Motivation Management Framework

Marcel Valový
Department of Information Technologies
Prague University of Economics and Business
xvalm00@vse.cz

Abstract
In this paper, the author presents his approach to addressing the challenge of effective management of software professionals' (SP) motivation, using the Self-determination theory. The paper illuminates the state of the art in the topics of personality and motivation research inside IS discipline and describes the essence of software engineering. The author then describes the methodological approach and presents his concept of the proposed Motivation Management Framework and its accompanying application.

***Keywords**:* software professional, motivation, personality, design research.

1. Introduction
This article presents the beginnings of a framework that aims to integrate motivation, personality, and the essence of software engineering. Why is this important? Organizations have long seethed ways to enhance the motivation of software personnel and more than ever before, information science researchers want to address the human aspects of software engineering.

The author proposes to create and validate the Motivation Management Framework (MoMaF), which will help managers to effectively manage motivation in software teams. For providing recommendations, it will take motivation as the dependent variable, personality as the independent variable (because personality is temporally stable), and essential SE tasks as the moderating variable (because individual SPs are motivated by different activities).

To provide useful information, the former two variables must be modelled in a quantifiable way. For modelling motivation, elements of motivation from Self-determination theory (Ryan & Deci, 2000) will be used. Personality will be assessed according to the Big Five model (Goldberg, 1993).

Because all motivational theories and frameworks should take the context of national culture into account (Latham & Pinder, 2005), the author will perform the research locally, in the Czech Republic.

Research problem:

How to effectively motivate software professionals.

Research questions:

RQ1. What are the software professionals' Big Five scores in the Czech Republic?

RQ2. What are the correlational coefficients between Big Five and Self-determination theory's elements of motivation for software professionals?

RQ3. What is the most effective assignment of the essential software engineering tasks in software teams when the individual Big Five scores and Self-determination theory's assessments are known?

2. State of the Art

2.1. Motivation and personality of software professionals
It has been long known that SPs might somehow be distinct in their attitudes to motivation (Ferratt & Short, 1986). It is also known that the differences in personalities between IT and non-IT professionals are significant (Wynekoop & Walz, 2000). These characteristic distinctions should be accounted for by the motivational methods used in software teams.

What is not known can be labelled as the "research gap", which is currently enormous in both areas. Three SLRs about motivation (Beecham et al., 2008; Sharp et al., 2009; França et al., 2011) arrived in unison at the conclusion that the understanding remains unclear of the software professionals' job, what

motivates them, how they are motivated, or the outcome and benefits of doing so. More recently, two large empirical studies have shown that motivated SPs are more innovative and successful, deliver higher quality software, and suffer less from attenuation (Verner et al., 2014; Beecham & Noll, 2015).

Regarding the research about the personality of SPs, two SLRs (Wiesche & Krcmar, 2014; Cruz et al., 2015) indicate that the state of the art is insufficient. In fact, it can be critically summarized in the following way: "The research work on personality in software engineering is incomplete, immature, insufficient and inconclusive" (Amin et al., 2020, p. 2). Well known, though, are the facts about its historical development, which is important to the choice of the research method. The research on the personality of SPs began in the 1980s when Couger and Zawacki and their colleagues (1980) developed the job diagnostics survey for data processing personnel (JDS/SP). Afterwards, many studies used Myer-Briggs Type Indicator (MBTI) for assessing personality, and while this method is still popular today, it has been widely discredited (Lewis, 2020). The current wave of research is assessing personality using the Big Five and is producing valuable results yet few to draw general conclusions.

After scrutinizing the studies about personality and motivation in IS discipline, the author assumes:

- **Variance exists between the personalities of SPs.**
- **Differences in attitude to motivation exist between SPs and stem from personality.**

2.2. The essence of software engineering

The *essence* of SE, the moderating part in the framework, can be defined as imagining an abstract program that transforms a business problem into a technological solution. The imagined abstract program has many essential complexities: it must be (i) conformant to all sorts of designs made by other people, (ii) changeable, (iii) extensible, yet also remains ephemeral for its invisibility, and then has accidental complexities, which are "those difficulties that today attend its production but that are not inherent" (Brooks, 1987). Software engineering is thus very different from other professions in most of its aspects and imposes specific challenges on its practitioners. Consequentially, the profession is troubled by the problem that many of its projects fail and that the productivity of its average and great practitioner differs by an order of magnitude (Brooks, 1995). The solution, as described by D.L. Parnas lies in adhering to established principles and techniques which require hard cognitive work, therefore will require a *highly motivated workforce* (Fraser et al., 2007).

Using these ideas as a guiding context, the author assumes that:

- **The solution to the essential complexity of SE is a highly motivated team.**
- **Assigning the essential activities of SE to SPs according to their motivational needs which stem from their predominant personality trait will increase the team's overall motivation.**

The initial working concept of the motivating essence of SE and predominant Big Five trait is:

1. Re-usability and conformity to foreign interfaces: conscientiousness.
2. Great design: openness to experience.
3. Iterative development: agreeableness.
4. Refactoring and design patterns: neuroticism.
5. Involvement of the client: extraversion.

Note: The current list of essential activities stems from "No Silver Bullet" (Brooks, 1987) and will be expanded after the first empirical study and then again after the deep interviews.

To conclude, the author postulates that if organizations want to improve the quality and productivity in SE, they can either reduce the accidental complexity – which has already been worked on extensively for half a century –, or they can increase the motivation of software professionals which will lead to better performance in solving the essential complexity of software engineering. The latter can be achieved by providing managers with effective motivation management tools, such as MoMaF.

3. Methodology

3.1. Empirical research

The author will follow a method for establishing empirically-based links between SPs and their SE behaviour proposed by Feldt et al. (2010). The proposed method has three main components: (i) one

or more psychometric measurement(s), (ii) one or more software engineering measurement(s), and (iii) statistical methods to analyse the links between the former two. The main idea is that statistical methods can capture knowledge about the links.

To study personality factors and their effect on software engineering the author has chosen to do a web-based survey which will take approximately 5 to 10 minutes to complete. It will be dispersed by managers in several companies but for ethical considerations, the results will be anonymized. The survey consists of three main parts, (i) a personality test, (ii) a motivation test, and (iii) a set of questions to probe the most performed and liked essential SE activities. For (i) and (ii), standardized psychometric questionnaires Big Five Inventory (John & Srivastava, 1999) and Multidimensional Work Motivation Scale (Gagné et al., 2015) will be used.

3.2. Statistical methods and tools

The author's choice of psychometric tests that have real-valued, continuous outcome variables enables him to use more powerful and nuanced statistical analysis such as the multi-variate analysis. The main statistical method employed will be cluster analysis, which can help in finding overall patterns in the psychometric measurements and reduces the number of links that need to be investigated. Generalized Linear Models will be used to establish connections between each dimension in the psychometric measurements and individual aspects of the software engineering measurement.

3.3. Interpretation of data

Data from the Big Five Inventory will be interpreted straightforwardly, it will define the personality of the SP and will serve in the framework as **the independent variable**. Because some dimensions of the Big Five are correlated (DeYoung, 2006), clusters around them will be identified and their moderated effect on motivation will be statistically measured. The report on the preferred SE activities will be used as **the moderating variable** in finding relations between personality and motivation of SPs. Data for motivation will be used as **the dependent variable**.

3.4. Current progress

Six hypotheses were derived from the synthesis of knowledge from multiple disciplines, including psychology, organizational behaviour, and software engineering:

H1: Software professionals will cluster around five distinct personality dimensions.

H2: Software professionals will score higher on openness to experience.

H3: Motivation of software professionals will be negatively associated with neuroticism.

H4: Motivation of software professionals will be positively associated with conscientiousness.

H5: The essence of software engineering "iterative development" will be a positive moderator of motivation for SPs with high levels of agreeableness and extraversion.

H6: The essence of software engineering "great design" will be a positive moderator of motivation for SPs with high levels of openness to experience.

An empirical study is currently being performed to prove or disprove the hypotheses and to measure the strengths of the links between the variables. After the first empirical study, the methods for the framework will be derived, and accompanying managerial application will be developed. The application, resembling an expert system, will be written in Java, use Jess inference engine and encompass MoMaF as its rule base. Following Design Science Research methodology, the application will then be deployed in case study IS companies and will be iteratively validated and improved.

4. Artefacts

4.1. Motivation Management Framework

The first artefact is the Motivation Management Framework (MoMaF). It will provide practical recommendations based on the (i) Self-determination Theory's basic psychological needs for autonomy, relatedness, and competency, (ii) software professionals' Big Five scores, (iii) rule base for assigning essential SE activities according to personality and motivational profiles. The framework will consist

of a knowledge base, set of relations and their strengths, and ever-growing set of hypotheses which will be tested over time as more data is collected to its knowledge base.

4.2. Managerial application

The managerial application will be a program containing a generalized inference engine and a rule base, designed to take input data from questionnaires and assumptions and heuristically explore the logical consequences through the inferences derivable from the rule base, yielding conclusions and advice, and offering to explain its results by retracing its reasoning for the manager. The managerial assistant will offer very generalized suggestions at first, but as more system structure is embodied in the rule base, it will come more particular in the hypotheses it generates and advice it commends.

4.3. Working concept

The recommendations, in their rawest form, could look as follows:

A) The framework evaluated three software professionals who do not have adequately satisfied needs for autonomy, relatedness, and competency. This imbalance is reducing their intrinsic motivation (John, Steve), introjected motivation (Alice), which to them is of particular importance to deliver performance and quality and saps their job satisfaction.

B) The framework recommends: "Software professional John needs more autonomy, his levels of motivation, particularly intrinsic motivation are rapidly decreasing in causality (current level 3.5, down from 4.3 when evaluated six months ago). It is recommended to assign John to a fresh project and allow him to take responsibility in navigating the course of the project. His personality profile, where openness and extraversion are predominant, suggests that he will excel in "great design". However, his low level of conscientiousness imposes a risk for errors if John also performs activity "requirements refinement and rapid prototyping" and it is suggested that Steve, who is high in conscientiousness and needs more relatedness, is assigned to cooperate with John and performs those tasks."

C) The framework will offer inquiries to its knowledge base to provide the manager with insights for even better assistance of his decisions.

4.4. Last remarks

The examination of the relation between the personality type and the level of the six elements of motivation is not about being able to change the personality type so that the motivation improves. That improvement will, however, be possible by satisfying the basic psychological needs (autonomy, relatedness, competency), through providing more of what the software professional needs or less if he or she is not ready yet, *e.g.*, the junior software professional needs the manager to provide less autonomy and more relatedness. The framework will recognize which forms of motivation are important for the software professional based on his personality and which forms of motivation are negligible for him or her and thus do not affect his or her performance or retention. The recognition of what is important and what is not will enable the application to advise the manager about what actions will be the most effective and which will not, as its rule base will contain the information about strengths of moderating effects. The inference engine will try variations of assignments of the professionals to the essences of SE and offer the manager the best recommendation for his team. After enough data is collected, the author will assess and publish the reference values describing the mean average level for the six elements of motivation for each of the corresponding Big Five profiles. It is not yet known how many Big Five profiles will be common among software professionals, but the cluster analysis can be able to tell. After that, the application will also reveal to the manager how he is doing against the reference.

Funding: This work was supported by an internal grant funding scheme (F4/34/2021) administered by the Prague University of Economics and Business.

5. References

Amin, A., Basri, S., Rahman, M., Capretz, L. F., Akbar, R., Gilal, A. R., & Shabbir, M. F. (2020). The impact of personality traits and knowledge collection behavior on programmer creativity. *Information and Software Technology, 128*, 106405.

Beecham, S., Noll, J. (2015). What Motivates Software Engineers Working in Global Software Development? *Springer International Publishing*, Berlin, Heidelberg, 193–209.

Beecham, S., Baddoo, N., Hall, T., Robinson, H., & Sharp, H. (2008). Motivation in Software Engineering: A systematic literature review. *Information and software technology*, *50*(9-10), 860-878.

Brooks, F. P. (1987) No Silver Bullet: Essence and Accidents of Software Engineering. *IEEE Computer* (20:4), April 1987, pp 10-19.

Brooks, F. P. (1995). The mythical man-month: essays on software engineering. Pearson Education.

Couger, J.D., Zawacki, R.A. (1980). Motivating and managing computer personnel. Wiley, New York.

Cruz, S., da Silva, F. Q., & Capretz, L. F. (2015). Forty years of research on personality in software engineering: A mapping study. *Computers in Human Behavior*, *46*, 94-113.

DeYoung, C. G. (2006). Higher-order factors of the Big Five in a multi-informant sample. *Journal of personality and social psychology*, *91*(6), 1138.

Feldt, R., Angelis, L., Torkar, R., & Samuelsson, M. (2010). Links between the personalities, views and attitudes of software engineers. *Information and Software Technology*, *52*(6), 611-624.

Ferratt, T. W., & Short, L. E. (1986). Are information systems people different: an investigation of motivational differences. *MIS Quarterly*, 377-387.

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

Fraser, S. D., Brooks Jr, F. P., Fowler, M., Lopez, R., Namioka, A., Northrop, L., ... & Thomas, D. (2007, October). No silver bullet" reloaded: retrospective on" essence and accidents of software engineering. In *Companion to the 22nd ACM SIGPLAN conference on Object-oriented programming systems and applications companion* (pp. 1026-1030).

Gagné, M., Forest, J., Vansteenkiste, M., Crevier-Braud, L., Van den Broeck, A., Aspeli, A. K., ... & Westbye, C. (2015). The Multidimensional Work Motivation Scale: Validation evidence in seven languages and nine countries. *European Journal of Work and Organizational Psychology*, *24*(2), 178-196.

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American psychologist*, *48*(1), 26.

John, O. P., & Srivastava, S. (1999). The Big-Five trait taxonomy: History, measurement, and theoretical perspectives (Vol. 2, pp. 102-138). Berkeley: University of California.

Latham, G. P., & Pinder, C. C. (2005). Work motivation theory and research at the dawn of the twenty-first century. *Annu. Rev. Psychol.*, *56*, 485-516.

Lewis, C. (2020). On personality testing and software engineering. In *31st Annual Workshop of the Psychology of Programming Interest Group (PPIG 2020)* (pp. 39-41).

Sharp, H., Baddoo, N., Beecham, S., Hall, T., & Robinson, H. (2009). Models of motivation in software engineering. *Information and software technology*, *51*(1), 219-233.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, *55*(1), 68.

Verner, J. M., Babar, M. A., Cerpa, N., Hall, T., Beecham, S. (2014). Factors that motivate software engineering teams: A four-country empirical study. *Journal of Systems and Software 92* (2014), 115–127.

Wiesche, M., & Krcmar, H. (2014). The relationship of personality models and development tasks in software engineering. In *Proceedings of the 52nd ACM conference on Computers and people research* (pp. 149-161).

Wynekoop, J. L., & Walz, D. B. (2000). Investigating traits of top-performing software developers. *Information Technology & People*.