotation. It is possible that in both cases, the increase of team flexibility was influenced by more effective communication and exchange of technical knowledge, but the studies did not explicitly mentioned these benefits.

Only two studies reported limitations associated to P2P rotation. One of them reported that implementing the practice was *Time Consuming,* in particular for software project managers or project management office in general. In the other one, P2P rotations were considered *Difficult to Plan* in order to achieve desired goals [JOB15]. Between these two studies reporting limitations, only [JOB15] did not achieve the expected goal, but reported a secondary benefit of the practice, as explained above.

This SLR demonstrated that the limitations were not strong enough to prevent goals to be achieved, although this required further investigation, since the studies did not have job rotation as the main goal. In other words, it also revealed the need for the development of more primary studies, to collect evidence from industry, in order to identify possible additional limitations not reported so far, and also, to plan techniques and approaches to avoid or inhibit boundaries among the practice and the achievement of the maximum appreciation of its benefits. These were obtained in the next phases of this research.

4.3 CASE STUDY REANALYSIS AND REPLICATION

The case study and the SLR developed in the initial phases of this research presented only one factor in common: *Task/Work Variety*. Both studies agreed on the direction of the relationship, considering Task Variety as potential benefit of P2P rotations. Further, Task Variety was the only individual level characteristic found in the SLR, indicating that software engineering studies have not focused on individual and social work characteristics, contrasting with the case study and also with the literature from other research fields discussed in Section 2.

This scenario prompted for two new directions for this research. First, to perform a broader analysis of the data collected in Case Study 1 seeking to identify factors that were ignored before due to the focus on motivational aspects. Second, to produce further primary qualitative and quantitative evidence from new empirical studies in software engineering to increase the strength of the evidence.

4.3.1 Case Study Extension and Re-analysis

A reanalysis in the data collected in Case 1 aimed to identify all the possible benefits and limitations of job rotation observed in the field and not only those directly related to motivation or satisfaction. This process resulted in seven new factors not previously found. Among these seven factors, two were found in the SLR and five are new findings from this reanalysis: two new benefits, two new limitations, and one factor that was classified as both benefit and limitation. These benefits and limitations were grouped in three levels, same as those in the SLR to facilitate comparisons. Table 11 shows all benefits and limitations identified in this phase.

Table 12 - Case Study Reanalysis

Factor	Effect of job rotation on factor	Impact of factor on the work	Benefit/Limitation
Organizational Level			
Communication (SLR)	+	+	Benefit
Workgroup Level			
Knowledge Exchange (SLR)	+	+	Benefit
Knowledge Transfer (Case 1)	+	-	Limitation
Feedback (Case 1)	-	+	Limitation
Social Conflicts (*new*)	+	-	Limitation
Individual Level			
Work Variety (Case 1)	+	+	Benefit
Knowledge Acquisition (Case 1)	+	+	Benefit
Workload (Case 1)	+	-	Limitation
Well-defined Work (Case 1)	-	+	Limitation
Motivation (*new*)	+	+	Benefit
Job Monotony (*new*)	-	-	Benefit
Social Interaction (*new*)	+/-	+	Benefit/Limitation
Cognitive Effort (*new*)	+	-	Limitation
Performance (Case 1)	-	+	Limitation

The reanalysis demonstrated that the participants see *Motivation* as one of the outcomes of job rotations, because the movement among projects can give them new opportunities of personal development, dynamism, and new challenges. Further, some of the factors identified so far, e.g. work variety and acquisition of knowledge, are also closed related to motivation, following the existing motivation theories (FRANÇA, 2014).

"(…) The dynamism (of rotations) is positive to the motivation, because it brings new stuff."

Job rotation is also perceived as a practice that reduces the *Job Monotony* at work, which might help to reduce boredom and other factors that can demotivate the individual in relation to the job.

"(…) I liked it (job rotation). Because it changes my everyday work, it changes what I normally do."

"(…) Normally, people like change. In my opinion, most of the people like when things change."

On the other hand, there are new limitations associated to the practice of job rotation identified in the reanalysis. One of these limitations is the *Cognitive Effort* required to equalize the need for new knowledge necessary for the new assignments.

"(…) My knowledge about the project was too little, so I had to work hard on that (to fulfil that lack of knowledge after the rotation)"

"The rotated person will have to study really hard for like… a month, or two months, to start to understand the project."

These limitations associated to the practice the job rotation can cause internal conflicts in the project. Interviewees reported that the frequent movement of individuals could cause *Social Conflicts* among professionals in the team, as exemplified below:

"Man, you try and try, and try to help, but the person don't want to be helped. (...) So, most of the times we just don't care about her."

"(…) Sometimes the team is not so friendly, because they were used to work with the other guy."

Finally, the *Social Interaction* can be positively or negatively affected by the rotations, in the sense that individuals can start, keep or drop contact with co-workers when they are moved among projects, as shown below:

Benefit - *"You'll start to work in a new project, with new people, so you end up starting new relationships. I think this is important."*

Limitation - *"It's negative, when you lose contact with people that you used to work with."*

4.3.2 Case Study Replication

Following the reanalysis, in order to enlarge the body of knowledge or achieve data saturation, Case 2 – Replication aimed to collected and analyzed new data of two different projects in the same software company where Case 1 was

performed. The new projects participating of this phase of the study are described below.

Project C – this team was developing a web-based system for a multinational company. Details about the type of system were not provided by interviewees, due to confidentiality issues. At the time of data collection, the project was running for 3 years and the team was working on the development of new features, fixing bugs, and working on the performance improvements. This team was composed of 11 professionals: One project manager, one technical team leader, one designer, two test engineer and six software engineers. Project C used an Agile process based on SCRUM.

Project D – this team was working on a research project, investigating algorithms to perform image-based search. The team worked in identifying these algorithms in the literature and implementing them to validate the results with the customer. At the time of data collection, the project was running for 3 years and the team was composed by one project manager, one technical team leader, and five software engineers. Project D also used an Agile process based on SCRUM.

Similar to Case 1, participants with different profiles and background were selected from each project aiming to achieve large variation in data collection, as presented in Table 13.

Table 13 - Profile of Participants

Projects	PC	PD
Team Roles	3: Software engineers 2: Test engineer 1: Designer 1: Project Manager	5: Software engineers 1: Team Leader 1: Project Manager
Genders	6: Males 1: Female	5: Males 2: Female
Ages	3: < 26 2: 26 – 35 2: > 36	1: < 26 4: 26 – 35 2: > 36
Education	2: Technician 4: B.Sc. 1: M.Sc.	1: Technician 5: B.Sc. 1: PhD
Time in the job	0: < 3 years 4: 3 – 5 years 3: > 6 years	1: < 3 years 1: 3 – 5 years 5: > 6 years

Experience with rotation	2: Never rotated 2: Rotated 1 or 2 times 3: Rotated > 3 times	0: Never rotated 6: Rotated 1 or 2 times 1: Rotated > 3 times

Similar to Case 1 - Reanalysis, open and axial coding were performed on the interview transcripts looking for benefits and limitations of P2P rotations using no pre-formed codes and no existing theories. This replication found three new factors: two were found in the SLR, but not in Case 1 and Case 1 – Reanalysis; one factor was new, and is discussed below. As presented in Case 1 – Reanalysis, Table 14 shows all benefits and limitations found in Case 2 – Replication.

Table 14 - Benefits and Limitations – Case 1 - Replication

Factor	Effect of job rotation on factor	Impact of factor on the work	Benefit/ Limitation
Organizational Level			
Communication (SLR/Reanalysis)	+	+	Benefit
Difficult to plan (SLR**)**	+	**-**	Limitation
Workgroup Level			
Knowledge Exchange (SLR/Reanalysis)	+	+	Benefit
Team Flexibility (SLR)	+	+	Benefit
Feedback (Case 1/Reanalysis)	-	+	Limitation
Individual Level			
Work Variety (SLR/Case 1/Reanalysis)	+	+	Benefit
Knowledge Acquisition (Case 1/Reanalysis)	+	+	Benefit
Workload (Case 1/Reanalysis)	+	-	Limitation
Well-defined Work (Case 1/Reanalysis)	-	+	Limitation
Motivation (Reanalysis)	+	+	Benefit
Job Monotony (Reanalysis)	-	-	Benefit
Social Interaction (Reanalysis)	+	+	Benefit
Cognitive Effort (Reanalysis)	+	-	Limitation
Specialization (*new*)	-	+	Benefit/Limitation
Productivity (Case 1/Reanalysis)	-	+	Limitation

Participants emphasized the negative effect of P2P rotations on job specialization, consistent with findings from the literature (HSIEH, CHAO, 2004). All participants that mentioned job specialization in the interviews made it clear that rotations would decrease the opportunity for the individuals to specialize in a given type of task, technology, or business domain. The difference among participants' perceptions was in respect to whether this impact was perceived as a benefit or limitation. For those participants that have a positive attitude towards becoming a

specialist, this impact was perceived as a limitation on their work, as exemplified below:

"There are people that don't want to be moved. You know, some people just prefer to be specialist."

"If you are comfortable with what you are doing (becoming a specialist). Maybe this is not good (rotation)."

"You keep moving, you never get to fully know or understand anything, so in the end you are not specialist in anything."

On the other hand, some professionals seem to have a different attitude towards job specialization, as emphasized by this participant:

"I don't think it's interesting when you become a specialist. (…) So the changes are very healthy."

For those participants that do not value specialization, the impact of the P2P rotations on specialization was not perceived as a limitation, but as a potential benefit.

Participants also emphasized the rotations were Difficult to Plan, because too much effort might be required to design an effective e successful process.

"Look, it's not something easy to do (plan), (…) it is extremely subjective, and that's why I think that it do not work 100%."

The case study reanalysis and the replication enlarged the body of evidence and also increased the intersection between the findings obtained in the initial phases. At this point, only one factor found in the SLR was not identified in any of the case studies: Time Consuming. Further, the body of evidence was increased in six new factors: two benefits, two limitations, and two factors considered as both benefits and limitations. However, it was clear that the data collected through case studies were converging and saturating, since most of the participants were constantly referring to the same factors, which increase the strength of the evidence, but reduce the variability. In addition, correlations among

factors were difficult to observe in many cases. Therefore, a new study was designed in order to collect evidence by applying a different approach.

4.4 SURVEY-BASED RESEARCH

The quantitative study was performed in order to obtain a different perspective in an attempt to reach a deeper understanding of this complex phenomenon. In this phase, the main target was the correlation among factors that might not been captured or observed in the qualitative studies. To achieve this goal, a sample of 126 software engineering professionals working in 39 different companies answered to a survey questionnaire, expressing their experiences with several work-related factors and the practice of job rotation.

This sample was composed by 50% (63/126) of *Developers*, 29% (35/126) of Systems *Analysts*, 13% (17/126) of Software *Testers*, 5% (6/126) of Project *Managers*, and 4% (5/126) of UX/UI *Designer*. Regarding the experience in software industry, 26% of the sample (33/126) was working in software development for less than 5 years, 31% of individuals (39/126) had been working in this field for a period between 5 and 10 years, and 43% of participants (54/126) had more than 10 years of experience in software development. Table 15 summarizes this information.

Table 15 - Summary of Participants

			Age		**Job Experience (years)**		**Sex**
Role	**Total**	**% (N=126)**	**M**	**SD**	**M**	**SD**	**%men**
Analyst	35	28%	36,5	9,6	13,1	13,1	21%
Manager	6	5%	45,2	6,7	22,7	22,7	1%
Tester	17	13%	35,9	3,9	8,4	8,4	6%
Developer	63	50%	31,5	5,4	8,9	8,9	47%
Designer	5	4%	37,8	4,9	8,6	8,6	3%
Total	126	100%					79%

The correlations among the factors presented in the questionnaire were obtained using the statistically significant correlations of Spearmans's ρ. The same

categories used in the WDQ model constructed and validated by Morgeson and Humphrey (2006) was applied to organize and present these factors.

Below, the abbreviations RI and JI refer to the two dimensions of job rotation: Rotation Intensity and Job Interchangeability, respectively. The descriptions in the literature and in the instruments applied guided the process to access the impact of each factor on the work of software engineers. Work design theories contend that work characteristics are all beneficial to the work; therefore, the impact of all characteristics are considered as positive when determining the benefits or limitations of job rotation. On the other hand, Role Conflict and Job Burnout are associated with negative impact on the work, and Satisfaction as positive. Table 16 presents the summary of results obtained in this phase of this research.

Table 16 - Survey Results

Factors	Correlation with factor	Impact of factor on the work	Benefit /Limitation
Work Characteristics			
Task Characteristics			
Task Identity	-(RI)*	+	Limitation
Feedback from Job (*New*)	-(RI)**	+	Limitation
Knowledge Characteristics			
Information Process (*New*)	-(JI)**	+	Limitation
Social Characteristics			
Initiated interdependence (*New*)	-(JI)**	+	Indeterminate
Outcomes			
Role Conflict (*New*)	-(JI)*	-	Benefit
Job Burnout (*New*)	+(RI)*	-	Limitation
Satisfaction (*New*)	-(RI)*	+	Limitation

* $p < 0.05$; ** $p < 0.01$ (two tailed)

Regarding the two measures of job rotation accessed in this study, there are important difference between them and their role during a rotation. *Rotation Intensity* is a measure related to the frequency of one's rotation, which reflects how frequently an individual is being moved among different teams, and therefore, how the rotation planning process is defining the right moment to rotate this individual or another individual in the team.

On the other hand, *Job Interchangeability* states the level of interchange between tasks, especially regarding its capacity of permitting mutual substitution, which means that if two workers are interchangeable, they could do each other's jobs. In other words, this second measure defines how easy is to fit a given individual in the task that is being performed by another. The higher the degree of Job Interchangeability, the easier would be to the rotated the individual to perform the new task assigned in the target project.

To perform a rotation practitioners must be aware of both measures and their impact on work related factors, since to successfully rotate one professional among software projects means to define a acceptable moment to start the rotation by establishing an interval between one rotation and the next one (from the perspective of the rotated person), and also, by observing how the degree of interchangeability will affect the candidate to be rotated. For instance, low levels of Job Interchangeability might trigger work-related factors that negatively affect one's work. However high levels of interchangeability could not produce positive effects enough. Therefore, both measures are important elements regarding job rotation.

Considering the importance of these two measures for a rotation, and their impact on work-related factors, *Rotation Intensity* showed a significant negative correlation with *Task Identity, Feedback from the Job,* and *Satisfaction*, together with a positive correlation with *Job Burnout*. In addition, *Job Interchangeability* presented significant negative correlations with *Information Processing*, *Initiated Interdependence* and *Role Conflict*, as summarized in TABLE 15. All the correlations obtained in this study are presented in Appendix VII.

The negative correlation between *Rotation Intensity* and *Task Identity* confirms and reinforces the results of Case Study 1. As observed before, *Task Identity* reflects the degree to which a job involves a whole piece of work, that is, a well-defined work. Therefore, the negative correlation emphasizes a reduction on the perception that software engineers have in understanding their work as a process with beginning, middle, and end, which can directly influence their motivation at work. Job rotation might have a negative impact on this factor, and

practitioners must be aware of that, to mitigate potential negative impacts on motivation.

Rotation Intensity is also negatively correlated with *Feedback from Job*. This factor reflects the degree to which the work itself can provide information about the effectiveness of professionals while performing a specific task. Consequently, a negative correlation between a dimension of job rotation and *Feedback from Job* means that software engineers seem to perceive less feedback resulting directly from their job activities. This negative effect might be increased by the negative influence of *Rotation Intensity* on *Task Identity*. The correlations in this study demonstrated that Feedback from Job and Task Identity are strongly and positively related, therefore, the extent to which software engineers lose the perception of a well-defined work, might increase their perception of losing feedback originated from the execution of assigned tasks. This is an important correlation to be observed since Case Studies 1 and 2 have demonstrated the importance of feedback for the satisfaction of software engineers.

Regarding work outcomes, a positive correlation between *Rotation Intensity*, *Job Burnout* and *Satisfaction* was observed. In this case, this result supported the early claims related to indirect effect of job rotation in the satisfaction of software engineers, considering that this practice influences work-factors that have direct impact on *Job Satisfaction*, such as feedback and performance. Further, there is the confirmation of the discussions of Hsieh and Chao (2004) that argued that the effect of job rotation is consistent with dimensions of Job Burnout (exhaustion, cynicism, and professional efficacy).

In fact, strongly negative correlations among *Job Burnout*, *Feedback from Job* and *Satisfaction* was also observed through this survey. The correlation among these factors reinforce the need for planning rotations accordingly to this aspect in order to balance these negative effects and possible consequences of burnout and dissatisfaction afterwards, such as the increase in the level of voluntary turnovers (MELO et al., 2011).

As for the second measure of rotations accessed in this survey, *Job Interchangeability* demonstrated a negative correlation with *Information Processing*. This work factor reflects the degree to which a job requires active information processing to be performed, which means that jobs that are easy to interchange (high JI) tend to be less demanding for the rotated person, in terms of information processing. Work design theories state that Information Process is a factor that positively affect individuals at work, therefore, decrease the level of this factor would negatively impact the rotated person.

Further, the obtained correlations also demonstrated that *Information Processing* is positively related to the level of variety experienced by software engineers. In this case, the more variety of tasks a project provides, the more information processing will be required by the individual. Since variety is one important element regarding the *Motivation* of software engineers (FRANÇA, da SILVA and SHARP, 2018), the negative effect of Job Interchangeability on Information Process needs to be considering while planning rotations.

Considering social characteristics of work, the *Job Interchangeability* dimension of job rotation showed significant negative correlation with *Initiated Interdependence*. In the work design theories, interdependence reflects the degree to which the job depends on others and others depend on it to complete the work. The *Initiated Interdependence* can be defined as the extent to which work flows from one job to other jobs or from one professional do another. For instance, the existing connection among the end of the activities of software requirements and the beginning of the work of developers in the project.

This negative correlation may be explained because a job with high *JI* may be simpler related to the kind of interdependencies it initiates, but further study is needed to better explain this correlation and to extend the understanding regarding what levels of interdependence will characterize it either a benefit or a limitation. Since much higher levels of interdependence might affect individuals in a negative way, e.g. causing stress at work, and low levels of interdependence is characterized as negative following the work design theories; this factor is defined as *indeterminate* in Table 15.

Further, a negative correlation between *Job Interchangeability* and *Role Conflict* was observed. This may be explained because jobs with high *JI* are likely to be well defined with clear cut role definitions, leading to low levels of Role Conflict. This correlation represents a benefit, since this type of conflict reflects how professional roles are precisely defined in a given project. The specification of roles will assure that individuals can be more easily assigned for other's people tasks, which might enable satisfactory levels of Job Interchangeability. In other words, this correlation expresses that the more interchangeable is a job, the less role conflicts might exist, and therefore, the less negative impact on one's satisfaction, since this results also demonstrated a negative correlation between *Role Conflict and Satisfaction*.

In summary, all the correlations identified in the survey were described and compared with the results obtained from the case studies and the SLR, resulting in a consistent and ample set of findings about the effects of job rotation in software engineers' work. The next step in this research was to place all these evidence together, aiming to resolve inconsistences and create a reliable set of characteristics and definitions to guide the development of a model to characterize job rotations in software engineering practice. This consolidation was achieved by performing a meta-ethnography that encompasses results from all the individual studies performed until this point.

4.5 META ETHNOGRAPHIC SYNTHESIS

This section presents the synthesis of the factors affected by the practice of job rotation among software projects (benefits and limitations) constructed using meta-ethnographic techniques explained in Section 3.5. As the main result of this synthesis process, the factors (benefits and limitations) were grouped into four higher-level categories: Organizational Factors, Team Factors, Work Characteristics and Outcomes. This is the same scheme applied in Section 2.1, regarding the effects of job rotation in several research fields. Table 17 summarizes the synthesis of all factors found in the five studies performed in this research. So

far, this represents the most comprehensive set of findings and evidence regarding the potential effects of P2P job rotation in software engineering practice.

Table 17 - Synthesis of Results

Factors	Case 1	SLR	Case 1 (Reanalysis)	Case 2 (Replication)	WDQ+ JR	Benefit /Limitation
Organizational Factors						
Communication		+	+	+		Benefit
Difficult to Plan		+		+		Limitation
Time Consuming		+				Limitation
Team Factors						
Team Flexibility		+		+		Benefit
Knowledge Exchange		+	+	+		Benefit
Work Characteristics						
Task Characteristics						
Task Variety	+	+	+	+		Benefit
Learning Opportunity	+		+	+		Benefit
Task Identity	-		-	-	- RI	Limitation
Feedback from Job					- RI	Limitation
Knowledge Characteristics						
Skill Variety			+	+		Benefit
Specialization				-		Benefit/Limitation
Information Process					- JI	Limitation
Knowledge Transfer	+		+			Limitation
Social Characteristics						
Initiated interdependence					- JI	Indeterminate
Feedback from others	-		-	-		Limitation
Social Support – Friendship Opportunities			+/-	+		Benefit/Limitation
Outcomes						
Individual Outcomes						
Motivation			+	+		Benefit
Satisfaction					- RI	Limitation
Performance	-		-	-		Limitation
Social Conflicts			+			Limitation
Job Outcomes and Correlates						
Job Burnout					+ RI	Limitation
Role Conflict					- JI	Benefit
Job Monotony			-	-		Benefit
Cognitive Effort			+	+		Limitation
Workload	+		+	+		Limitation

This synthesis provides a broader view of the potential effects of job rotations of professionals among software projects than any previous research in Software Engineering literature. In the process to develop it, the strength of evidence collected from different unique studies (Case 1, Case 1 – Reanalysis,

Case 2 – Replication, SLR and Survey) was improved, by confirming findings in complementary ways.

First, the SLR findings were confirmed with primary evidence from the qualitative case studies. In this sense, *Task Variety*, *Knowledge Exchange*, *Team Flexibility*, and *Communication* were identified as potential benefits in the SLR and confirmed by the at least one of the case studies. Similarly, the potential limitation related to rotations being *Difficult to Plan* was also found in the SLR and confirmed in one case study. Only one factor found in the SLR was not confirmed by the other studies, namely *Time Consuming*.

Further, the replication of the case studies produced confirmations for 15 of the total set of 18 factors found in both studies. Replicating the study in the same organization increased the confirmation, and data variability was increased by sampling different participants from projects with different characteristics in the replication. Therefore, this confirmation indicates a degree of generalization of the results and not a potential bias by using the same organization.

Regarding the diversity of the findings, the variability is a result of different types of studies yielding different correlations. Therefore, the results obtained from different research methods point out the relevance of using mix-methods research and replications when investigating complex phenomenon in the natural settings. In summary, the findings from the meta-ethnography demonstrated very good strength of evidence, considering the consistency of findings among studies (reliability) and the amount of different results with consistent findings (replications).

When all results were read together, the initial model presented in Figure 8 (Chapter 4.1.2) could be modified and important new evidence can be applied in the process of plan a job rotation, depending on what outcome practitioners are targeting. For instance, if a rotation is planned to be performed targeting the increase on the motivation of a professional, the process might consider the correlations among the work elements that could influence one’s motivation, for instance, variety of tasks or learning opportunities. However, since several factors interact together, practitioners need to be aware of the negative impacts of such

rotation, and plan the ideal configuration depending on each specific case, individual, and required outcome, such as performance, satisfaction, or performance.

Further, findings from the first stages of this research had evidenced that a rotation could be configured and planned, considering basically two triggers, namely, *Project Needs* and *Individual Requests*. However, the correlations and the meaning of concepts discovered in this meta-ethnographic synthesis demonstrated that to plan a rotation in software project managers need to consider:

- *Rotation Intensity*, which means that practitioners need to observe the frequency of rotation that one are experiencing, for example, recently rotated or never rotated, in order to select the ideal moment for the rotation to happen for each individual. Of course, the rotation intensity might depend on project needs or individual requests in certain moment. However, when possible, practitioners should consider the frequency of how many times a given individual was rotated, when was his/her latest rotation, and the moment when the new rotation will occur.
- *Job Interchangeability*, which reflects how easy it would be to move an individual to perform someone else's activities, considering the tasks performed in the source project and the tasks to be performed in the target project. At this point, the results obtained in the correlational study suggest that practitioners should be aware of the amount of new information to be processed in case of rotation, since low interchangeability between jobs might trigger the need for knowledge transfer and possibly reduce individual performance during a period of adjustment. Job Interchangeability is the element of rotation that might improve smoothness in the moving process that one will experience.

Based on the information gathered in this process, the following model was developed. The M-JRSE illustrates the dynamics in the practice of rotation of software engineers among different projects. Figure 9 presents the model elaborated based on the synthesis of evidence presented in Table 16 and the

correlation between factors presented in Chapter 4. To build this model, work characteristics and work outcomes that are directly related to the individuals were used. Organizational factors and team factors are not incorporated to this model, since the perception of software engineers regarding the impact of P2P rotations was the focus on this work.

The M-JRSE was completely designed collecting data from software engineers and the context of software engineering practice, using information from the field, supported by the literature, including comparisons with the general literature from other fields, such as Business Administration and Management. In general, this scheme shows that, in order to achieve maximum advantage of P2P rotations, managers must be aware of the Job Rotation Configuration, which can be defined as the combination of:

a) The reasons that triggered the need for a rotation;

b) The intensity of such rotations, in terms of when the rotation will occur and how frequently and how recently the chosen individual has being rotated, and;

c) The ease of interchange between tasks developed before and after the rotation.

Further, there are many factors involved in the process that can be positively or negatively affected by the rotation, and that might produce impacts that will affect one’s work temporarily or permanently. Finally, the ultimate effect of a rotation would be the individual motivation, satisfaction or the performance at work. Considering these statements, the M-JRSE is detailed as follows.

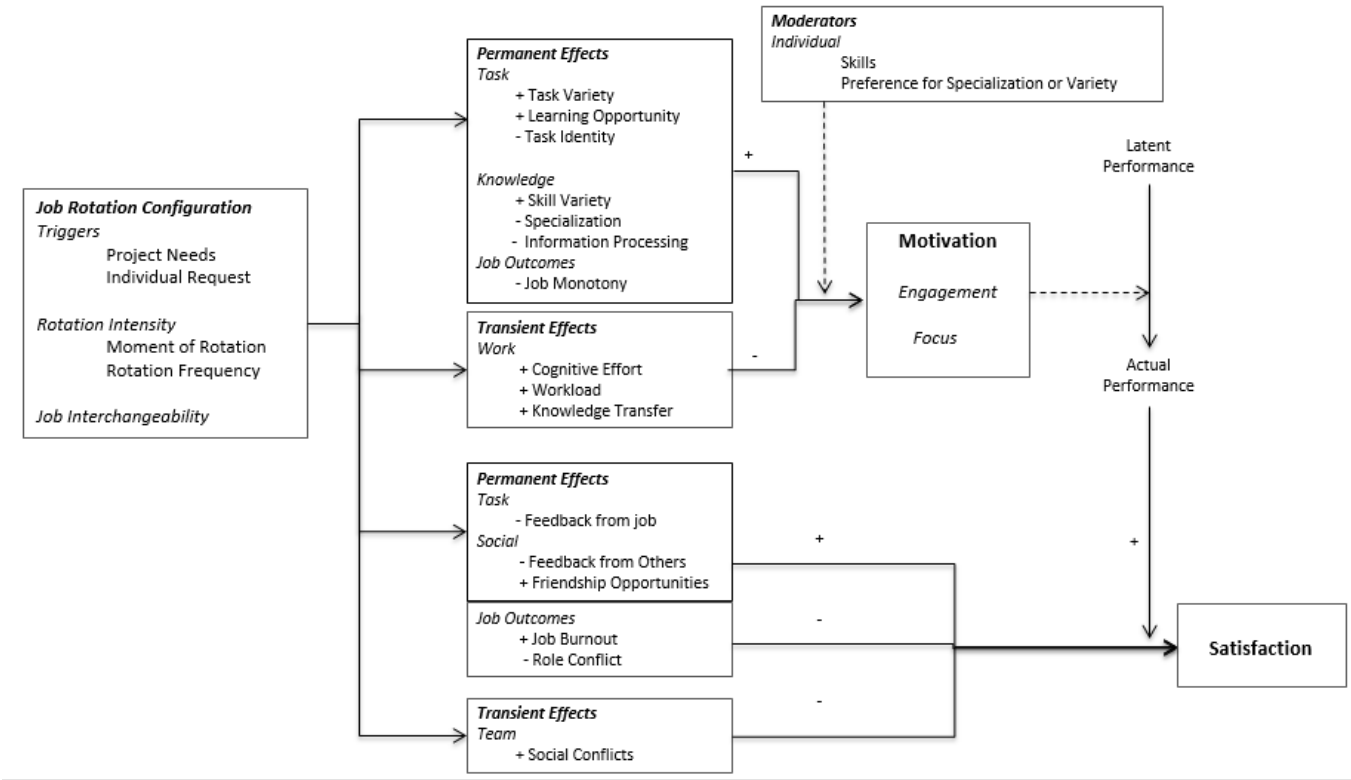


Figure 9. M-JRSE and the practice of Job Rotation in Software Engineering

Job Rotation Configuration – First step towards moving professionals among software teams is the definition of the ideal configuration of rotation by defining three elements: the trigger, the rotation intensity and the job interchangeability. These are the factors that will establish how successful the result of the rotation will be, in terms of balancing the process, in order to increase positive effects on software engineers' work, while try to reduce or eliminate negative effects.

- Firstly, there are two triggers to be considered in a rotation, namely, project needs and an individual request. Both situations can trigger a rotation, however, the ideal scenario would be to plan a movement that matches the needs of the target project for a specific professional skill and a request for change from an individual who possesses such skill. These triggers will be responsible for the identification of possible candidates to the rotation. Therefore, once the trigger is identified, it is necessary to consider the intensity and the level of interchangeability based on how it would affect the possible rotation candidate.
- Secondly, the *Rotation Intensity*, characterized by two factors, the frequency which one had experienced a rotation, and the moment when the rotation will occur. These factors can be used to define the potentially most adequate time to move someone. In this case, managers should take into consideration whether or not one has finished his assignments in the source project (with impacts on Task Identity), and also, that such individual has not been recently rotated or frequently rotated (moved many times). In this sense, to set the moment of rotation means to define a strategy to minimize the negative effects that the rotation might cause in the following factors: *Task Identity*, *Specialization*, *Knowledge Transfer*, and *Feedbacks*. Further, by accessing the frequency of rotation, managers will be able to provide software engineers with opportunities to perform different tasks in a regular basis, possibly developing different skills and acquiring new knowledge, increasing the positive effect on *Task Variety*, *Skill Variety* and *Learning Opportunity*, while reducing *Job Monotony*. Lastly, too many rotations in a short period might increase the negative effects in the work-related factors and neutralize the positive effect of variety. This negative effect would be accumulated in each rotation triggering the possibility of *Burnout*.
- Finally, *Job Interchangeability* is the part of the rotation configuration responsible to the smoothness of the movement among projects, considering interchanges between the tasks on the source and target projects. Therefore, it is necessary to identify potential negative outcomes

related to the levels of interchangeability. In this context, job interchangeability needs to be carefully analyzed to define how ease would be for one to fit in the tasks assigned in the target project, after the rotation, considering the skills that such individual already possess. Low levels of interchangeability between the tasks performed in the source project and those assigned in the target project might trigger needs for *Workload* and increase *Cognitive Efforts*, especially considering the negative impact of JI on *Information Processing*. Lastly, when analyzing interchangeability between software projects, managers should consider that, in general, *Job Interchangeability* is negatively related to *Role Conflict*, therefore very low levels of interchangeability could result in such conflicts after the rotation, considering that the new task tend to be somehow unfamiliar, from the perspective of the rotated person.

The rotation configuration is a novel definition presented in this research and it represents what is simply defined as “job rotation” in several other studies from several research fields. This means that, for practitioners in software companies, the first step of a rotation must be the definition of a configuration that fits in its purposes, since this configuration will be responsible for how individuals experience the positive and negative effects inherent to this process. These effects on several work-related factors could be either transient or permanent, and they affect software engineers at work in many ways, as presented below.

Permanent Effects – The permanent effects can be understood as the effects caused by job rotations on software engineers at work in a manner that, once it is produced, it cannot be easily undone or recovered. These effects can be produced on task, knowledge or social work-related factors that could directly affect one’s motivation or satisfaction and indirectly affect one’s performance at work. In this process, in general:

- A rotation might increase the chance of software engineers to work in different types of activities, possibly working in a wide range of assignments, developing various technical and interpersonal skills, through

the positive effect of job rotation on *Task Variety* and *Skill Variety.* In addition, rotations also tend to increase *Learning Opportunities*, since target projects might require different types and levels of a specific knowledge, while decrease the levels of *Monotony* at work. On the other hand, rotations can reduce *Specialization*, since individuals are usually dealing with a variety of different tasks. At the same time, job rotation often has a negative effect on *Task Identity*, since individuals often tend to lose their perception of a well-defined work, with beginning, middle and end. Furthermore, depending on the level of interchangeability presented in the rotation, a negative impact can be observed in *Information Processing*, which means that tasks with high interchangeability in the target project will provide to the rotated person a job with possibly less new information to be processed. These factors have a close relationship to the motivation of software engineers, since all of them are positively related to *Engagement*, which is one important characteristic of software engineers' motivation (FRANÇA, 2014; FRANÇA, da SILVA and SHARP, 2018).

- Job rotations can permanently affect software engineers' perceptions on the feedback about their work, since in general a rotation can negatively affect *Feedback from Job* and *Feedback from Others.* In this sense, it was observed that once an individual is moved to a target project, the feedback regarding previous activities developed in the source project might not be easily accessed after the rotation. To avoid this permanent negative effect, the rotation configuration must be planned observing these scenarios, and the company needs to develop practices to create and maintain short-time feedbacks to support the rotations. Further, in some specific cases, job rotation can cause *Burnout*, which is a factor that is not simple to recover from, once it occurs, but that could be avoided by the configuration that will define the rotation. Finally, rotations can create permanent opportunities for friendships and the development of social cycles through the organization. It was observed that social links, such as friendship among individuals, tend to continue even after a rotation, although in few cases, there is a possibility of these links disappear. Both the types of feedbacks and friendship

opportunities are work-related factors that demonstrated positive effect in one's *Satisfaction* (FRANÇA, da SILVA, SHARP, 2018; Appendix VII), while the burnout perception and the conflict related to the roles demonstrated the opposite effect (HSEIH and CHAO, 2004; Appendix VII).

Transient Effects – Different from the permanent effect that job rotation can cause on some work-related factors, it can also produce transient effects in another group of factors that also can affect motivation and satisfaction of software engineers. It means that some factors are temporary positively or negatively influenced by the rotations. However, these effects tend to fade in a period after rotation is performed. Again, the rotation configuration will define the level of these effects along with their duration.

- After a rotation, a common transient effect is the need for a software engineer maintain a link with the source project, even when the work in the target project started. This *Knowledge Transfer* process is necessary to guarantee that the previous work will not be impaired. Evidence demonstrated that this factor produces a negative effect on software engineers' concentration. Similar to this, a rotation can momentary increase *Cognitive Effort*, since one might need to learn a considerable amount of information about the target project in order to fulfill the tasks. Consequently, individuals might need to work extra time in the target project, and this *Workload* caused by the change of projects, due to the rotation, has also a negative effect on one's work. Despite of their transient characteristic, these three factors might directly affect the motivation of software engineers, since their *Focus* at work might be compromised (FRANÇA, 2014; FRANÇA, da SILVA and SHARP, 2018).
- Job rotation can create temporary social conflicts between individuals. Software engineers observed that, in some cases, temporary conflicts were observed in the team after a new member was added in the middle of the development. These conflicts were not related to the tasks or to the project, they were pointed as interpersonal and the causes for this conflict was not collected in the individual studies. However, since interpersonal conflicts

can affect one's happiness at work, the transient effect on this factor has a direct negative influence on *Satisfaction*.

Moderators – As previously stated, the rotation configuration is responsible for the intensity on how software engineers experience the permanent or transient effects of the practice. However, not only the configuration defines the level of perception of these factors. Following the results obtained in this research, there are at least two moderations of the effects, namely, *Individual Skills* and *Preference for Specialization or Variety.* These two elements can moderate how software engineers perceive the levels of variety involved in a rotation, and therefore, must be considered when a job rotation is planned. In other words, the perception of *Task Variety* and *Skill Variety* can change, depending on the skills that the individual holds in the moment of the rotation, and therefore, this moderator will also influence *Learning Opportunities* and *Cognitive Effort*. Finally, despite of job rotation having a negative effect on *Specialization,* it is the attitude of each individual towards becoming a specialist or not that will define the perception regarding these factors (positive or negative). That is, one's preference for specialization or variety. At the end, these moderators will influence how permanent and transient effects on motivation are perceived and dealt.

Individual Outcomes – There are at least three outcomes resulting from the process of job rotation: *Motivation*, *Satisfaction* and *Performance*. This means that, depending on the configuration established in the rotation plan, the factors permanently or temporary affected by the process might improve or impair these outcomes. Since the three outcomes are correlated, individual motivation might affect the performance at work, which will directly reflect in one's satisfaction in relation to the job (FRANÇA, 2014; FRANÇA, da SILVA and SHARP, 2015; FRANÇA, da SILVA and SHARP, 2018). Therefore, based on the results obtained in this research it is possible to state that:

- The ideal configuration would be one that, depending on the individual, will affect the work-related factors, both transient and permanent, in order to increase the levels of motivation, and positively affect the performance

afterwards. In this case, it is expected an increase in the levels of satisfaction.

- The natural configuration, that is, the general process, might decrease one's motivation in the moment of the rotation, due to the negative effect on engagement and focus, through transient and permanent effects. Therefore, performance will be temporary impaired, tending to decrease. However, the levels of motivation tend to increase in the target project at some point, and performance and satisfaction will follow the same effect.
- Inexpressive configurations would be those incapable of producing results over time. It would be the case of a rotation that will produce low variation keeping the same levels of motivation, performance and satisfaction.
- Finally, a detrimental configuration would decrease one's motivation over time, since the individual might experience all the negative effects in the process that will also impair performance and satisfaction. In the end, he/she will not be able to recover. This case can be more common than expected, since one of the triggers for a rotation are often only the project needs. Therefore, practitioners must be aware of the rotation configuration, in order to avoid this type of result.

One important fact regarding the individual outcomes is the close relationship among them, not only because they share part of the effects of the work-related factors affected by job rotation, but also especially because they are interrelated among them. In this sense, since Motivation is characterized as one's desire to perform a given task, it will directly affect the individual performance, which together with the feedback that such individual receive about his/her work will interfere in the levels of satisfaction (FRANÇA, da SILVA and SHARP, 2018). Therefore, it is practically impossible to isolate the effects of job rotation in one of these three factors. The configuration established in the rotation planning might only determine whether the rotation will produce more benefits or bring disadvantages to the individual involved in the process. Figure 10 illustrates the four main types of results of a rotation considering the expected outcomes.

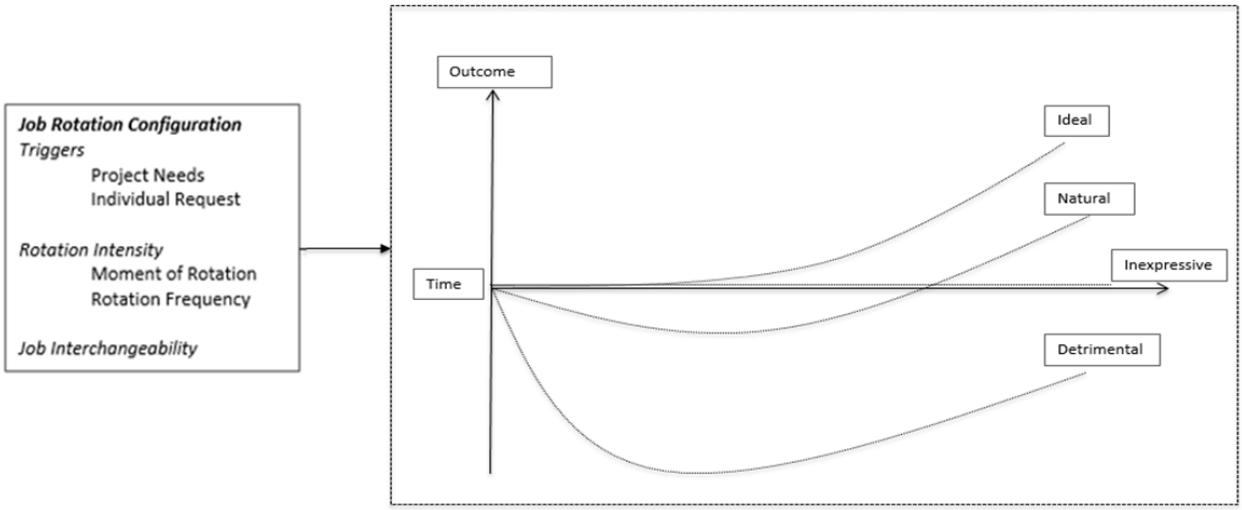


Figure 10. M-JRSE: Job Rotation Configuration X Outcomes

It is important to state that although the results of a rotation can generate four general types of outcomes (Figure 10), there are a large number of different configurations that can be performed depending on the software project, the company and the individuals involved in the rotation.

Following, to simplify the use of the M-JRSE the following scenarios can applied to illustrate different rotations.

Scenario #1. *There is a project need for a software engineer (developer) who works with Java Web and there are two possible candidates to participate in this rotation: Candidate A, who is working with Java Mobile and who has never been rotated and Candidate B, who has been rotated before and who has previous experience both with Java and C++. Both professionals are about to finish their biweekly assignments*.

In cases when the software project manager has options of professionals that matches the target project needs, the first step to select the candidate would be to observe the frequency of rotation. That is, among the possible candidates for the rotation who is the individual who has been less rotated in regular bases? For instance, individuals never rotated shall be considered first since the rotation would provide levels of variety that will carry other benefits never experienced before. This will trigger positive effects in his/her motivation and satisfaction afterwards. Following, the moment of rotation should be observed, which means that, to not negatively impact task identity and trigger the need for knowledge transfer between projects, the professional should be rotated after finish a given assignment, for instance, at the end of cycle (e.g., a sprint in scrum projects), or after deliver a feature. In this scenario, since both candidates are about to finish an assignment, the moment of rotation represent a low impact in this specific rotation configuration. Finally, the job interchangeability should be accessed in order to guarantee as low levels of cognitive effort and workload, as possible. In this scenario, the best candidate for the rotation would be Candidate A, considering his/her frequency of rotation (never rotated) and assuming that both would easily fit in the assignments of the target project (job interchangeability high), since both have experience in the technology domain required and both are working in similar activities.

Scenario #2. *There is a project need for a software engineer (developer) who works with Java Web and there are two possible candidates to participate in this rotation: Candidate A, who is working with Java Mobile and who has never been rotated and Candidate B, who has been rotated before and who has previous experience both with Java and C++. Candidate A is in the middle of an assignment, while Candidate B are about to finish their biweekly assignments*.

This scenario is very similar to Scenario #1, which means that the specifications about the frequency of rotation and the job interchangeability must be addressed as stated before. The difference here is that, in this case, the rotation of Candidate A would directly impact task identity in the negative way. That is, to move this professional means that he/she will not be able to perform a complete

task, losing the perception of well-defined work and compromising the motivation. Therefore, the rotation of Candidate B might be more feasible in this scenario.

Scenario #3. *There is a project need for a design thinking specialist. He is the only one with this specialization in the company, and because of it, he has been frequently rotated, every other month. After every rotation, another designer is allocated to be responsible for the activities that he previously initiated*.

This is a scenario where the rotation will cause the opposite effect on the levels of variety. The frequency of rotation is too high, which means that the professional had little time to adjust and to overcome the inevitable negative effects of the process. This professional would experience cognitive overload, due to the continuous changing in the software project contexts, which would directly impact his focus and therefore, his motivation. In addition, the need for keep transferring knowledge to the sources projects after the rotation happen will increase this negative effect. Job interchangeability seems not to be a problem in this scenario since the levels of interchange will remain high due to the similarity of tasks. However, the moment of rotation might constantly cause problems in task identity. This is the type of scenario that could drive to a detrimental result as shown in Figure 10.

Scenarios #1, #2 and #3 are just examples of the many configurations that a rotation can have and the many effects that it might cause. In particular, practitioners need to plan such configurations, evaluating the effect that this arrangement can produce on the work related factors, and their influence on the three outcomes (motivation, performance and satisfaction) afterwards. To facilitate the use of the M-JRSE the following scheme can be applied together to support decisions (Figure 11).

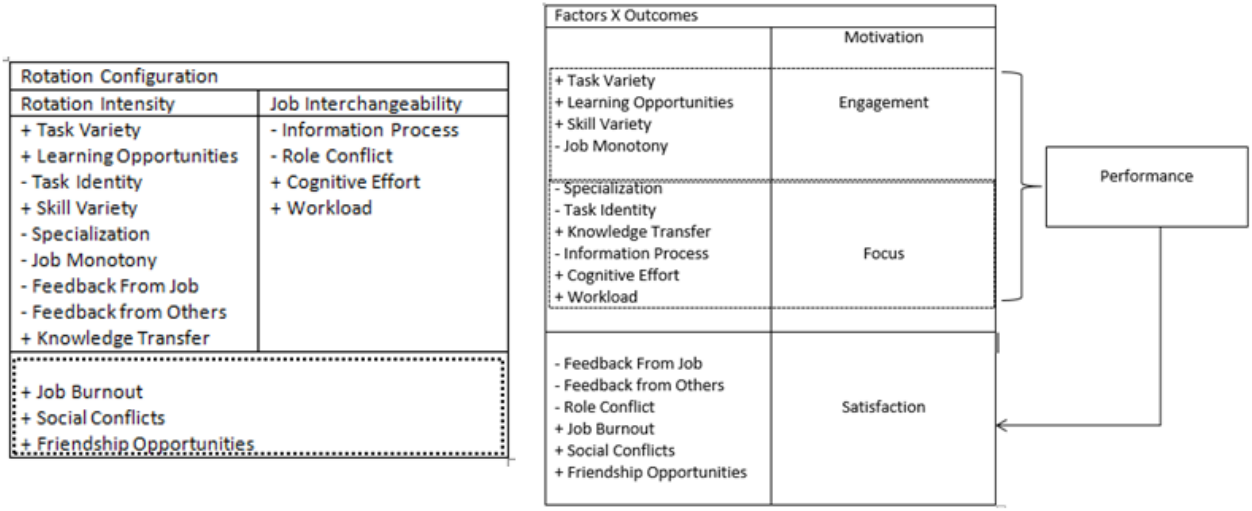


Figure 11. Job Rotation Configuration – Effects and Outcomes

In summary, the rotation intensity is the part of the configuration that can affect task variety, learning opportunity, task identity, skill variety, specialization, job monotony, feedback from job and from others, and knowledge transfers. This means, that the frequency of rotation and the moment of rotation will trigger the effect on this factors, as well as the level of intensity regarding how these effects are perceived. On the other hand, the similarity of tasks, that is, the job interchangeability, is the part of the configuration that will impact information process factor, as well as the increase on workload and cognitive effort, while it can also cause role conflicts. Finally, there are some factors that are more difficult to predict when they will be manifested, namely, burnout, social conflicts and friendship opportunities. For instance, whether a rotation will cause personal conflicts or provide friendships opportunities among teammates or not will not exactly depend to a specific configuration. Many configurations, even those that will likely drive for an ideal scenario can trigger these factors. As for burnout, the evidence demonstrated that low levels of interchangeability in association to high levels of variety caused by frequently rotations can trigger this factor. However, it is difficult to predict since it will highly depend on the individual participating in the rotation.

Finally, considering the outcomes, task variety, learning opportunities, task skill variety and job monotony are factors related to engagement, which is one of the facets of motivation. Further, specialization, task identity, information process, cognitive effort and workload are factors related to focus, the second facet of motivation. This means that when a configuration affect these factors the rotation will directly impact one`s motivation, and the result of this, would be the impact on individual performance at work, which would directly affect one`s satisfaction. In addition, the satisfaction can be directly affected by some factors that can be triggered depending on the configuration; they are feedbacks, conflicts of role and social, burnout and friendship opportunities. Therefore, each configuration should be planned depending on the particular scenario involving the rotation and the outcome that the practitioners are targeting.

4.6 SPECIALIST VERIFICATION: APPRAISING THE PROPOSED MODEL

Since the model was finalized and the definitions and correlations regarding work-related factors were explained, the final step in this research was to check the statements and access its usefulness for industrial practice. In this process, as stated in Chapter 3, the Specialist Verification consisted in a 1 hour interview with a senior software project manager to debate process of project-to-project rotations, and exploring cases of success and failures, in order to analyze whether different scenarios are applicable and covered by the theory.

This verification was performed with only one participant. The interviewee is a senior software project manager (over 50 years old), and nearly 30 years of experience in software development. His highest scholar level is a college specialization, which in Brazil means a degree between an undergraduate university degree and a Master degree. Regarding his daily assignments, the participant has being working in this company for over 12 years, where he is responsible for managerial activities regarding software teams and software development, such as estimations, allocations and re-allocations (through P2P

rotations). In summary, he was responsible for an average of 1 to 2 rotations every month in 78 different projects over the last years.

Since this was a confirmatory study, the interview process was simplified and the participant was asked to comment the process to plan and perform a rotation from the beginning to the end, and report cases where the process succeed and cases where it failed. In addition, he pointed out effects that he observed in the field. In a dynamic process, while the participant explained his viewpoint, a graphic scheme was being developed to represent the rotations being reported, in order to compare the real examples with the general model and the theoretical statements constructed in this research.

Therefore, the main result in this specialist verification was the development of a sub-scheme that summarizes many years of experience with the practice of job rotation in a software company. This sub-scheme was constructed based on the evidence collected with the specialist, in a completely different context from those where the data was collected in the previous stages of this research. In summary, the sub-scheme fits into the model developed and presented in Chapter 4.5. In other words, all the configuration factors, effects, outcomes and moderators collected from the specialist interview were observed before and all of them are part of the model proposed in this research, as presented below and demonstrated in Figure 12.

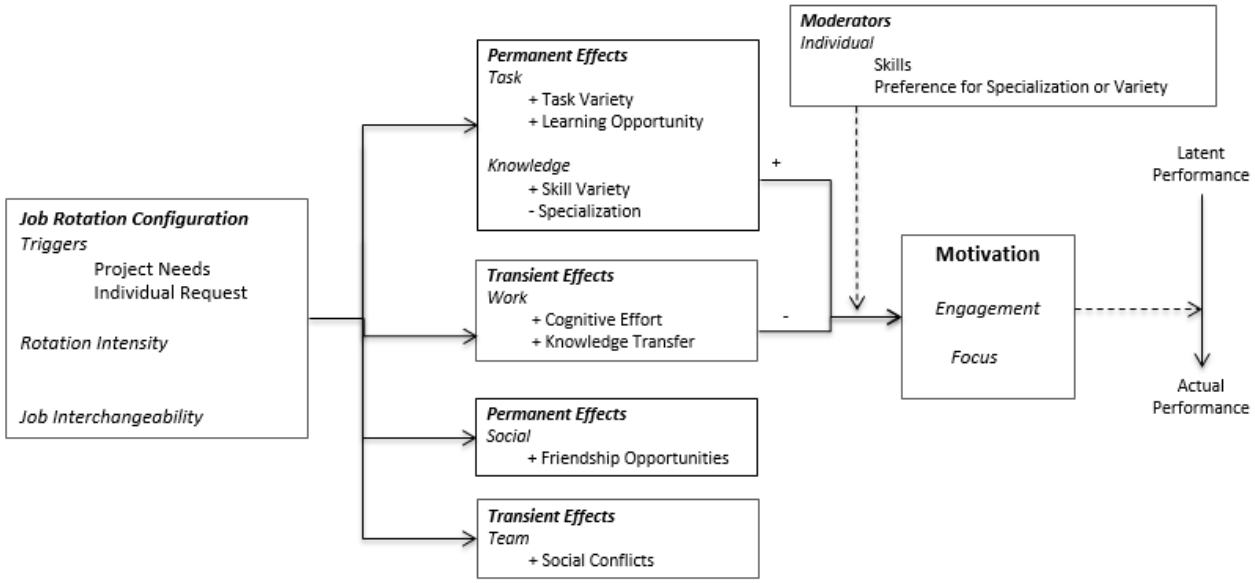


Figure 12. Job Rotation Subset Scheme Based on Specialist Experience

Job Rotation Configuration – The specialist confirmed the use of mainly two triggers as a start point for a P2P rotation: *Project Needs* and *Individual Request*. In this company the *Rotation Frequency* is observed in order to select professionals to be rotated, while *Job Interchangeability* is also an important element, especially regarding the differences among tasks. Quotations below illustrate this evidence.

"*As we are centered in people needs (…) we try to converge between projects needs and the interest of each person*".

"*If the problem is too complex [in target project], it is necessary balance level of experience from professionals [involved in the rotation]*".

Permanent and Transient Effects – Regarding the effects of rotation on software engineers' work, the interviewee confirmed the increase in *Task Variety*, *Skill Variety*, and *Learning Opportunities*, together with the development of *Friendship Opportunities*:

"*There is this pleasure for someone who's starting a new work, which is to learn and accumulate the maximum of different experiences*".

"*The learning curve has specific characteristics for each individual and there are people who learn faster than others*".

"*Some people have developed closer friendship relation with teammates (…) Therefore we make these relations possible to occur [through rotation]"*.

On the other hand, the need for *Knowledge Transfer* and *Cognitive Effort*, and their negative effect on one's concentration was confirmed, in addition to the possibility of *Social Conflicts* in the target project after the rotation, as demonstrated in the following quotes:

"*Think of you working, concentrating and someone [from the source project] is interrupting you, I don't know, every other hour or 5 times a week [with questions]"*.

"That person that you rotated [to the target project] can be someone with no personal attachments to the teammates [yet]", and personal relations are simply whether I like you or not".

Moderators – Specialist verification confirmed the existence of two moderators, two crucial factors that might influence the intensity how software engineers perceive permanent and transient effects during a rotation. They are, *Individual Skills* and *Preference for Specialization*, and the quotes below illustrated the confirmation found in this case.

"*Sometimes the project is naturally more specialized. Therefore, it requires someone more open to the idea of develop such specialization*".

"*Sometimes the individual skills and one's rhythm influence*".

Outcomes – The interview confirmed that *Performance* is one of the outcomes targeted when managers plan a rotation. That is, increase the level of productivity of software engineers at work. Further, the participant indirectly commented that *Motivation* is another outcome to be considered in this process.

Satisfaction was not commented in the first moment, although it was confirmed after the model was presented in the end of the process. Quotations below demonstrated the confirmation on Performance and Motivation.

"*Performance (…), sometimes one is not performing very well and it could be for various reasons"*.

"*You have to talk the project up, so the individual will be engaged [in the target project]"*.

Finally, after spontaneously commenting and exemplifying his experience with job rotations, the interviewee was asked to analyzed the M-JRSE (Figure 9) and evaluate if there was any divergences between the model and what was discussed during the interview or what he experiences in his daily work. In summary, the interviewee confirmed that the model embraces the rotations that he experienced and performed, also highlighting that it cover rotation cases that were not commented or remembered during the interview. The participant also emphasized the existence of other factors beyond those listed in his interview, and that are present in the model, as illustrated by the following quotes.

"*Engagement… Motivation… It is all here. Score!*"

"*Learning opportunities…Varieties of skill. I told you!*"

"*Feedback? You are kidding me! You have it here, and I forgot to tell you about. Good...!*"

"Well, you can see the whole picture with this scheme. (…) It is good, because all rotations tend to go wrong in some level. So, you have to interfere in this rotations to make it work. If you do not keep your eye on it, you might fail." [about the importance of this research and the proposed model]

In summary results from Specialist Verification were important in this research for three reasons. Firstly, it checks the model proposed, which was constructed in the context of software companies, by testing its coverage with an experienced software project manager. Secondly, this was the first attempt to test

the transferability of the model, since the sub-scheme (Figure 11) demonstrated that the M-JRSE could be customized to fit in different realities. Finally, it confirms the saturation achieved in the research and the consistency of the results obtained in this research, although the limitation in this phase was the fact that the verification was performed with only one professional.

5 IMPLICATIONS AND CONCLUSIONS

In this study, data was collect from multiple sources, by applying different methods and by performing different types of analysis. The findings obtained from the individual studies evolved into a synthesis produced using a meta-ethnographic approach, whereas the findings obtained were consistency compared with studies developed in different research fields in order to increase the understanding about the particularities of job rotations in the context of Software Engineering. A list of publications produced during this period is presented in Appendix I.

Initially, results demonstrated the existence of contradictory evidence between software engineering and other research fields regarding two factors, *Knowledge Transfer* and *Satisfaction*. Different from what was observed in other fields, this research showed that job rotation could have a negative impact on the satisfaction of software engineers. This scenario is resulting from the fact that job rotations have negative impact in several factors that are related to the satisfaction of individuals, such as feedback (FRANÇA, 2014; FRANÇA, da SILVA and SHARP; 2018), job burnout (HSEIH; CHAO, 2004) and performance (FRANÇA, 2014; FRANÇA, da SILVA and SHARP; 2018). As stated in the results, the rotation configuration is a starting point to reduce this negative effect. However, software companies need to establish methods to maintain and forward individual feedbacks among source and target projects during the rotations, in order to suppress its negative effects on the satisfaction of software engineers.

Further, software engineers have considered the *Knowledge Transfer* as another limitation related to this practice, while other professionals commonly considered this factor as a benefit (MOHAPATRA et al., 2016). The evidence demonstrated that, during the software development, the need for knowledge transfer could increase the workload on the rotate person, when this individual needed to support the previous project after the rotation. This process might increase cognitive workload and decrease individual performance. Therefore, managers need to adjust rotation configurations in order to determine the right

moment for the rotation occur. In addition, there is a need for observe the level of interchange between the tasks on the source project and the target project in order to avoid cognitive effort and knowledge transfer due to tasks with low levels of interchangeability participating in the rotation. Hypothetically, the development of practices to increase knowledge redundancy in software teams is one of the practices that might turn rotations more effective by reducing the need of knowledge transfer, and inclusively, facilitating interchangeability among projects.

Results demonstrated the importance of developing a balance on the frequency of rotations of a given person, considering not just the negative effects presented above, but also other similar issues. For instance, rotations performed too often might decrease the perception of well-defined work (*Task Identity*), and might have a negative impact on *Feedback*. On the other hand, leaving a person for too long in the same project is not desirable because software engineers tend to value variety (task and/or skill) and the possibility of acquire new knowledge about techniques, tools or procedures. Therefore, one key factor that must be evaluated when performing a rotation is the amount of variety (tasks and skills) that will be involved.

Research findings also demonstrated that little variety, such as moving an individual to the same role in a project with similar technical requirements, or having this individual rotated to work on the same business domain applying the same technologies, might create less opportunity to learn and, therefore, it would provide less direct benefits to the rotated person. On the other hand, too much variety may create a long and steep learning curve for the rotated person, which could cause loss of performance and increase cognitive workload. It is desirable to plan a rotation configuration taking the amount of variety into consideration whenever possible.

The practice of job rotation in software engineering practice depends on a well-established balance among the work-related factors positively and negatively affected in this process. In summary, job rotations might be used to achieve organizational goals related to project resource allocation as well as individual motivational needs. However, addressing these needs might produce potentially

conflicting outcomes that may not be simple to predict. The model developed in this research is a step forward towards such prediction.

The statements about the practice of job rotation in Software Engineering and the model presented here were developed mostly with evidence collected in software companies, in addition to evidence from literature, especially software engineering literature. The M-JRSE was designed to support practitioners in the process of planning, performing and evaluating rotation of software engineers among different teams. The proposed model was presented to a specialist from industry and the results claim that it can be applied in different companies for the proposes of planning, executing and evaluating rotations of software engineers among software projects. The expectations are that this consistency allows the model to fit in diverse scenarios. However, only a set replications and its actual use will confirm this.

The amount of knowledge collected and summarized to build this model is, so far, the most extensive body of knowledge regarding this theme in Software Engineering, and such great amount of evidence identified and synthesized here has no precedents before this research. Before this research, findings related to P2P rotations in Software Engineering was restricted to studies that did not investigate this phenomenon as their primary goals, and also being highly concentrated on organizational and workgroup level factors, with individual factors highly neglected. Now, relevant new evidence and significant findings based on practice were added to the body of knowledge about this specific topic in software engineering. Thus, this research has contributed with academic research and industrial practice in several ways, namely:

a) A systematic literature review describing the current state of research about this topic.
b) An extensive study of job rotation in an industrial practice, comprised of two case studies, with one data reanalysis.
c) Insights regarding the use of job rotation in software engineering, and the benefits and limitations of this practice in this context.

d) A model regarding job rotation in software engineering, constructed mostly with empirical evidence collected from the field, having its coverage and use tested with a specialist.

Overall, these results successfully answer the research question established in this research:

RQ1: How does the practice of job rotation affect software engineers at work?

RQ2. How this practice can be applied in software companies in order to improve software development?

In summary, the practice of job rotation can affect software engineers in different levels, since the number of potential benefits and limitations of this practice are wide, and the interacting effects between these factors may produce unexpected results, which usually requires a balance among the lasting gains and the temporary losses involved in this process. Therefore, since several factors interact together, practitioners need to be aware of the negative impacts of such rotation, and plan a configuration that best comprises the purposes of such rotation depending on each specific case, individual, and desired outcomes. The proposed model was developed to guide practitioners to the early stages of planning a rotation (regarding rotation configuration) and through the whole process by informing about its potential effects of the practices, inclusively, helping to predict the influence on work outcomes.

Altogether, the results of this PhD research might significantly benefit research and practice in complementary ways. In the research context, software engineering researchers might be able to reuse the theoretical background and methods to investigate questions intrinsically related to the practice of job rotation. In addition, the methods and procedures presented here can be replicated to investigate similar research problems. On the other hand, software practitioners might adapt the M-JRSE in order to improve managerial processes in software companies from different contexts. However, the model and the theoretical body of

knowledge as currently stated leave open at least four immediate questions and opportunities for future research, such as:

- *Raising generality and replicating the verification*: The M-JRSE was developed mostly by using information collected from the field. In addition, data was also collected from Software Engineering literature, and in the end, it was contrasted with theories and findings from the general literature. However, due to the nature of the research methods applied in this work, the M-JRSE remains context dependent. The specialist verification was a step forward testing its generality. However, this generality needs to be improved by verifying its applicability in a larger sample of companies and individuals, which might include cross-country replications.
- *Improving the usability of the proposed model*: The M-JRSE demonstrated the importance of defining a configuration that better fits in the purposes of each rotation, in order to reduce negative effects on individual outcomes, such as motivation, performance and satisfaction. However, the existing correlations among the work-related factors that are temporary or permanently affected by the rotation configuration needs to be further explored in order to increase the prediction power of possible rotation configurations. Therefore, one of the next steps of this research could be the proposition of assessment tools that, given a specific configuration, demonstrate the most likely impact of the rotation on one's work.
- *Developing methods and strategies to overcome negative impacts*: This research demonstrated that negative effects of job rotation are practically inevitable, since there are too many factors interacting together during the process. The M-JRSE is a step forward visualizing these negative effects. However, it informs practitioners about the limitations of the process, but it does not provide strategies to deal with them. Future research can explore each individual factor and their correlations to propose ways to reduce their negative

effect. For instance, this research hypothesized that knowledge redundancy would be a strategy to reduce the need for knowledge transfer, caused by rotations with low level of Job Interchangeability. In this sense, there must be strategies to be proposed towards the reduction of the negative impact produced by other factors, such as lack of feedback, increase of cognitive effort, and decrease of task identity, among others.

- *Understanding the impact of job rotation on software teams and the organization*: the M-JRSE was build taking into consideration work-related factors that directly affect the individuals at work. In this process, few factors observed in the findings were not further explored, such as team related factors and organizational factors, e.g., team flexibly, knowledge exchange and communication dynamics along the company. Therefore, it is possible that the impact of job rotations extrapolate the individual level and produce impacts both on the team and the company as a whole. These impacts must be addressed in future studies.

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APPENDIX A - LIST OF PUBLICATIONS

Santos, R.E.S., Baldassarre, M. T., da Silva, F. Q., Magalhães, C.V. C., Capretz, L. F. and Correia-Neto, J. S. Work design and job rotation in software engineering: results from an industrial study. In Proceedings of the 12th International Workshop on Cooperative and Human Aspects of Software Engineering (pp. 139-146). IEEE Press, 2019.

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APPENDIX B - LIST OF PUBLICATIONS – LITERATURE REVIEW

[1] M. Alei, P. S. Shahrezaei. A Theoretical Structure for Strategic Human Resource Management in Project Oriented Manufactures. Cumhuriyet Science Journal, 2005.

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[10] A. Richardson, M. Douglas, R. Shuttler, M. R. Hagland. Critical care staff rotation: outcomes of a survey and pilot study. Nursing in Critical Care, 2003.

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[12] P. C. Weerd-Nederhof, P. J. Pacitti, J. F. S. Gomes, A. W. Pearson. Tools for the improvement of organizational learning processes in innovation. Journal of Workplace Learning, 2002.

APPENDIX C - LIST OF PAPERS FROM THE SLR

[JOB01] Alnuem, M. A., Ahmad, A., 2012. Khan, H. Requirements Understanding: A Challenge in Global Software Development. International Conference on Computer Software and Applications.

[JOB02] Ang, K. T., Thong, J. Y. L, Yap, C. S. 1997. It Implementation Through The Lens of Organizational Learning: A Case Study of Insuror. International Conference on Information Systems. Atlanta, USA.

[JOB03] Birk, B.; Heller, G., John, I., Schmid, K., Von Der Maßen, T., Muller, K. 2003. Product line engineering, the state of the practice. IEEE Software, v. 20, n. 6, p. 52-60.

[JOB08] França, A. César C., Felx, A. L. C.,Da Silva, F. Q. B. 2012. Towards an Explanatory Theory of Motivation in Software Engineering: A Qualitative Case Study of a Government Organization. International Conference on Evaluation and Assessment in Software Engineering.

[JOB09] Fowdar, C. D., Nagowah, S. D. 2012. Knowledge Management Practices in IT Project Based Companies in an African Country. International Conference on Computer & Information Science.

[JOB11] Kankanhallia, A., Tan, B. C. Y., Wei, K., Holmes, M. C. 2004. Cross-cultural differences and information systems developer values. Decision Support Systems.

[JOB12] Kukko, M., Helander, N., Virtanen, P. 2008. Knowledge management in renewing software development processes. Hawaii International Conference on System Sciences.

[JOB13] Melo, C., Cruzes, D. S., Kon, F., Conradi, R. 2011. Agile Team Perceptions of Productivity Factors. Agile Conference. Fortaleza, Brazil.

[JOB14] Moe, N. B., Dingsøyr, T., Dybå, T. 2009. Overcoming barriers to self-management in software teams. IEEE Software.

[JOB15] Passos, C., Cruzes, D. S., Mendonça, M. 2013.Applying Theory of Reasoned Action in the Context of Software Development Practices.

International Conference on Evaluation and Assessment in Software Engineering. Porto de Galinhas, Brazil.

[JOB17] Siy, H. P., Herbsleb, J. D., Mockus, A., Krishnan, M., Tucker, G. T. 2001. Making the Software Factory Work: Lessons from a Decade of Experience. International Conference on Software Metrics Symposium. London, UK.

APPENDIX D - INTERVIEW SCRIPT (PT_BR)

GUIA DE ENTREVISTA COM ENGENHEIROS DE SOFTWARE SOBRE JOB ROTATION

APRESENTAÇÃO

- Apresentação do pesquisador e cumprimentos.
- Agredecimento ao participante
- Solicitação de permissão para gravar (caso o participante não autorize a gravação, todos os passos seguintes devem ser registrados por escrito.)

INTRODUÇÃO

O objetivo desta pesquisa é entender aspectos relacionados a movimentaçcao de pessoas dentro de equipes de desenvolvimento de software. Todas as informações fornecidas nesta entrevista serão tratadas como confidencial. Apenas a equipe de pesquisa, relacionada ao assunto, terá acesso às informações fornecidas. Em particular, nenhuma pessoa direta ou indiretamente ligada a empresa terá acesso às informações fornecidas nesta entrevista e em nenhuma outra fase da pesquisa. A equipe de pesquisa empregará todos os meios possíveis para evitar que informações individuais possam ser associadas diretamente aos participantes.

Sua participação nesta pesquisa é voluntária e você pode decidir não participar ou se retirar da pesquisa a qualquer momento. Caso você decida não participar, não receberá nenhuma sanção ou penalidade. Você concorda em participar desta pesquisa?

IDENTIFICAÇÃO DO ENTREVISTADO

- As informações a seguir serão utilizadas caso a equipe de pesquisa precise entrar em contato com você no futuro para esclarecimentos sobre a entrevista.
- Por favor, diga seu nome.
- Por favor, diga seu endereço de e-mail.

SOBRE AS RESPOSTAS

Não existem respostas certas ou erradas nesta entrevista. Nosso objetivo é coletar suas impressões, opiniões e sentimentos sobre os vários assuntos abordados. Leve o tempo que for necessário, tudo o que for importante para você me interessa. Reforçando que suas respostas não serão disponibilizadas para a empresa e, portanto, não terão nenhuma influência em avaliações realizadas pela empresa. Por favor, responda da forma mais sincera possível.

PERGUNTAS

AQUECIMENTO

Caracterização do entrevistado

- Idade
- Estado civil
- Qual e quando foi a última Titulação
- Tempo de atuação profissional

1. *Vamos iniciar com algumas informações gerais sobre sua história dentro desta organização. Por favor, conte-me em detalhes sua história, da seleção até o dia de hoje.*

2. *De que forma as suas opiniões e sentimentos a respeito da empresa modificaram-se desde a sua entrada? Você atribui essa mudança a que?*

3. *Que mudanças importantes você identifica na história da empresar? Como isso afetou suas equipes? Como isso lhe afetou?*

4. *Hoje em dia, o que é determinante para você continuar trabalhando nesta empresa?*

JOB ROTATION

Nesta empresa existe a cultura de movimentação de colaboradores entre equipes durante e ao final dos projetos (Job Rotation). As próximas perguntas estão relacionadas as movimentações (entradas e saídas de pessoas) durante o desenvolvimento de um projeto.

Para todos os entrevistados

5. *O que você acha sobre essas movimentações internas?*
    - ✓ *Como você acha que os funcionários se sentem?*
6. *Como você se sente com a possibilidade de ser "movimentado" para outra equipe no meio do desenvolvimento de um projeto? Por quê?*
7. *Como você se sente com a possibilidade de ocorrer uma movimentação (saída ou entrada de novos membros) dentro da sua equipe atual? Por quê??*

Apenas para os entrevistados que já foram movimentados

8. *Você já foi mudado de equipe no meio de um projeto? Quantas vezes, aproximadamente? Fale me sobre essa experiência? Como você avalia a experiência?*
    - ✓ *Em que fase do projeto ocorreu essa movimentação?*
    - ✓ *Como e porque ocorreu essa movimentação?*
    - ✓ *Como você se sentiu? Teve problemas de adaptação?*
    - ✓ *Você acha que essa movimentação afetou o seu desempenho?*

Apenas para os entrevistados que já tiveram pessoas movimentadas na equipe

9. *Nas equipes que você já participou, alguma vez ocorreu alguma movimentação de outras pessoas da equipe? Fale me sobre essa experiência.*
    - ✓ *Como você avalia a experiência?*
    - ✓ *Como a equipe se sentiu? Como você se sentiu?*
    - ✓ *Quais foram os impactos positivos e negativos causados por essa movimentação?*
    - ✓ *Afetou estimativas, tempo, custo, escopo, etc.? Como?*
    - ✓ *Afetou a cooperação entre os membros?*

Para todos os entrevistados

10. *O que você diria se te oferecessem a oportunidade agora de mudar para outro projeto? O que você pesaria?*
    - ✓ *Se você tivesse a chance de fazer o mesmo tipo de trabalho em outra equipe como você se sentiria sobre a mudança?*
11. *Se você fosse movimentado agora para outra equipe, como isso impactaria o andamento do seu projeto atual?*
    - ✓ *Como você avaliaria a importância das suas atividades para o projeto.*

12. *E qual seria o impacto da sua saída em outros aspectos da sua equipe atual não diretamente associado ao desenvolvimento do projeto?*
    - ✓ *Como você avaliaria a sua influência dentro da sua equipe?*

APPENDIX E - MEMBER CHECKING INTERVIEW SCRIPT (PT_BR)

N	*Afirmação*	Concordância
1	**Work variety (Variedade do Trabalho)** Movimentações internas permitem que os engenheiros de software possam trabalhar com diferentes projetos e tecnologias, trazendo variedade de trabalho.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
Comentários		
2	**Acquisition of useful knowledge (Aquisição de Conhecimento)** Movimentações internas possibilitam que os engenheiros de software obtenham conhecimento técnico e prático sobre diversos aspectos profissionais.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
Comentários		
3	**Cognitive workload (Sobrecarga Cognitiva)** Movimentações internas afetam o indivíduo quando as suas novas responsabilidades em outro projeto requerem um alto grau esforço mental e de concentração.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
Comentários		
4	**Feedback (Feedback)** Movimentações internas afetam o feedback do trabalho, uma vez que uma pessoa pode não passar tempo suficiente em uma equipe para serem avaliado.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
Comentários		
5	**Well Defined Work (Compromisso com a Tarefa)** A movimentação interna faz com que os indivíduos tenham de sair do projeto	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente

	sem finalizar completamente o trabalho que estava desenvolvendo anteriormente.	
Comentários		
6	**Knowledge Transfer (Troca de conhecimento)** Geralmente, após uma movimentação, a pessoa movimentada precisa ficar em constante contato com a equipe anterior para repassar informações sobre o trabalho que estava desenvolvendo anteriormente.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
Comentários		
7	**Performance (Performance)** A movimentação interna dos membros pode afetar a performance individual. Ao ser movimentado, o indivíduo terá baixo desempenho até que consiga assimilar corretamente as suas atividades na nova equipe.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
	Performance (Performance) A movimentação interna dos membros pode afetar a performance individual, pois requer tempo para treinar um novo membro recém chegado na equipe.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
	Performance (Performance) A movimentação interna dos membros pode afetar a performance individual, pois essa movimentação pode ocasionar aumento na carga de trabalho de alguns membros da equipe anterior que terão de suprir a falta deixada pelo membro que foi movimentado para outro projeto.	( ) Concordo Completamente ( ) Concordo Parcialmente ( ) Discordo Parcialmente ( ) Discordo Totalmente
Comentários		

	Afirmação	**Concordância**

	Work variety (Variedade do Trabalho) As movimentações internas trazem oportunidade de trabalhar com um novo projeto ou tecnologia.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca
Comentários		
	Acquisition of useful knowledge (Aquisição de Conhecimento) As movimentações internas possibilitam a obtenção de novos conhecimentos.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca
Comentários		
	Cognitive workload (Sobrecarga Cognitiva) As movimentações internas requerem um alto grau de concentração para desenvolver as novas atividades no novo projeto.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca
Comentários		
	Feedback (Feedback) As movimentações internas prejudicam o recebimento de feedback sobre o trabalho.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca
Comentários		
	Well Defined Work (Compromisso com a Tarefa) As movimentações internas fazem com que não seja possível desenvolver um trabalho ou tarefa em um projeto do início ao fim.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca
Comentários		
	Knowledge Transfer (Troca de conhecimento) Após uma movimentação, a pessoa movimentada precisa manter contato com a equipe anterior para repassar informações sobre o trabalho que estava desenvolvendo anteriormente.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca

Comentários		
	Performance (Performance) A movimentação causa queda temporária da performance individual.	( ) Sempre ( ) Frequentemente ( ) Raramente ( ) Nunca
Comentários		

APPENDIX F - SURVEY QUESTIONNAIRE (PT_BR)

Introdução

O HASE (Human Aspects in Software Engineering), é um grupo de pesquisa originado no Centro de Informática (CIn) da UFPE que desde 2003 estuda a influência dos fatores humanos e sociais na engenharia de software. Este grupo é coordenado pelo Prof. Fabio Q. B. da Silva, do CIn-UFPE e conta, atualmente, com 3 pesquisadores doutores, 12 alunos de doutorado e 4 pesquisadores colaboradores, além do próprio coordenador.

Objetivo da Pesquisa

Esta pesquisa está sendo conduzida pelo HASE, coordenada pelo Prof. Fabio Silva, que é o responsável geral pelo projeto. O objetivo desta pesquisa é entender aspectos relacionados à dinâmica das atividades executadas pelos profissionais de engenharia de software na prática de seu trabalho.

Condições de Participação

Sua participação nesta pesquisa é voluntária. Caso você decida não participar, não receberá nenhuma sanção ou penalidade.

Caso deseje contribuir com a pesquisa, asseguramos que todas as informações fornecidas por você neste questionário serão tratadas como confidenciais. Em particular, nenhuma pessoa direta ou indiretamente ligada a sua empresa ou local de trabalho terá acesso às informações e dados individuais coletados na pesquisa. Serão empregados todos os meios possíveis para evitar que informações individuais possam ser associadas diretamente aos participantes.

Ao responder ao questionário, forneça respostas relacionadas ao seu trabalho **atual**. Não existem respostas certas ou erradas. Portanto, tente responder as questões da forma mais sincera e objetiva possível, sendo fiel às características do seu trabalho atual e aos seus sentimentos em relação a este trabalho. Tente, também, não deixar nenhuma questão em branco, mesmo que ela seja semelhante a outras que você já tenha respondido.

Os pesquisadores do HASE agradecem sua colaboração.

IDENTIFICAÇÃO DO PARTICIPANTE

Por favor, responda as questões fechadas com um X. Nome e e-mail são informações opcionais, mas muito importantes caso os pesquisadores necessitem entrar em contato para esclarecimento de dúvidas. Por favor, tente responder a todas as questão não opcionais.

1. Nome Completo (opcional)	
2. E-mail (opcional)	
3. Nome da empresa	
4. Sexo	
5. Idade	
6. Formação atual de maior grau (completa)	( ) Médio ( ) Técnico ( ) Superior ( ) Especialização ( ) Mestrado ( ) Doutorado
7. Curso formação de maior grau informada na Pergunta 6	( ) Ciência da Computação ( ) Engenharia de Computação ( ) Sistemas de Informação ( ) Engenharia de Software ( ) Outro. Qual? _____
8. Ano de obtenção formação completa informada na Pergunta 6	Ano: _____
9. Formação em andamento	( ) Não se aplica. Não está fazendo formação em andamento. ( ) Médio ( ) Técnico ( ) Superior ( ) Especialização em andamento ( ) Mestrado em andamento ( ) Doutorado em andamento
10. Ano de início da formação em andamento (se for o caso)	Ano: _____
11. Anos de experiência profissional (desde o início da sua vida profissional em qualquer atividade)	
12. Anos de experiência	

profissional em desenvolvimento de software	
13. Função atual	( ) Analista ( ) Desenvolvedor (codificação; manutenção) ( ) Testador ( ) Gerente ( ) Outra. Qual? _____
14. Anos de experiência na função atual	

CARACTERÍSTICAS DO TRABALHO

Nesta parte do questionário, estamos interessados em informações sobre as características do seu trabalho atual. Por favor, seja objetivo em relação às características reais do trabalho. Em uma escala de 1 a 5, na qual 1 significa "Discordo totalmente" e 5 significa "Concordo totalmente", por favor, marque **apenas um item** para a resposta que melhor representa seu nível de concordância com **cada afirmativa**.

1	2	3	4	5
▲	▲	▲	▲	▲
Discordo Totalmente	Discordo Parcialmente	Nem discordo nem concordo	Concordo Parcialmente	Concordo Totalmente

Afirmativa	**1**	**2**	**3**	**4**	**5**
Meu trabalho permite-me tomar minhas próprias decisões sobre como programar minhas tarefas.	○	○	○	○	○
Meu trabalho exige a realização de uma grande amplitude de tarefas.	○	○	○	○	○
Meu trabalho envolve a execução de tarefas variadas	○	○	○	○	○
Meu trabalho envolve a realização de tarefas relativamente simples	○	○	○	○	○
Meu trabalho envolve uma grande variedade de tarefas.	○	○	○	○	○
Outras pessoas na organização, tais como gerentes e colegas de trabalho, fornecem informações sobre a efetividade (ex., qualidade e quantidade) do meu desempenho no trabalho.	○	○	○	○	○
No meu trabalho, eu tenho a possibilidade de conhecer outras	○	○	○	○	○

pessoas.					
Meu trabalho exige o meu envolvimento em uma grande quantidade de atividades que envolvem pensamento	○	○	○	○	○
O meu supervisor está preocupado com o bem-estar das pessoas que trabalham para ele/ela.	○	○	○	○	○
Meu trabalho exige uma variedade de habilidades	○	○	○	○	○
Meu trabalho permite-me planejar como eu faço as minhas tarefas	○	○	○	○	○
O meu trabalho não pode ser feito a menos que os outros façam o seu.	○	○	○	○	○
No meu trabalho, eu me comunico frequentemente com pessoas que não trabalham na minha organização.	○	○	○	○	○
Meu trabalho envolve a realização de tarefas que tem um início e um fim claramente definidos	○	○	○	○	○
Meu trabalho obriga-me a manter o controle de mais de uma coisa ao mesmo tempo	○	○	○	○	○
As pessoas com quem trabalho são amigáveis.	○	○	○	○	○
Meu trabalho requer o uso de um considerável número de habilidades.	○	○	○	○	○
As atividades do meu trabalho são muito afetadas pelo trabalho de outras pessoas.	○	○	○	○	○
Meu trabalho envolve a interação com pessoas que não são membros da minha organização.	○	○	○	○	○
Meu trabalho exige que eu faça somente uma tarefa ou atividade de cada vez.	○	○	○	○	○
As tarefas desenvolvidas no meu trabalho têm um impacto significativo sobre pessoas fora da organização.	○	○	○	○	○
Meu trabalho obriga-me a monitorar uma grande quantidade de informações	○	○	○	○	○
Outros trabalhos dependem diretamente do meu trabalho.	○	○	○	○	○
Eu tenho a oportunidade de me encontrar com outras pessoas no meu trabalho.	○	○	○	○	○
De forma ampla, meu trabalho, em si, é muito significativo e importante	○	○	○	○	○

Meu trabalho ocorre em um ambiente limpo.	○	○	○	○	○
Meu trabalho envolve a resolução de problemas que não têm respostas corretas óbvias	○	○	○	○	○
Meu trabalho consiste em fazer uma série de coisas diferentes.	○	○	○	○	○
Meu trabalho envolve muitas interações com pessoas fora da minha organização	○	○	○	○	○
Meu trabalho exige conhecimento e competências muito especializados.	○	○	○	○	○
Meu trabalho me dá a possibilidade de usar minha iniciativa ou julgamento pessoal na realização das minhas tarefas	○	○	○	○	○
As pessoas com quem trabalho têm um interesse pessoal em mim.	○	○	○	○	○
Meu trabalho é altamente especializado em termos de propósito, tarefas ou atividades	○	○	○	○	○
Meu trabalho permite-me decidir por conta própria sobre como proceder para realizar minhas tarefas.	○	○	○	○	○
Meu trabalho exige profundidade de conhecimento e experiência.	○	○	○	○	○
Meu trabalho envolve um ambiente livre de riscos para a saúde (por exemplo, produtos químicos, gases, etc.)	○	○	○	○	○
O clima no meu local de trabalho é confortável em termos de temperatura e umidade.	○	○	○	○	○
Meu trabalho depende do trabalho de muitas pessoas diferentes para ser completado.	○	○	○	○	○
Meu trabalho obriga-me a utilizar uma variedade de diferentes habilidades a fim de completar as tarefas.	○	○	○	○	○
Foi necessário muito tempo para aprender a usar os equipamentos utilizado no meu trabalho.	○	○	○	○	○
O trabalho, em si, fornece *feedback* sobre o meu desempenho.	○	○	○	○	○
Meu trabalho está organizado de modo a que eu possa fazer uma tarefa completa, desde o início até fim	○	○	○	○	○
Eu tenho a oportunidade de desenvolver amizades no meu trabalho.	○	○	○	○	○
Meu trabalho abrange a realização de tarefas relativamente descomplicadas	○	○	○	○	○
Meu trabalho exige muito esforço físico.	○	○	○	○	○

Meu trabalho exige uma grande resistência muscular	○	○	○	○	○
Meu trabalho me dá considerável oportunidade de independência e liberdade na forma como eu realizo minhas tarefas	○	○	○	○	○
As atividades do trabalho, em si, fornecem informações diretas e claras sobre a efetividade (por exemplo, qualidade e quantidade) do meu desempenho no trabalho	○	○	○	○	○
Meu trabalho exige-me o uso de um número de habilidades complexas ou de alto nível.	○	○	○	○	○
Meu trabalho envolve passar uma grande parte do meu tempo com pessoas fora da minha organização.	○	○	○	○	○
Meu trabalho permite-me tomar muitas decisões por conta própria	○	○	○	○	○
A disposição dos espaços de trabalho é adequada (por exemplo, espaços amplos para sentar, cadeiras confortáveis, apoio postural bom).	○	○	○	○	○
Meu trabalho envolve alcances físicos (ou distâncias) excessivos.	○	○	○	○	○
O trabalho, em si, me dá informações a respeito do meu desempenho.	○	○	○	○	○
Meu trabalho me exige ser criativo	○	○	○	○	○
A menos que o meu trabalho seja feito, outros trabalhos não poderão ser completados.	○	○	○	○	○
Meu trabalho permite-me decidir sobre a ordem em que as tarefas são feitas	○	○	○	○	○
Meu trabalho exige que eu analise muita informação	○	○	○	○	○
Meu trabalho envolve a utilização de tecnologia ou equipamentos complexos.	○	○	○	○	○
Meu trabalho envolve a utilização de uma variedade de equipamentos diferentes.	○	○	○	○	○
O meu local de trabalho é normalmente livre de ruído excessivo.	○	○	○	○	○
As ferramentas, procedimentos, materiais utilizados neste trabalho são altamente especializados	○	○	○	○	○
Meu trabalho exige uma grande quantidade de força muscular.	○	○	○	○	○
Meu trabalho envolve lidar frequentemente com problemas que eu não conhecia anteriormente.	○	○	○	○	○

As tarefas no meu trabalho são simples e descomplicadas	○	○	○	○	○
Meu trabalho exige ideias ou soluções únicas para os problemas	○	○	○	○	○
Meu trabalho tem um baixo risco de acidente	○	○	○	○	○
O local de trabalho acomoda todas as diferenças de tamanho entre as pessoas em termos de alcance, altura dos olhos, espaço para as pernas, etc.	○	○	○	○	○
Meu trabalho me dá autonomia significativa na tomada de decisões	○	○	○	○	○
Meu trabalho permite-me tomar decisões sobre os métodos que eu uso para completar minhas tarefas	○	○	○	○	○
Meu trabalho exige que eu realize minhas tarefas antes que outras pessoas possam completar as suas tarefas.	○	○	○	○	○
Meu trabalho me dá a possibilidade de terminar completamente as tarefas que começo	○	○	○	○	○
Eu recebo uma grande quantidade de informações da minha chefia e dos colegas de trabalho sobre o meu desempenho no trabalho.	○	○	○	○	○
Eu recebo feedback sobre o meu desempenho no trabalho de outras pessoas da minha organização (como a minha chefia ou colegas de trabalho).	○	○	○	○	○
Os resultados do meu trabalho podem afetar significativamente a vida de outras pessoas.	○	○	○	○	○
Meu trabalho me permite completar as tarefas que inicio	○	○	○	○	○
Meu trabalho tem um grande impacto sobre pessoas fora da organização	○	○	○	○	○

SENTIMENTOS SOBRE O TRABALHO

Nesta parte do questionário, estamos interessados nos seus sentimentos em relação ao seu trabalho atual. Em uma escala de 1 a 5, na qual 1 significa “Discordo totalmente” e 5 significa “Concordo totalmente”, por favor, marque **apenas um item** para a resposta que melhor representa seu nível de concordância com **cada afirmativa**.

1	2	3	4	5
▲	▲	▲	▲	▲

Discordo Totalmente	Discordo Parcialmente	Nem discordo nem concordo	Concordo Parcialmente	Concordo Totalmente

Afirmativa	1	2	3	4	5
Estou perdendo o entusiasmo pelo meu trabalho	○	○	○	○	○
No meu trabalho, eu me sinto confiante de que realizo minhas tarefas com efetividade	○	○	○	○	○
Acho que meu trabalho não contribui para nada	○	○	○	○	○
Considerando tudo, estou satisfeito com meu trabalho	○	○	○	○	○
Trabalhar o dia todo é realmente motivo de tensão para mim	○	○	○	○	○
Quero apenas fazer o meu trabalho sem ser incomodado	○	○	○	○	○
Sinto-me esgotado pelo meu trabalho	○	○	○	○	○
Em minha opinião, eu sou bom no meu trabalho	○	○	○	○	○
Tornei-me menos interessado com o meu trabalho desde que comecei neste emprego	○	○	○	○	○
Em geral, não gosto do meu trabalho	○	○	○	○	○
Sinto-me emocionalmente esgotado com o meu trabalho	○	○	○	○	○
Sinto que estou contribuindo efetivamente com os objetivos da organização onde trabalho	○	○	○	○	○
Sinto-me muito bem quando realizo alguma coisa no trabalho	○	○	○	○	○
No meu trabalho, tenho realizado várias coisas que valem a pena	○	○	○	○	○
Em geral, eu gosto de trabalhar aqui	○	○	○	○	○
Posso resolver efetivamente os problemas que surgem no meu trabalho	○	○	○	○	○
Sinto-me cansado quando me levanto pela manhã e preciso encarar outro dia de trabalho	○	○	○	○	○
Não acho que meu trabalho seja importante	○	○	○	○	○
Sinto-me esgotado no final de um dia de trabalho	○	○	○	○	○

Eu recebo uma tarefa sem os materiais adequados para executá-la	○	○	○	○	○

Eu trabalho com dois ou mais grupos de pessoas que atuam de forma bastante diferente	○	○	○	○	○
Eu tenho que ignorar e até quebrar regras ou políticas da organização, a fim de realizar uma tarefa	○	○	○	○	○
Eu trabalho em coisas desnecessárias	○	○	○	○	○
Eu recebo solicitações incompatíveis de duas ou mais pessoas ao mesmo tempo	○	○	○	○	○
Eu tenho que fazer coisas que deveriam ser feitas de forma diferente sob diferentes condições	○	○	○	○	○
Eu faço coisas que são aceitáveis para uma pessoa e não aceitáveis para outras	○	○	○	○	○
Eu tenho que fazer tarefas sem ter os recursos humanos necessários para completá-las	○	○	○	○	○

No meu trabalho, eu sei quais são as minhas responsabilidades	○	○	○	○	○
No meu trabalho, a explicação sobre o que precisa ser feito é clara	○	○	○	○	○
No meu trabalho, eu sei que eu distribuo o meu tempo de forma adequada para atender diferentes tarefas	○	○	○	○	○
Os objetivos do meu trabalho são claros	○	○	○	○	○
No meu trabalho, eu sei exatamente o que é esperado de mim	○	○	○	○	○
No meu trabalho, eu tenho certeza sobre a quantidade de autoridade que eu tenho	○	○	○	○	○

CARACTERÍSTICAS DO TRABALHO E ROTAÇÃO

Esta parte do questionário é sobre as características do seu trabalho em equipe. Por favor, marque com um X uma única resposta que melhor reflete sua visão sobre o seu trabalho.

1. O local em que você trabalha atualmente realiza movimentações de profissionais de um projeto para o outro ou de uma equipe para a outra, durante o processo de desenvolvimento do software:

( ) Nunca ( ) Raramente ( ) As vezes ( ) Frequentemente ( ) Muito frequente

2. Você é movimentado de uma equipe para outra antes do projeto ser terminado e precisa deixar as suas atividades na equipe anterior para outra pessoa finalizar:

( ) Nunca ( ) Raramente ( ) As vezes ( ) Frequentemente ( ) Muito frequente

3. Você é alocado para realizar uma tarefa ou função, no mesmo projeto, que antes estava sendo realizada por outro membro da sua equipe e precisa deixar as suas atividades para outra pessoa finalizar:

( ) Nunca ( ) Raramente ( ) As vezes ( ) Frequentemente ( ) Muito frequente

4. Durante os últimos 3 meses, quantas pessoas da sua equipe realizaram as mesmas tarefas que você fez, além de você mesmo?

( ) Nenhuma
( ) Apenas uma pessoa
( ) Algumas poucas pessoas
( ) A maioria das pessoas
( ) Todo mundo

5. Quantas pessoas da sua equipe você acredita que são qualificadas ou capazes de realizar as tarefas que você realiza atualmente?

( ) Nenhuma ( ) Apenas uma pessoa ( ) Algumas poucas pessoas ( ) A maioria das pessoas ( ) Todo mundo

6. O quão fácil (viável) seria realizar uma permuta de tarefas entre os membros da sua equipe, ou seja, realizar trocas de tarefas entre os membros da equipe, de modo que cada um continue desenvolvendo com bom desempenho a nova atividade que recebeu e que antes era de outra pessoa?

( ) Muito difícil. A maioria das pessoas iria necessitar de muito treinamento (retreinamento).

( ) Relativamente difícil. Algumas das pessoas iriam necessitar de treinamento (retreinamento).

( ) Um pouco difícil. Poucas pessoas iriam necessitar de treinamento (treinamento).

( ) Relativamente fácil. Algumas pessoas iriam necessitar de pouquíssimo treinamento (retreinamento).

( ) Muito fácil. Ninguém iria precisar de treinamento

APPENDIX G - INTERCORRELATIONS AMONG STUDY VARIABLES

Construct	1	2	3	4	5	6	7	8	9	10
Task Characteristics										
1. Work scheduling autonomy	-									
2. Decision-making autonomy	,668**	-								
3. Work methods autonomy	,662**	,776**	-							
4. Task variety	,337**	,315**	,322**	-						
5. Significance	,290**	,262**	,333**	,376**	-					
6. Task identity	,483**	,477**	,434**	,076	,320**	-				
7. Feedback from job	,400**	,347**	,359**	,199*	,355**	,432**	-			
Knowledge characteristics										
8. Job complexity	-,159	-,136	-,147	,073	-,123	-,286**	-,118	-		
9. Information processing	,234**	,299**	,300**	,553**	,368**	,133	,181*	,226*	-	
10. Problem solving	,268**	,283**	,185*	,363**	,359**	,144	,226*	,091	,377**	-
11. Skill variety	,307**	,385**	,367**	,431**	,343**	,129	,306**	,083	,451**	,401**
12. Specialization	,198*	,326**	,297**	,309**	,254**	,363**	,322**	-,023	,360**	,243**
Social Characteristics										
13. Social support	,474**	,348**	,346**	,205*	,314**	,482**	,294**	-,126	,219*	,266**
14. Initiated interdependence	,073	,158	,053	,239**	,241**	-,012	,101	,012	,286**	,286**
15. Received interdependence	,009	,003	,001	,129	,126	,144	-,061	-,150	,220*	,216*
16. Interaction outside organization	,252**	,307**	,260**	,322**	,177*	,103	,136	,022	,397**	,202*
17. Feedback from others	,457**	,366**	,362**	,278**	,393**	,474**	,741**	-,166	,109	,218*
Outcomes										
22. Job Burnout	-,390**	-,376**	-,433**	-,168	-,308**	-,445**	-,414**	,205*	-,143	-,186*
23. Role Conflict	-,118	-,076	-,054	,260**	-,062	-,354**	-,245**	,103	,097	,164
24. Role Ambiguity	-,431**	-,362**	-,342**	-,123	-,374**	-,558**	-,459**	,224*	-,225*	-,114
Job Rotation										
25. Rotation Intensity	-,109	-,117	-,132	,014	-,136	-,220*	-,267**	,130	,046	,157
26. Job Interchangeability	-,019	-,083	-,084	-,141	-,009	,065	,096	-,007	-,230**	-,005
Outcomes 2										
Satisfaction	,355**	,327**	,349**	,166	,287**	,369**	,415**	-,089	,209*	,261**

	11	12	13	14	15	16	17	22	23	24	25	26
Knowledge characteristics												
11. Skill variety	-											
12. Specialization	,536**	-										
Social Characteristics												
13. Social support	,266**	,319**	-									
14. Initiated interdependence	,292**	,273**	,168	-								
15. Received interdependence	,110	,202*	,144	,313**	-							
16. Interaction outside organization	,138	,168	,243**	,104	,066	-						
17. Feedback from others	,274**	,396**	,451**	,119	,005	,168	-					
Outcomes												
22. Job Burnout	-,273**	-,202*	-,521**	-,002	,093	-,113	-,490**	-				
23. Role Conflict	-,002	-,101	-,334**	,052	,148	,083	-,255**	,524**	-			
24. Role Ambiguity	-,230**	-,269**	-,534**	-,152	-,147	-,098	-,612**	,554**	,426**	-		
Job Rotation												
25. Rotation Intensity	-,084	-,027	,009	,165	,119	,074	-,162	,186*	,137	,115	-	
26. Job Interchangeability	-,081	,060	,151	-,245**	-,107	-,119	,117	-,037	-,190*	,039	,211*	-
Outcomes 2												
Satisfaction	,310**	,260**	,555**	-,006	-,160	,085	,534**	-,706**	-,346**	-,483**	-,207*	,034