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Towards understanding the underlying structure of motivational factors for software engineers to guide the definition of motivational programs

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ABSTRACT

Aim: In this article, factors influencing the motivation of software engineers is studied with the goal of guiding the definition of motivational programs.
Method: Using a set of 20 motivational factors compiled in a systematic literature review and a general theory of motivation, a survey questionnaire was created to evaluate the influence of these factors on individual motivation. Then, the questionnaire was applied on a semi-random sample of 176 software engineers from 20 software companies located in Recife-PE, Brazil.
Results: The survey results show the actual level of motivation for each motivator in the target population. Using principal component analysis on the values of all motivators, a five factor structure was identified and used to propose a guideline for the creation of motivational programs for software engineers.
Conclusions: The five factor structure provides an intuitive categorization for the set of variables and can be used to explain other motivational models presented in the literature. This contributes to a better understanding of motivation in software engineering.

1. Introduction

In this article, findings from an experimental study on factors that influence the motivation of software engineers are presented. A set of motivational factors (hereafter called *motivators*) have been compiled in a systematic literature review developed by Beecham et al. (2008) and used by Sharp et al. (2009a) to develop a model of motivation for software engineers. Using an operational definition of these motivators, a field survey involving 176 software engineers from 20 Brazilian software companies was conducted. The survey data was analyzed using statistical methods and used to propose a guideline to assist practitioners (project managers, team leaders, supervisors, etc.) to define motivational actions or more comprehensive motivational programs. Besides, the results are compared to the model developed by Sharp et al. (2009a).

The socio-technical nature of software development has been recognized since the early days of software engineering (Baker, 1972; Brooks, 1975; White, 1984a,b). A naïve account of this socio-technical nature would tend to see social and technical aspects separately: the social aspects including forms of interaction, behaviours, and organization of people, while the technical ones addressing the use individuals and teams make of technologies, methods, processes and tools for software development. However, Sawyer (2004), quoting Guinan et al. (1997), states that "in practice, it is difficult to disentangle the way people do things from the methods, techniques, and computing technologies they use". This more complex understanding of the problems that relate social and technical aspects in software engineering spawned significant research and industrial efforts.

Starting in the early 1990s, several studies began to investigate the influence of human factors such as personality, individual behaviour, and cognition, on the performance of individuals and teams in software engineering (Rasch and Tosi, 1992; Bradley and Herbert, 1997; Guinan et al., 1998; Faraj and Sproull, 2000; Constantine, 1995; Curtis and Hefley, 2001). Motivation is one of these human related factors that started to attract attention from both the academic researchers and practitioners due to its reported (albeit inconclusive) effects on productivity (Boehm, 1981), quality (Mcconnell, 1998), and project failure (Demarco and Lister, 1999), besides being also difficult to manage (Couger and Zawacki, 1980; Mak and Sockel, 2001). According to Sommerville (2007) and Pritchard and Ashwood (2008), the study of motivation is closely related to the study of management in companies, since one of the management functions is to influence the behaviour of the people to achieve the objectives of the job. Since the 1980s, a significant although unconnected body of work has been produced about motivation in software engineering.

Recently, an extensive study has been carried out by researchers in Britain about motivation. After identifying that the "since

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Bartol and Martin's literature review in (Bartol and Martin, 1982) no comprehensive body of research has been published to provide a complete picture of the available material on motivation in Software Engineering", Beecham et al. (2008) carried out a comprehensive systematic review (Kitchenham, 2007) that collected evidence from over 90 studies published between 1980 and June, 2006. The results cover five important aspects for the study of motivation in software engineering: software engineer characteristics; motivators and de-motivators in software engineering; external signs of motivated and de-motivated software engineers; aspects of software engineering that motivate and de-motivate software engineers; and models of motivation in software engineering.

Then, Sharp et al. (2009a) used the evidence collected about the first four aspects to produce a model of motivation for software engineering and compare this "new model" with the existing models that came out from the fifth aspect of the literature review. This new model, named MOCC, related software engineers characteristics, mediators, controllers, motivators, de-motivators, and external signs, in an attempt to create a comprehensive, "birds eye" view of motivation in software engineering. This research has been complemented and extended in other works (Hall et al., 2008, 2009; Sharp et al., 2009a; Sharp and Hall, 2009b).

Although the MOCC model consolidates a wide range of aspects related to motivation in software engineering, most of the constructs related in the model still require operational definitions to support the development of empirical studies using the model. Such an operational definition could be used to empirically test aspects of the model and, at the same time, provide practitioners with instruments to be used in practice. These opportunities for new research are the central motivation of this work.

In this work, an operational definition of a subset of 20 motivators from the MOCC model is constructed using the Expectancy Theory (Vroom, 1964). This operational definition provides the operations necessary to measure, categorize, and manipulate the variables used to represent some of the constructs in the models: the motivators. That is, the operational definition presents both a scale and a measurement instrument that can be used to give values to the level of influence of each motivator on a person's actual motivation.

Complementing the operational definition of variables, scale, and operations, a survey questionnaire was constructed to be used to collect data from individuals regarding their current motivation in a real working context. Using this questionnaire, a cross-sectional survey was carried out with practitioners from software companies located in the Porto Digital Science Park, in the City of Recife, Brazil. From the data collected, values for all 20 motivators for each individual were computed. Then, using factorial analysis, the set of variables was reduced to a five factor structure that was then used to create guidelines for motivational actions or programs and to compare the results with the structure of the motivators proposed in the MOCC model.

This article contributes to industrial practice and academic research on motivation in software engineering. In the industrial context, the guidelines proposed using the five factor structure of motivator can be applied to create practical motivational programs, which can also be subjected to experimental test using the same research instruments used to create the guidelines. On the other hand, the operational definition of (a subset of) the MOCC constructs provides an instrument to support experimental evaluations of the model. Results from the experiments, including those related to the use of motivational programs, can be used to refine and evolve the model.

The remainder of this article is organized as follows. In Section 2, the definition of motivation is presented together with the motivation theory that underlies this study and some relevant related work. In Section 3, the research steps and the experimental parameters are described, as well as the variables, scales and the measurement instrument used in the survey. In Section 4, the findings of this work are presented and compared to the motivation model presented by Sharp et al. (2009a), and a guideline for the definition of motivational programs for software engineers is suggested. In Section 5, the results and main contributions are summarized, the limitations and threats to validity are discussed and future works are suggested.

2. Conceptual background

In this section, we provide a brief listing of the main studies about human motivation and select the Expectancy Theory of Motivation (Vroom, 1964) as the theoretical framework of this research. We then describe a model, called MOCC, which describes motivation in terms of the relationships among motivational factors, outcomes of motivated individuals, context in which the individual perform his or her tasks, and characteristics of the individual, such as personality. The MOCC model was developed to address motivation in software engineering (Sharp et al., 2009a). Although the model presents the constructs, such as motivational factors, and their supposed relationship, it does not provide operational definition of the model constructs. Therefore, we finish this section showing how to provide and operational definition of the motivational factors of the MOCC model using the Expectancy Theory. This operational definition evaluates the intensity of a motivational factor in an individual and will be used in the survey performed in this study.

2.1. Human motivation and the Expectancy Theory

Human motivation has been studied since the early 1900s. The first attempts to scientifically understand and explain motivation came from the field of psychotherapy, psychometrics, and learning theories (Pritchard and Ashwood, 2008). Only after the 1930s, was this theme broadly disseminated in business management as part of the thoughts of the School of Human Relations. The definition of motivation is polemic and has stimulated researchers and practitioners, resulting in many different theories and definitions. In Table 1, some definitions of motivation found in the literature are presented.

As seem above, there are many competing and complementary theories of motivation. The diversity of theories and models makes difficult the process of managing motivation in organizations, especially because motivation is usually confounded with other popular constructs, such as desire, enthusiasmand conditioning. Chen and Kanfer (2006) also describe that the motivation process of teams is even more complex to deal with than individual motivation, since there may be *team-level* motivators which differ from *individual-level* motivators. The present work does not address the problem of teams' motivation.

In this research, Expectancy Theory was chosen as the conceptual background and definition of motivation. The Expectancy theory was first published in 1964 by the psychologist Victor Vroom. According to Vroom (1964), the motivational process is not based only on individual needs, as proposed, for instance, in Maslow's Hierarchy of Needs (Maslow, 1943), in McClelland's "n-ach, n-affil, n-pow" approach (Mcclelland, 1958), or in Herzbeg's Motivation-Hygiene Theory (Herzberg et al., 1959). Therefore, in the Expectancy Theory, motivation is defined as "the conscientious governance process for decision between the existing possible ways of volunteer action" (Bowditch and Buono, 2007). This definition of motivation and the Expectancy Theory are part of the theoretical framework of this research.