THE ROLE OF MOTIVATIONAL FACTORS IN DISTRIBUTED SOFTWARE DEVELOPMENT TEAMS: AN EMPIRICAL INVESTIGATION

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Abstract

Distributed teams are found extensively in today’s globalized software development industry. Collaboration in such teams is based mostly on electronic communication. The limitations in terms of feedback and interaction in general, as well as aspects such as the isolation of team members or subgroups, have the potential to create motivational challenges and can therefore affect team performance. According to the social psychological VIST model, four factors determine the motivation level of members of distributed teams: Valence, Instrumentality, Self-efficacy, and Trust. This study examines the role of motivational factors in distributed software teams. We apply the VIST model for the first time in the context of distributed software development teams.

In a global online survey, data about the VIST factors, individual motivation, and team success were collected from 206 software development professionals. Using structural equation modelling, our analysis confirms that the VIST factors in general and interpersonal Trust and Instrumentality in particular do influence individual motivation to a significant degree and that individual motivation in turn significantly influences team success.

We conclude that it is worthwhile for future research on distributed software development, as well as managers in practice, to consider the VIST factors and take actions to influence them in a positive manner.

Keywords: VIST model, motivation, distributed teams, IT project management, software development.
1 Introduction

Distributed software development is defined as the activity of software development performed by a team that is geographically distributed, either nationally, continentally, or globally (de Farias, 2012). Distributed or virtual teams mostly use electronic communication for cooperation and coordination (Carmel, 1999). In large software projects the use of such distributed software development (DSD) teams is practically the norm today (Herbsleb, 2007).

Work in distributed teams creates new challenges for workers within the teams as well as the management of the teams. Compared to co-located teams, personal and direct communication between members is significantly decreased or often non-existent in distributed teams (Herbsleb and Mockus, 2003), creating a host of challenges. One important challenge is the possible reduction of team members’ individual motivation when working in a distributed team (Hertel, 2002).

Software development is a creative task that requires a lot of communication between team members (Herbsleb and Mockus, 2003). While coordination problems in DSD teams have already been the subject of extensive research, motivational problems require further quantitative evaluation for better understanding and improvement of management techniques. The problem of motivation in distributed teams itself is relevant, as the number of globally distributed teams is likely to increase for future software development projects.

This study intends to contribute to a better understanding of motivational factors in DSD teams. The paper therefore is of great interest to managers of distributed teams and to researchers in that domain.

In this study the authors posed the following research questions: What are the specific individual motivational challenges for DSD teams and how strong is their influence? How strong is the influence of individual motivation on team success?

To explain motivational factors and their relation to team success in DSD teams, we borrow from social psychology research. The VIST model (Hertel 2002) will be tested for applicability in the IS context. The proposed construct will be examined by conducting an empirical study using structural equation modelling.

2 Literature Review

2.1 Motivation in distributed software development teams

According to Law and Raylene (2005), motivation can be understood as a source of performance improvement, which leads to an increase in productivity through effective teamwork. The importance of motivation in software development teams has been studied extensively and a positive impact on productivity and the software developers’ quality of work has been proofed (Beechamet 2007). It was found that, for example, intense contact with other team members and participation in decision-making can help minimize the negative impacts of motivational challenges (de Farias et al. 2012). Since DSD teams can struggle even more with personal motivation, the explicit consideration of influencing factors is important in DSD research.

Šteinberga and Šmite (2011) focus on the question of how motivating and demotivating factors present themselves for software engineers in DSD. They derive motivators and demotivators from a literature review and discuss whether they are influenced by the distribution of a team. They found that 13 out of 21 motivators are challenged by distribution while 6 out of 15 demotivators are triggered by it. Relevant intrinsic motivational factors include teamwork, development practice, technically challenging work, trust, and employee participation. Influencing extrinsic factors are feedback and a sense of belonging.
De Farias et al. (2012) investigate key success factors in the motivation of distributed teams in their literature review. They distinguish 11 success factors: creation of appropriate infrastructure, the nature of the work, setting standards, autonomy, perception of importance, feedback, sharing leadership, promoting team spirit, training, attention to cultural differences, and attention to individualities. De Farias et al. categorize each of their factors according to a proposal integrating Maslow and Herzberg’s motivational theories. De Farias et al. explain that the motivational factors have a significant influence on team performance. The findings demonstrate that these motivational factors are related to different levels of motivation. De Farias et al. conclude that the motivational factors have to be considered carefully when working with distributed teams, because even the factors related to higher motivational levels are dependent.

In summary, current research on DSD emphasizes the importance of motivation and influencing factors. Nevertheless, there are no empirical studies investigating those relationships and giving insights into their strength thus far. Furthermore, the papers presented above neglect existing and established psychological constructs. In order to fill this research gap, we will borrow from social psychological research, with the VIST model being a promising approach. It extends the current perspective by explicitly integrating the perceptions of DSD members. Moreover, transferred into our context, it allows first empirical insights into the relationship of influencing factors, personal motivation, and team success.

2.2 The VIST model of motivation

The VIST model of member motivation in distributed teams was developed by Hertel (2002) and based on social psychology theories. It integrates different theories relating to motivation from social psychology and adapts these to the specifics of distributed teams. The VIST model assumes that individuals in virtual teams generally try to maximize the expected subjective value of their actions. According to the model, the expected value of an action - and thus the individual motivation for the execution of the action - is determined by four different components.

Valence (V) describes the subjective evaluation of the team's goals by the individual team member. Thus, the higher the importance placed upon the team's goals by the individual, the higher his motivation to engage in the achievement of these goals will be. This is especially relevant in distributed teams because the subjective importance of the team's goals may be reduced due to the anonymity felt and decreased team identification (Hertel, 2002). Instrumentality (I) describes the perceived importance of the individual's contribution towards the achievement of the team's goals. If one's own contribution is perceived to be important, motivation and effort should be high. While it is rational to reduce effort when one's own contribution is in fact not important, problems arise when one's own contribution is in fact important, but is perceived to be unimportant (Hertel, 2002). Self-efficacy (S) describes the perceived capability of performing the work needed for the achievement of the team's goals. In other words, this is the expectation that high effort will lead to high performance. If the individual team member believes that he is not capable of performing the required tasks, his motivation will be low, even when the team's goals and one's own contribution are perceived to be important (Hertel, 2002). Trust (T) describes the expectation of a team member that other team members will not exploit him and that they will show adequate effort for the team's goals. This form of Trust is called interpersonal Trust (Hertel, 2002; Hertel et al., 2004). Low interpersonal Trust (Tp) has the potential to decrease individual motivation. Besides interpersonal Trust, Hertel (2002) also proposed the consideration of Trust in technology (Tt), which describes the reliability of the technical equipment and work processes in the team. If the systems used do not work reliably, individuals may feel that team success is mostly determined by the system and not by their effort (Hertel, 2002).

In the model, the four VIST components are understood as factors that contribute additively to individual motivation (Hertel, 2002; Hertel et al., 2003). Furthermore, as individual motivation is seen as an influential factor for individual performance, which in turn influences team success, the model
also implies a positive relation between individual motivation and team success (Hertel, 2002; Hertel et al., 2004).

As discussed above, the VIST model is appropriate for our context. It provides an empirical testable model to describe individual motivation, influencing factors, and success in the context of DSD. Moreover, it extends current IS research by integrating a perception-based perspective. Thus, it answers the first part of our research questions.

2.3 Prior research on the VIST model

So far the VIST model in its entirety has been evaluated in five published studies (Table 1), which were all conducted by the research group around Hertel and Konradt.

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>Sample</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hertel, Niedner, Hermann (2003)</td>
<td>Field study, online survey</td>
<td>39 voluntary developers who worked in subsystem groups of the Linux open source software development project</td>
<td>VIST component structure confirmed, VIS components positively correlated with motivation/performance measures</td>
</tr>
<tr>
<td>Hertel, Konradt, Orlikowski (2004)</td>
<td>Field study, online survey for team members, structured interviews with team managers</td>
<td>31 distributed teams with 109 members. One IT service provider and one sales subsidiary of a global software company</td>
<td>VIST component structure confirmed, VI components positively correlated with team success</td>
</tr>
<tr>
<td>Geister, Hertel, Konradt (2006)</td>
<td>Experimental study, two different tasks, online feedback system for half of the teams</td>
<td>104 students from eight German universities forming 52 distributed teams of two students</td>
<td>VIST component structure confirmed, VIS and Tp components positively correlated with motivation, motivation correlated with team success</td>
</tr>
<tr>
<td>Andreßen (2008)</td>
<td>Field study, survey (on- and offline) for team members and managers</td>
<td>132 international teams from 23 companies with different degrees of distribution</td>
<td>VIST component structure confirmed, all VIST components positively correlated with motivation, motivation partly correlated with performance</td>
</tr>
</tbody>
</table>

Table 1. Overview of studies about the VIST model.

The four studies in Table 1 found evidence for the validity of the VIST model in distributed teams. The study by Konradt et al. (2009) used the model in a collocated setting so its significance in the context of this study is limited. Nevertheless, it provides evidence that some basic assumptions of the model are valid. The VIST-scales displayed good internal consistencies, homogeneity, and discriminant validity. However, the whole model has not been evaluated independently.

The studies presented here do not allow direct conclusions to be drawn for the specific domain of DSD because of the samples used. Hertel et al. (2003) did in fact study a group of software developers, but these were all voluntary members of the open source Linux Kernel project. Motivational processes and factors in such voluntary teams differ substantially from those in teams of paid professionals (Lakhani and Wolf, 2002; Hertel, 2007). Therefore, the results cannot be transferred to the domain of commercial DSD. Hertel et al. (2004) studied 20 distributed service teams from an IT service provider and sales teams from a global software company. While these teams may have been partly involved in software development projects, it was not their main task, so these results cannot be transferred either.

Overall, the five studies conducted thus far provide convincing evidence that the assumptions of the VIST model are valid. It therefore seems appropriate to use the VIST model for the evaluation of motivational processes in DSD teams. No study has yet applied the model in this specific context. This study aims to close this research gap in order to draw conclusions for the effective management of DSD teams.
3 Research Design

The goal of the empirical study is to answer the research questions concerning the factors that determine the individual motivation of team members in distributed teams and the relationship between the individual motivation of team members and team success. The VIST model that was introduced before will be used as the basis for this study.

To answer the second part of our research questions, the VIST model will be evaluated in an empirical study. The following hypotheses have been formulated based on the assumptions of the VIST model translated from German language:

- **H1.** The higher the Valence, the higher the individual motivation.
- **H2.** The higher the Instrumentality, the higher the individual motivation.
- **H3.** The higher the Self-efficacy, the higher the individual motivation.
- **H4.** The higher the Trust, the higher the individual motivation.
- **H5.** The higher individual motivation, the higher the team success.

![Figure 2. VIST factors and research model.](image)

This study follows a confirmatory research approach with hypotheses based on a theoretically founded model. Our statistical procedure consisted of the following five steps: data preparation, item and scale analysis, confirmatory factor analysis, testing bivariate correlation, and multiple regressions.

3.1 Operationalization

The theoretical constructs that are the subject of this study and need operationalization are the VIST components, individual motivation, and team success. The VIST components were measured using scales adopted from Hertel et al. (2004). The translation and rephrasing was done by the authors; afterwards, the English version was checked for understandability and logic by three native English speakers.

According to Hertel et al. (2004), the Valence, Instrumentality and Self-efficacy were measured with four items each. Trust was split into interpersonal Trust (Tp) and Trust in technology (Ti) with nine and four items respectively. The technology dimension is included in this study because DSD teams often use sophisticated and complex collaboration technology, such as software configuration management and revision control systems. Motivation (M) was operationalized with three items. Global success indicators for team success were derived from Hertel et al. and, according to Procaccino et al. (2005) and Saarinen (1996), extended to fit the specifics of software development. Since indicators for effectiveness and efficacy are covered, team success is abbreviated with an E.

3.2 Data collection, preparation and rectification

For this study an online survey method was chosen because it allows for easy data collection from a large group of dispersed people in a standardized way (Orlikowski, 2002). The different items measuring the VIST components, individual motivation, and team success were designed as
statements to which the participants indicated their level of agreement on five-point Likert-type rating scales (1 = strongly disagree, 5 = strongly agree).

The basic population about which this study attempts to draw conclusions consists of all paid professionals who work or have worked in DSD. The link to the survey was distributed among IT professionals through specific channels. In total, 2553 individual survey invitations were sent out. 252 participants passed the three filter questions, which were asked to determine whether the participant is a member of the population, and clicked through the survey. This gives a return rate of just below 10%. Of the 252 cases, 46 were excluded due to quality criteria such as missing values, the implausibility of demographics and project characteristic answers, or because they were multivariate outliers. Overall, 206 complete cases that fulfilled all quality criteria were collected. The average respondent was 36.61 years old with 12.98 years of professional experience. Statements on job profiles were as follows: managers (project manager, team manager etc.) 35.9%, technical staff (developer, analyst etc.) 58.7%, administrative/support staff 1.0%, customer/user representatives 1.0%, and consultants 3.4%. The distribution of countries in which the participants were based during the project shows a large diversity, with participants from 49 different countries. The biggest participant groups were from the USA (23.8%), India (12.1%), and Ukraine (6.8%).

3.3 Quality of the measurement scales

The reliability and validity of the measurement scales for the VIST components, individual motivation, and team success were evaluated in an item and scale analysis. All measurements scales were checked for one-dimensionality and reliability using exploratory factor analyses and internal consistency checks with Cronbach’s α (≥ 0.65). Item difficulty (≥ 1.5; ≤4.5) and corrected item-total correlation (≥ 0.3) were also inspected.

Except for the Valence scale, from which two items had to be removed due to very low item difficulty and which had low internal consistency, the scales measuring the VIST and Motivation (M) constructs exhibited acceptable or good reliability and were homogenous as expected. These results can also be interpreted as a first hint for the construct validity of the VIST model (Gregory, 1996), which was further investigated in a confirmatory factor analysis.

Factor analysis of the team success (E) scale revealed that this scale had to be differentiated into two distinct scales. These two scales were both very homogenous and had high internal consistency. After reviewing them, they can be separated into input and output dimensions of team success. Input-related items (Ei) measure time- and budget-related characteristics, whereas output related items (Eo) cover functional and non-functional project outcomes. For all developed scales, unweighted index scores (sum of variable scores divided by the number of variables) were calculated for each case for further analysis.

The assumed structure of the VIST model with its five constructs and the respective items loading on these was evaluated in a confirmatory factor analysis. To evaluate validity of the model, different model fit indicators (Hu and Bentler, 1999), calculated with the Maximum Likelihood method, were compared for the theoretically assumed five-factor model and a simple one-factor model with all items loading on a single factor.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>χ²</th>
<th>df</th>
<th>χ²/df</th>
<th>p</th>
<th>P (adj.)</th>
<th>CFI</th>
<th>RMSEA</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 factor model</td>
<td>207.5</td>
<td>142</td>
<td>1.46</td>
<td>.000</td>
<td>.041</td>
<td>.943</td>
<td>.047</td>
<td>.0594</td>
</tr>
<tr>
<td>1 factor model</td>
<td>733.3</td>
<td>152</td>
<td>4.82</td>
<td>.000</td>
<td>.000</td>
<td>.494</td>
<td>.137</td>
<td>.146</td>
</tr>
</tbody>
</table>

P(adj.)=p after Bollen-Stine Bootstrap with 2500 samples

Table 2. Model fit indicators for the VIST model.

For the five-factor model, exact model fit has to be rejected based on the χ² (p = 0.000). However, the adjusted p (after the Bollen-Stine Bootstrap) of 0.041 is only just below the threshold for significance,
giving a first indication that no major misspecifications are present in the model. The approximate fit indicators all point in the same direction, demonstrating that the specified model fits the collected data quite well. In contrast, all fit indicators show poor model fit for the one-factor model. One can conclude that the theoretically assumed model of five factors fits the data much better than the single-factor model, which supports the construct validity of the VIST model.

4 Results

In the next step, the collected data was scrutinized in a bivariate correlation analysis. Afterwards, the relations between the different VIST components, individual motivation, and team success were examined in more detail in multiple regression analyses. Finally, the hypotheses were evaluated based on the results.

The scale index score means, standard deviations, and Cronbach’s alpha computed for the scales are displayed in Table 3. All further correlation and regression analyses are based on the scale index scores.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>SD</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valence (V)</td>
<td>3.72</td>
<td>.795</td>
<td>.569</td>
</tr>
<tr>
<td>Instrumentality (I)</td>
<td>4.20</td>
<td>.574</td>
<td>.804</td>
</tr>
<tr>
<td>Self-efficacy (S)</td>
<td>4.02</td>
<td>.553</td>
<td>.686</td>
</tr>
<tr>
<td>Interpersonal Trust (Tp)</td>
<td>3.44</td>
<td>.668</td>
<td>.831</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>SD</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust in the system (Tt)</td>
<td>3.33</td>
<td>.888</td>
<td>.743</td>
</tr>
<tr>
<td>Individual motivation (M)</td>
<td>4.06</td>
<td>.650</td>
<td>.736</td>
</tr>
<tr>
<td>Team success - output (Eo)</td>
<td>3.73</td>
<td>.703</td>
<td>.902</td>
</tr>
<tr>
<td>Team success - input (Ei)</td>
<td>3.54</td>
<td>.825</td>
<td>.853</td>
</tr>
</tbody>
</table>

Table 3. Means and standard deviation of scale scores.

4.1 Bivariate correlation analysis

The bivariate Pearson Product-Moment Correlation coefficients were computed for all five VIST components, individual motivation, and the two team success dimensions. These can be found in Table 4. As hypotheses H2 and H3 are directional and imply positive correlations between VIST components, individual motivation, and team success, one-tailed significance scores were examined.

The correlations between the five VIST components are all positive and low to moderate in their effects, which suggests that the constructs are reliable and have adequate discriminant validity. The input and output dimensions of team success are strongly correlated (r = 0.678, highly significant) indicating that success in the both dimensions is strongly connected.

Based on the theoretical assumptions of the VIST model, causal relations can be assumed for the correlations between the VIST components and individual motivation and between individual motivation and the team success dimensions. The correlations of the VIST components with individual motivation are all positive and highly significant. Tp (r = 0.468) and I (r = 0.427) have the strongest bivariate correlations with M, whereas Tt (r = 0.352) and S (r = 0.252) have the weakest correlations. The bivariate correlations between individual motivation and the team success dimensions are positive and highly significant as well. Interestingly, the correlation of M and Eo (r = 0.432) is considerably higher than the correlation of M and Ei (r = 0.279).

Most correlations with the success dimensions are lower than the respective correlation of the component with individual motivation. This supports the basic structural assumption of the model by which motivation acts as a mediator and indicates that team success is also influenced by variables besides individual motivation. However, both Tp and Tt have slightly higher correlations with Eo than
with M, indicating that these components might have an effect on team success that is not mediated through individual motivation.

<table>
<thead>
<tr>
<th>Constructs</th>
<th>V</th>
<th>I</th>
<th>S</th>
<th>Tp</th>
<th>Tt</th>
<th>M</th>
<th>Eo</th>
<th>Ei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valence (V)</td>
<td></td>
<td></td>
<td></td>
<td>.36**</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Instrumentality (I)</td>
<td></td>
<td>.36**</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy (S)</td>
<td>.16**</td>
<td>.49**</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpersonal Trust (Tp)</td>
<td>.33**</td>
<td>.12*</td>
<td>.09</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust in the system (Tt)</td>
<td>.26**</td>
<td>.27*</td>
<td>.23**</td>
<td>.41**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual motivation (M)</td>
<td>.39**</td>
<td>.43**</td>
<td>.25**</td>
<td>.47**</td>
<td>.35**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team success – output (Eo)</td>
<td>.20**</td>
<td>.22**</td>
<td>.22**</td>
<td>.48**</td>
<td>.36**</td>
<td>.43**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Team success – input (Ei)</td>
<td>.15*</td>
<td>.12*</td>
<td>.15*</td>
<td>.38**</td>
<td>.28**</td>
<td>.28**</td>
<td>.68**</td>
<td>1</td>
</tr>
</tbody>
</table>

N = 206; ** = p < 0.01 (1-tailed); * = p < 0.05 (1-tailed)

Table 4. Correlation matrix of VIST, individual motivation and success.

### 4.2 Multiple regression analysis

In order to assess the influence of VIST components on individual motivation and of individual motivation on team success, single regressions were computed. Table 5 displays the results of the regressions.

<table>
<thead>
<tr>
<th>Regression</th>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>( \beta )</th>
<th>p</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. VIST on individual motivation (M)</td>
<td>Constant</td>
<td>.716</td>
<td>.344</td>
<td>-</td>
<td>.039</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valence (V)</td>
<td>.113</td>
<td>.051</td>
<td>.138</td>
<td>.029</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instrumentality (I)</td>
<td>.333</td>
<td>.077</td>
<td>.294</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-efficacy (S)</td>
<td>.040</td>
<td>.076</td>
<td>.034</td>
<td>.598</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interpersonal Trust (Tp)</td>
<td>.338</td>
<td>.062</td>
<td>.348</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trust in the system (Tt)</td>
<td>.062</td>
<td>.047</td>
<td>.084</td>
<td>.187</td>
<td></td>
</tr>
<tr>
<td>2a. Individual motivation (M) on team success – output (Eo)</td>
<td>Constant</td>
<td>1.831</td>
<td>.281</td>
<td>-</td>
<td>.000</td>
<td>R² = .186</td>
</tr>
<tr>
<td></td>
<td>Individual motivation (M)</td>
<td>.467</td>
<td>.068</td>
<td>.432</td>
<td>.000</td>
<td>adj. R² = .182</td>
</tr>
<tr>
<td>2b. Individual motivation on team success – input (Ei)</td>
<td>Constant</td>
<td>2.106</td>
<td>.351</td>
<td>-</td>
<td>.000</td>
<td>R² = .078</td>
</tr>
<tr>
<td></td>
<td>Individual motivation (M)</td>
<td>.354</td>
<td>.085</td>
<td>.279</td>
<td>.000</td>
<td>adj. R² = .073</td>
</tr>
</tbody>
</table>

Table 5. Regressions of VIST components on individual motivation (1) and of individual motivation on team success – output (2a) resp. on team success – input (2b).

**Regression of VIST components on individual motivation.** First, a regression with the VIST components as independent variables (IV) and M as dependent variable (DV) was computed. The \( R^2 \) of regression 1 shows that the five VIST components together explain 38% of the variance of M and the F-test shows that the relation between IVs and DV is highly significant (p < 0.001). The regression coefficient B is positive for all VIST components, meaning that an increase of any component will lead to an increased M, which is similar to the result of the bivariate correlation analysis. However, the effect sizes and significances in the multiple regression show a more differentiated picture. The Tp and I components, which also had the highest bivariate correlations with M, both show highly significant effects. Tp, with a B of 0.338 (\( \beta = 0.348 \)), has a slightly greater effect than I, with a B of 0.333 (\( \beta = \))
Regression of individual motivation and VIST components on team success. Second, two regressions with motivation as IV and team success output (2a) resp. input (2b) as DV were computed. The $R^2$ of model 2a shows that M explains 18.6% of the variance of Eo. This relation is highly significant ($p < 0.001$). Individual motivation has a highly significant B of 0.467 ($\beta = 0.432$, equal to the bivariate correlation of M and Eo). When Ei is the DV, the model is highly significant, with an $R^2$ of 0.078 (7.8% of the variance of Ei explained). Thus, M has a much lower predictive power for Ei than for Eo. B is at 0.354 ($\beta = 0.279$) for M and highly significant.

4.3 Evaluation of the hypotheses

The results of the bivariate correlation analysis support hypotheses H1-H4. All correlations of VIST components with individual motivation were positive and highly significant so that higher VIST ratings clearly go along with higher individual motivation. Based on the VIST model a causal relation can be assumed here. The multivariate analysis did, however, show a more differentiated result. The model with all VIST components as IVs was highly significant and explained a share of 38% of the variance of individual motivation. Two of the VIST components, namely Self-efficacy (H3) and Trust in technology (H4), only had small and insignificant regression coefficients.

As two different dimensions for team success were defined in the item and scale analysis, hypothesis H5 has to be evaluated separately for both dimensions. Bivariate correlations support H5 in both dimensions, with highly significant positive correlations of the success dimensions and individual motivation. The results of the bivariate regressions are also highly significant and show that individual motivation as the single IV explains 18.6% of the variance of Eo and 7.8% of the variance of Ei. Regression coefficients of individual motivation were positive and highly significant. Correlation and regression analysis thus supported H5, although the effect of M on Ei was small.

Overall, the hypotheses derived from the VIST model were confirmed in this study, which leads to the conclusion that the VIST model can be applied to the field of distributed IT software development. The model is valid in its basic factorial structure: the components are predictors of individual motivation and individual motivation in turn is a predictor of team success. However, the different components have shown considerable differences in the magnitude of their effects. These differences will be further evaluated in the discussion of the results, along with an evaluation of the research questions.

5 Discussion

5.1 Evaluation of the research questions

Our first research question dealt with specific individual motivational challenges for DSD teams. We borrowed from social psychological research and proposed the VIST model to be applicable in our context. According to the model, we assumed that Valence, Instrumentality, Self-efficacy, and interpersonal Trust, as well as Trust, in the system are influencing factors on individual motivation in DSD. In the second portion of our research questions, we asked for the impact of each factor. It was assumed that the five components of the VIST model explain the individual motivation of team members in an additive model. In the multiple regression analysis, the model with the VIST components as IVs and M as DV explained 38% of the variance of M, which means that a
considerable share of variance is caused by variables outside the VIST model or measurement errors. This is not surprising because the construct's name 'individual motivation' already implies that this is a highly individual phenomenon, which can potentially be influenced by a large number of different personal traits and characteristics. For example, factors such as cultural background, private problems, or general attitude towards work can have a strong influence on an individual's motivation. In addition, the scales used to measure the VIST components did not all show high reliability, so measurement errors must be expected. In light of these considerations, an explained variance of 38% is a satisfactory result that supports the importance of the VIST components for individual motivation.

In our research, we found that interpersonal Trust clearly has the strongest effect on individual motivation of professionals in distributed software development teams. The importance of trust to a distributed software team is also underlined by the argumentative-deductive research of de Farias et al. (2012). We attribute this to the fact that team members in face-to-face teams work cooperatively on a single product and frequently make use of and build upon previous work of their colleagues (Sengupta et al., 2006). We also assume that the high diversity in DSD of, e.g., expertise, age, or culture leads to a lack of trust. Diversity can affect the working styles of team members and how they take up a task. Different approaches among team members can lead to a lack of trust and thus, decrease team cohesion.

Instrumentality also has a strong effect on individual motivation. As it was rated with a relatively high mean of 4.2 (Table 3) by the participants of this study one can argue that high instrumentality leads to motivation gains of team members. This fits the reasoning of Šteinberga and Šmite, who point out that the team work, responsibility, employee participation, and sense of belonging are challenged by distribution. Furthermore, our results show that Valence also has a significant effect on individual motivation. The effect is, however, weaker than those of interpersonal Trust and Instrumentality. One possible reason for the effect of Valence may lie in the typical characteristics of distributed software projects: conflicting goals can easily occur due to team members working for multiple projects simultaneously and different organizations being involved. Trust in technology and Self-efficacy did not show significant effects on individual motivation in the regression analysis.

The third part of our research questions dealt with the general impact of motivation on team success. In this study, team success was measured in two dimensions: input and output. For both dimensions, the VIST model and simple logic imply a causal relation in which higher individual motivation leads to higher team success. This basic positive causal relationship was clearly confirmed by both correlation and regression analyses. It would, however, be presumptuous to assume that individual motivation is the only important factor for team success (Brodbeck, 1996). The bivariate regression model for the effect of individual motivation on the output dimension of team success explained 18.6% of the variance. This indicates that individual motivation is one important factor for team success (output) but not the only one. This is not a surprising result, considering that many other important factors can potentially influence the output of a software development project (e.g., level of expertise of engineers and managers, resource availability, time and budget restrictions). This predictive power is even higher than in the studies around Hertel. The bivariate regression model for the effect of individual motivation on the input dimension of team success explains 7.8% of the variance. Apparently, individual motivation has a stronger effect on the quality and quantity of the output of a software development project than on the input (cost and time) needed for project completion. For the input dimension, individual motivation seems to only be a minor factor for success compared to other factors such as the accuracy of initial input estimates, changes in the project environment, or functional requirements.

5.2 Limitations of the study

First of all, the collected sample does not meet strict representative standards. Furthermore, participants' ratings of feelings and emotions retrospectively may have been subject to considerable memory bias (Brodbeck, 1996; Tourangeau, 2000). In addition, the team success ratings collected
were highly subjective because different individuals and stakeholders in software development projects can have very diverse perceptions of project success (Jiang et al., 2002). The causal relations between VIST components, individual motivation, and team success found here must therefore be viewed with some caution. Another limitation lies in the very heterogeneous nature of the sample collected, in terms of participant demographics and project characteristics.

As pointed out in Chapter 4.3, two items of the Valence measurement scales were removed due to low item difficulty and internal consistency. Therefore, the new Valence construct only consists of two items, which also explains the low Cronbach’s alpha value. It should also be mentioned that the bivariate correlation analysis of both Trust measures revealed a slightly higher correlation with Eo than with Motivation. This indicates that these components might have an effect on team success that is not mediated by individual motivation. Future research should test modifications of the model structure to examine this effect.

6 Summary and Conclusion

The goal of this study was to evaluate the role of motivation in distributed teams as a success factor in software development. For this purpose, current literature was reviewed. The VIST model, which proposes four components that determine individual motivation in distributed teams, was used as a basis for an empirical study. Data was collected with a web survey in a cross-sectional research design. Overall, 206 software professionals from 49 different countries participated in this survey.

It was shown that the VIST model holds in the context of DSD. The assumptions of the VIST model were mostly confirmed through the data analysis. The VIST components have significant predictive power for individual motivation. In DSD teams, interpersonal Trust, Instrumentality (the perceived importance of one’s own contribution for the team’s goals), and Valence (the perceived importance of the team’s goals) were found to have particularly strong effects on individual motivation. Individual motivation in turn had significant predictive power for team success.

With our study, we contribute to science as well as practices. First of all, this paper is a first step towards an empirical motivation-based research on DSD. Our empirical findings strongly suggest the consideration of motivational factors. Moreover, we extended current knowledge in the field of DSD by introducing constructs from social psychological research including a perception perspective.

This study also contributes to social psychological research, as we are the first independent group to examine the VIST model. For practitioners, our work has confirmed that efforts to increase and maintain the individual motivation of their team members are highly relevant. DSD managers should especially consider activities that improve interpersonal trust and instrumentality.

References


