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An initial analysis of software engineers' attitudes towards organizational change

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Abstract Employees' attitudes towards organizational change are a critical determinant in the change process. Researchers have therefore tried to determine what underlying concepts that affect them. These extensive efforts have resulted in the identification of several antecedents. However, no studies have been conducted in a software engineering context and the research has provided little information on the relative impact and importance of the identified concepts. In this study, we have combined results from previous social science research with results from software engineering research, and thereby identified three underlying concepts with an expected significant impact on software engineers' attitudes towards organizational change, i.e. their *knowledge* about the intended change outcome, their understanding of the *need for change*, and their feelings of *participation* in the change process. The result of two separate multiple regression analysis, where we used industrial questionnaire data (N=56), showed that the attitude concept *openness to change* is predicted by all three concepts, while the attitude concept *readiness for change* is predicted by *need for change* and *participation*. Our research provides an empirical baseline to an important area of software engineering and the result can be a starting-point for future organizational

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change research. In addition, the proposed model prescribes practical directions for software engineering organizations to adopt in improving employees' responses to change and, thus, increase the probability of a successful change.

Keywords Software engineering · Human aspects · Organizational change · Attitudes · Openness to change · Readiness for change · Systematic literature review · Behavioral software engineering · Social psychology

1 Introduction

In order to cope with a complex and changing environment, organizations seek to find new and more efficient ways to conduct their business (Platt 2007; Serour and Younessi 2006; Serour and Winder 2007; Greenwood and Hinings 1996). The capacity to manage change has become a key determinant of competitive advantage and survival (D'aveni 2010), and, therefore, industries need to adopt and utilize new processes, technologies and innovations that may enable them to achieve their goals.

Even if the importance of organizational change has been acknowledged, many of the change efforts fail to achieve their intended aims (Beer 2000). For example, a survey of over 3,000 executives reported that two thirds of the respondents indicated that their companies had failed to achieve an improvement after implementing organizational changes (Meaney and Pung 2008).

In response to the high failure rate, work and organizational researchers have sought to identify factors that increase the likelihood of successfully implementing organizational changes. The research has shown that one of the most critical factors is employees' attitude towards change (Rafferty et al. 2013; Oreg et al. 2011). An organizational change cannot be considered successful without a change in the employees' behavior (Kotter and Cohen 2002), which, according to social psychology researchers (Ajzen 2001), is controlled and predicted by attitudes.

To gain deeper knowledge of how to influence the employees' attitudes towards organizational change, researchers have tried to determine what underlying concepts that affect them. The results from these research efforts have been summarized in several comprehensive literature reviews (Choi 2011; Oreg et al. 2011; Piderit 2000; Bouckenooghe 2010). The studies reveal that approximately thirty underlying concepts so far have been identified and analyzed in various organizational contexts. Even if the research shows that the attitudes are context dependent (ten Have et al. 2016; Oreg 2006; Pettigrew et al. 2001), none of the underlying factors have, however, been explored in a software engineering organization.

The ability to conduct and cope with organizational change is especially important in software engineering organizations, where rapid changes in influential technologies, changing customer demands, and constantly evolving methodologies create a turbulent environment (Highsmith and Cockburn 2001; Nerur et al. 2005; Lenberg et al. 2015b). The employees in software engineering organizations are frequently exposed to organizational change, which is a considerable source of stress (Ferrie et al. 1995; Woodward et al. 1999). Thus, these changes need to be managed as smoothly as possible in order to maintain healthy stress levels and keep employees motivated.

Given the importance of organizational change, the significance of attitudes in the change process and the proven contextual influence on such attitudes, we think that it is high time that attitudes towards organizational change are further explored in a software engineering context. Thus, the purpose of this study is to create, verify and validate a model that predicts

software engineers' attitude towards organizational change. We aim to identify and include concepts that are relevant for software engineering and that have a significant impact on their attitudes.

We argue that previous attitude research forms a relevant starting-point for this study in spite of that no studies have been conducted in a software engineering context. Even if software development is different from many other types of work, we find it unlikely that it would constitute a whole different type of human endeavor.

We acknowledge that existing work and organizational psychology research presents a rich description of attitude towards organizational change, but note that it provides little or no information regarding the hierarchy between the underlying concepts in terms of impact. In view of the contextual importance, and in order to identify and select factors with a significant impact on software engineers' attitudes, we conducted a literature review of organizational change in software engineering organizations. Then we combined the knowledge gained through the review with knowledge from existing attitude research (Choi 2011; Oreg et al. 2011; Piderit 2000; Bouckenooghe 2010) to compile the model.

The model was verified using industrial data collected from a department within a Swedish software development company. The department, which developed safety critical software for the global market, aimed to transfer from a project-driven development process to a product-driven development process. It also wanted to move from having temporary project development teams towards having more stationary product development teams. Thus, the intended changes affected both the organizational structure and the software development processes. The data were captured at a single occasion in the beginning of the change process and, therefore, we cannot, in this study, make any statement regarding the outcome or success of that specific change.

This present work contributes to the understanding of change in software engineering organizations by selecting and identifying three underlying concepts with a significant impact on the employees' attitudes. In addition, it adds knowledge to prior attitude research by identifying and verifying two previously unexplored underlying concepts. Furthermore, the model proposed in this study provides a baseline for future software engineering attitude research and prescribe practical directions for software engineering organizations to adopt in improving employees' responses to change.

In the next section, we give further background information regarding attitudes in general and also attitudes in relation to organizational change. Then, we present the method and results of our analysis. Finally, the result is discussed and concluded.

2 Background and Related Research

In the following sections, we briefly describe previous research that we have deemed relevant and that has affected our study. This includes software process improvement, work and organization psychology, behavioral software engineering, the attitude concept and, finally, attitudes in relation to organizational change.

2.1 Software Process Improvement

Software process improvement (SPI) models such as the Capability Maturity Model (CMM) and CMMI, and standards such as ISO's SPICE (ISO/IEC-15504 1998) focus on improving processes (Niazi et al. 2006). SPI research is motivated by the assumption that there is a direct relation between process quality and the quality of the produced software (Cugola

and Ghezzi 1998). The aim of SPI is, thus, to increase product quality, but also to reduce time-to-market and production costs (Cugola and Ghezzi 1998).

Little attention has been paid to the effective implementation of the SPI models and standards, which has resulted in limited success for many SPI efforts (Herbsleb and Goldenson 1996; Niazi et al. 2006). Researchers have suggested that SPI may not be delivering the benefits promised because insufficient attention has been paid to the human aspects of the implementation (Baddoo and Hall 2004). In addition, a review study (Lavallée and Robillard 2012) identified developers resistance towards SPI as one of seven factors that have an impact the implementation of SPI.

2.2 Work and Organizational Psychology

Psychology is the study of the mind and behavior (Association 2015). Naturally, organizational psychology[1] is the application of psychology in the workplace, i.e. is concerned with 'behavior in the workplace' (Muchinsky 1997).

Work and organizational psychology has been in existence for about the last century. The question of what is significant for an individual's well-being and job satisfaction has been one of the most important research areas in organizational psychology since the 1920s. In the 1920s the research concentrated on physical work conditions such as lighting, ventilation and noise level. In the beginning of the 1930s to the beginning of the 1940s, the interest in the social aspects of the work environment increased. During these years the "human relations" – movement began, with Elton Mayo (1946) as one of its main spokesmen. Today work and organizational psychology raises important questions about how to manage effectively in organizations, in particularly with the increasing number of knowledge workers whose commitment is critical to organizational success.

2.3 Behavioral Software Engineering

Lenberg, Feldt and Wallgren have defined the research area of Behavioral Software Engineering (BSE) as the study of cognitive, behavioral and social aspects of software engineering performed by individuals, groups or organizations (Lenberg et al. 2014). A BSE literature review (Lenberg et al. 2015a) indicated that the human aspect of software engineering is a growing area of research that has been recognized as important. However, the review also showed that there are knowledge gaps and that earlier research has been focused on a few concepts, which have been applied to a limited number of software engineering areas, and, also, that the BSE research, so far, rarely has been conducted in collaboration by researchers from both software engineering and social science.

2.4 The Attitude Concept

According to (Ajzen 2001), it is commonly accepted that attitude represents a summary evaluation of an object captured in dichotomous dimensions such as good-bad, harmful-beneficial, pleasant-unpleasant and likable-dislikeable. One frequently used attitude model is the expectancy-value model (Fishbin 1972), which basically states that the overall attitude

[1] Also sometimes referred to as industrial and organizational psychology, occupational psychology, or work psychology.

towards an object is determined by the sum of the beliefs towards the same object. Each belief is weighted by the strengths of its constituting, individual beliefs.

Furthermore, attitudes are considered an important area of research in social psychology since they predict behavior (Crano and Prislin 2006). The most prominent behavior prediction model is the theory of planned behavior (TPB) (Ajzen 1991) and, its somewhat less used predecessor, the theory of reasoned action (TRA) (Fisbein and Ajzen 1975). According to TPB, people act in accordance with their intentions and perceptions of control over the behavior while intentions in turn are influenced by attitudes towards the behavior, subjective norms and perception of behavior control. Another acclaimed theory, also closely associated with attitude change, is the cognitive dissonance theory developed by Festinger (1962) in the 1950's. The theory states that people are motivated to reduce dissonance, which can be achieved through changing their attitudes or beliefs.

Regarding the formation and change of attitudes, (Crano and Prislin 2006) state the there exists two types of process models; single or dual process models. The single process model operates automatically while the dual process operates in a controlled fashion (Gawronski and Creighton 2013). The dual process models are the most influential and an example of such is the heuristic-systematic model (HSM), which describes two depths in the processing of attitude change: systematic and heuristic (Johnson and Eagly 1989). The level of process is, to a certain extent, determined by the level of motivation and/or cognitive ability, where systematic processing occurs when individuals are motivated and have a high enough cognition to process a message, and, consequently, heuristic processing occurs when the individuals have low motivation and/or low cognitive ability to process a message. Hence, when an individual is unmotivated or unable to process a message, they will use less cognitive intensive features to form the attitudes. The individual uses what Crano and Prislin (2006) refer to as "peripheral cues" or heuristics (e.g. "Dad's usually right"), which are more related to the source than the actual message content. In the latter case, the source will play a more important part in the attitude formation. However, it should also be noted that heuristic attitudes are less stable and less likely to influence behavior, compared to those formed by systematic processing.

Furthermore, when attitudes change, Wilson et al. (2000) state that the new attitudes override the old attitudes. The old attitudes do not, however, disappear. Instead, people can simultaneously hold two different attitudes toward a given object in the same context, one attitude implicit or habitual, the other explicit, where, yet again, motivation and cognitive ability are assumed to be required to retrieve the explicit attitude.

2.5 Organizational Change and Attitudes

Organizational change is both the process in which an organization changes its structure, strategies, operational methods, technologies or organizational culture to affect change within the organization and also the effects of these changes on the organization (JUMA 2014).

Attitude researchers have used several different concepts in order to measure different facets of attitudes towards organizational change. According to Choi (2011), the four most commonly used concepts are: readiness for change, openness to a change, commitment to change and cynicism about an organizational change. These attitude concepts are susceptible to situational variables and may change over time as the individuals' experiences change, and they are, therefore, better conceptualized as states than as personality traits.

Since the amount of research concerning attitudes towards organizational change is substantial, researchers have tried to comprehend it by classifying it into categories. As an

example, in a literature study, Bouckenooghe (2010) divide the research into four dualities: (1) the nature of change (episodic change or continuous change); (2) the level of change (individual level or collective level); (3) the positive versus negative focus on change (negative problem-solving or positive potential view); and (4) the research method (variance or process methods). Bouckenooghe concludes that since employees' attitudes are rooted in psychology, the majority of studies (84 %) adopted an individual level of analysis. He also argue that even though there is a general agreement that the individual employees' attitudes and behavior are crucial in the chance process, there is an evident need for more multidimensional view of change.

Furthermore, Oreg et al. (2011) analyzed 79 quantitative studies related to organizational change published between 1948 and 2007. The researchers present a model of change recipient reactions that consists of three categories. The first category, *antecedents*, consists of prechange antecedents (i.e. change recipient characteristics and internal context), and change antecedents (i.e. change process, perceived benefit/harm, and change content). The second category, *explicit reactions*, includes variables directly related to how change recipients feel (affect), what they think (cognition), or what they intend to do (behavior) in response to the change. The third and final category, *change consequences*, includes more indirect, long-term effects.

The review presents approximately thirty concepts classified into the *antecedent* category. Overall, the most common concepts in this category were, by far, factors that considered change recipient characteristics, e.g. trait, self-efficacy and locus of control. Far less attention has been given to employees' coping styles and motives, which address the questions of how employees deal with change and why they deal with it as they do.

Finally, worth noting is also that even if the literature reviews (Choi 2011; Oreg et al. 2011; Piderit 2000; Bouckenooghe 2010) present a rich description of attitudes towards organizational change, none presents a hierarchy in term of impact between the antecedents and, also, that none of the studies included in these reviews has been conducted in a software engineering organization.

3 Method

We chose to use a quantitative research design with questionnaires. According to Creswell (2013), if the problem is identifying factors that influence an outcome, the utility of an intervention, or understanding the best predictors of outcomes, then a quantitative approach is preferred. Given that much qualitatively research exists on identifying which factors affect attitudes, we argue that it is also time to build more quantitative models.

Our procedure to create the model was based on the recommendations in the *Traditional Measurement Development Process* outlined by Viswanathan (2005). As shown in Fig. 1, our procedure included seven steps, which are detailed in the following sections.

3.1 Identify Dependent Variables

We chose to represent the software engineers' attitude towards organizational change using the two concepts *readiness for change* and *openness to change* for the following reasons. First, we aimed to use concepts that had already been verified in previous research, and a literature review by Myungweon (Choi 2011) identified these as two of the most frequently used. Second, the organizational change that we explored in this study was planned by the management and, according to Miller et al. (1994), *openness to change* is defined

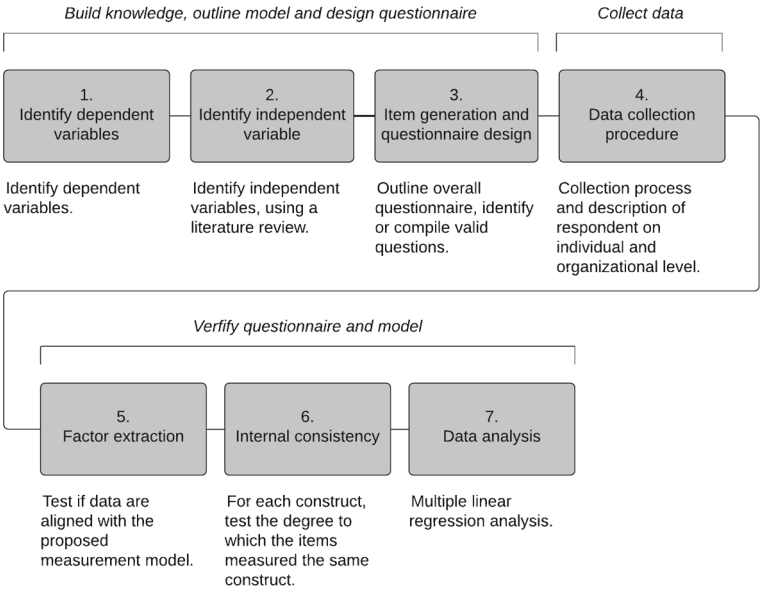

Fig. 1 Procedures used to generate the model

as an initial condition for such planned change. Third and final, since specific attitudes are a better predictor of behavior than general (Ajzen and Fishbein 1977), we wanted the questions measuring the attitudes to be directed towards the specific organizational change, not to organizational changes in general. The *readiness for change* and *openness to change* concepts met this requirement.

3.2 Identify Independent Variables

To identify human-oriented variables with a significant effect on organizational change in software engineering organizations, we performed a literature review. To the best of our knowledge, no such previous review has been conducted. In the next two sections we present the review method used and also the result.

3.2.1 Review method

Our review was based on the guidelines by Kitchenham (2004) and included the following stages: selecting data sources, selecting search string, defining research selection criteria, defining research selection process and defining data extraction and synthesis.

Selecting data sources Since we consider organizational change in software engineering to be an interdisciplinary research subject, we selected databases likely to cover both technical as well as social research; PsycINFO, Scopus and Web of Science.

Selecting search string The purpose of the search string was to capture publications related to organizational change in software engineering organizations. Therefore, we combined synonyms to 'organizational change' with synonyms to 'system engineers' (defined by Cruz et al. (2011)) with the logical AND operator.

One main contributor to organizational changes in software engineering organizations the past fifteen years has been the introduction of agile methodologies. In order to make certain that these publications were captured, we also included synonyms to 'agile transition' to the search string. The final search string looked like this: *(("organizational change" OR "organisational change" OR "organizational development" OR "organisational development") OR ((agile OR kanban) AND (transition OR adaptation OR employment OR adapt OR adoption OR adopt OR employ OR implementation OR transformation OR improvement))) AND ("software engineering" OR "software development" OR "agile development" OR "software engineer" OR "software developer" OR "software project").*

The quality of the search strings was verified by a pilot search for three known organizational change related publication (Cohn and Ford 2003; Smits and Rilliet 2011; Mockus 2010). The search string caught all of them.

Research selection criteria In order to reduce the likelihood of bias, the study selection criteria were derived. The criteria were intended to identify those primary publications that provide direct evidence regarding the aim of the review.

Inclusion Criteria

Publication Year: We limited the search to include publications between January 2000 and July 2015. The start date was set in order to capture studies related to the agile software development approach, which has had a major influence on Software Engineering.
Publication Type: We choose to include peer-reviewed papers published both in journals and in conference proceedings.
Content: Two conditions were to be met in order for the publication to be included based on content. First, the publication shall be related to organizational change in software engineering organizations, i.e. the change had to have been studied in relation software engineering activities or to software engineers. We defined organizational change as the process in which an organization changes its structure, strategies, operational methods, technologies or organizational culture to affect change within the organization, and the effects of these changes on the organization (JUMA 2014). Second, one or several human factors related concepts shall be analyzed or considered in the study. As a general guidance when identifying such factors, we used a concept list that we defined in a previous study (Lenberg et al. 2015a).

Exclusion Criteria

Language: We limited this study to only include papers written in English.
Publication Type: We excluded papers where we could not locate a full paper version, although only one paper was affected by this exclusion criterion.

To verify the criteria two researchers independently applied them to three publications. The analysis yielded similar results.

Research selection process In total, the search identified 2506 publications. First, we applied to selection criteria to the titles and excluded papers that did not relate to change in software engineering organizations. This reduced the number of potential publications down to 196. We then analyzed the abstract and removed papers that clearly did not consider

any human aspects in the relation to the change, which further reduced the number down to 128. After a full review, we finally identified 107 publications.

Data extraction and synthesis We only extracted one property, i.e. human factor related concepts. As a starting point and general guidance for the extracting process we used a concept list that we defined in a previous study (Lenberg et al. 2015a).

Regarding the synthesis, to identify relevant categories we used a simplified form of thematic analysis based on the guidance of Braun and Clarke (2006). First, we familiarized ourselves with the data by read through the entire publications. Then, we generated codes.

Table 1 Human factor related concepts affecting change outcome

Human aspects	No of publications	Publications
Management	18	(Angeline and Sudha 2015 ; Gandomani et al. 2014; Gandomani et al. 2014a; Nikitina et al. 2012; Hajjdiab et al. 2012; Smits and Rilliet 2011; Mathiassen et al. 2005; Schatz and Abdelshafi 2005; Kautz and Nielsen 2004; Cao et al. 2009; Cohn and Ford 2003; Lenberg et al. 2015b; Nerur et al. 2005; Gandomani et al. 2013; Gannon 2013; Livermore 2007; Boehm and Turner 2005; Ghani and Bello 2015)
Need for change	14	(Gandomani et al. 2015; Gandomani et al. 2014b; Hutchinson et al. 2014; Gandomani et al. 2014; Gandomani et al. 2014a; Nikitina and Kajko-Mattsson 2011; Serour and Winder 2007; Serour and Henderson-Sellers 2005; Lenberg et al. 2015b; Little 2003; Duka 2013; Seffernick 2007; Boehm and Turner 2005; Ghani and Bello 2015)
Knowledge	13	(Gandomani et al. 2014b; Hutchinson et al. 2014; Gandomani et al. 2014; Gandomani et al. 2014a; 2013; Nikitina et al. 2012; Nikitina and Kajko-Mattsson 2011; Savolainen et al. 2010; Chan and Thong 2009; Duka 2013; Kim and Ryoo 2012; Hayes and Richardson 2008; Livermore 2007)
Participation	11	(Gandomani et al. 2015; Gandomani et al. 2014; Gandomani et al. 2014a; Nikitina et al. 2012; Nikitina and Kajko-Mattsson 2011; Serour and Winder 2007; Serour and Henderson-Sellers 2005; Kautz and Nielsen 2004; Gandomani et al. 2013; Duka 2013; Kouzari et al. 2015)
Organizational culture	10	(Rodríguez et al. 2013; Escobar-Sarmiento and Linares-Vasquez 2012; Nikitina et al. 2012; Smits and Rilliet 2011; Mathiassen et al. 2005; Cao et al. 2009; Nerur et al. 2005; Cestari Silva and Goldman 2014; Rosenberg 2015)
Communication	7	(Nikitina et al. 2012; Piri et al. 2012; Conboy et al. 2010; Lenberg et al. 2015b; Chan and Thong 2009; Hui 2013; Kouzari et al. 2015)
Motivation	5	(Gandomani et al. 2015; Gandomani et al. 2014b; Prokhorenko 2012; Savolainen et al. 2010; Cestari Silva and Goldman 2014)
Commitment	4	(Gandomani et al. 2015; Hutchinson et al. 2014; Escobar-Sarmiento and Linares-Vasquez 2012; Mathiassen et al. 2005)
Trust	2	(Piri et al. 2012; Nerur et al. 2005)
Miscellaneous	13	(Parizi et al. 2014; Sato et al. 2013; Gandomani et al. 2013; Noordeloos et al. 2012; Mockus 2010; Li et al. 2010; Qumer and Henderson-Sellers 2008; Nelson et al. 2009; Seffernick 2007; Olsson et al. 2012; Sato et al. 2013; Thomas et al. 2011; Iivari and Huisman 2007)

A code marked a sentence(s) or a key word(s) that appeared to be related to a human factors concept. The codes were then grouped in a simplified thematic map (Cruzes and Dyba 2011). Finally, we categorized the codes into themes using the thematic map as well as surrounding information. In addition, we extracted the frequency of the theme among the included publication. The result is presented in Table 1.

3.2.2 Review Result

As shown in the Table 1, the review identified *management* as the most frequently occurring human-oriented concept. However, its definition was rather broad and diverse, meaning that it referred to both the leadership style of the individual manager but also to the commitment, knowledge and support from management in general. We did not find any appropriate way to operationalize such a diverse factor without jeopardizing the validity and reliability of the measurement and, consequently, we decided not to include it into our model.

Apart from *management*, the most frequently considered concepts, each included in more than ten publications, were *knowledge*, *need for change* and *participation*. *Knowledge* relates to the software engineer's understanding about the outcome of the planned change. If he/she has sufficient insights in order to determine how it will affect the company, but also how it will affect his/hers everyday work. In addition, this concept also relates to if the software engineer has previous experience of the change outcome. The second concept (*need for change*) describes if the employee understands why the change is necessary, i.e. to the reasons behind the initiation of the change. Does the software engineer feel that the organization needs to change, or does he/she think that everything is working quite well? The third concept (*participation*) relates to the software engineer's feeling of influence over the change process.

Previous attitude research has identified *participation*(Choi 2011; Oreg et al. 2011; Piderit 2000; Bouckenooghe 2010) as an antecedent to attitude towards organizational change. It has, however, not been explored in a software engineering context. The relation between the two other potential concepts, i.e. *knowledge* and *need for change*, and attitude towards organizational change has not previously been explored in any context. Even if their direct relation to attitudes has not been studied, we made the assessment that they, or at least concepts with similar meaning, have previously been used in organizational change theories.

Rendahl and Hart (1996) have proposed a theoretical model claiming that an effective organizational change is the sum of the three concepts: (1) that the employees understand the causes of the change, (2) that the employees accepts the proposed solution, and (3) that there is quality in the solution. Our hypothesis is that the *need for change* concept in our study is related to the cause of the change (1) and the *knowledge* concept is a prerequisite to the acceptance of the solution (2).

The *need for change* concept is, also, related to the first step in Kotter's (Kotter 1996) eight-step change process, i.e. *sense of urgency*. Kotter argues that the purpose of this first step is to help others see the need for change and the importance of acting immediately. By developing a sense of urgency around the need for change, you will be able to spark the initial motivation to get things moving.

Regarding *knowledge*, Beer et al. (1990) and Robey et al. (2002) have shown that effective training strengthens employees' commitment to change. In addition, according to Rendahl, a key component in achieving a quality solution (3) is to involve the employees in the change process, which means that it relates to the *participation* concept in our study.

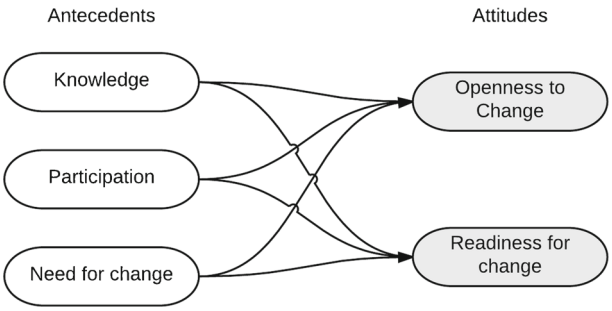

Fig. 2 Model used to predict attitudes

We also made the assessment that the three potential concepts are to be conceptualized as states, over which managers exert influence. For example, we made the assumptions that *knowledge* could be affected by training, that *need for change* could be affected by adequate information and, finally, that *participation* could be affected by the design of the change process.

Hence, as shown in Fig. 2, we chose to include the variables *knowledge*, *participation*, *need for change*, *openness to change* and *readiness for change* into our model.

3.3 Item Generation and Questionnaire Design

The questionnaire included two main parts. The first part included five items (or questions) related to background information about the respondent, The respondents were asked what type of work they performed (administrative or technical), if he/she was responsible for personnel or not, for how many year they had been working (0-5 years, 6-10, 11-15, >15) and, finally, for how many years that had been working for the department (0-5 years, 6-10, 11-15, >15). The second part included items related to the five variables in the model, see Table 2. The answers to all of these questions were measured using a five-point Likert scale with the following alternatives: 1 “strongly agree”, 2 “agree”, 3 “neither agree nor disagree”, 4 “disagree” and 5 “strongly disagree”.

Openness to change was measured using an eight-item measure developed by Miller et al. (1994), and is conceptualized as willingness to accommodate and accept change, positive affect about the potential consequences of the change, and considered a necessary, initial condition for successful planned change.

Readiness for change was measured using six items proposed by Cunningham et al. (2002), and included questions reflecting the precontemplative, contemplative, preparatory, action and maintenance stages of the change model developed by Prochaska et al. (1994). The *participation* variable was assessed using four items developed by Wanberg and Banas (2000), which measured the extent to which employees perceived that they had input into the change. We updated these two variables and directed the question towards the specific organizational change that the company was currently undergoing, i.e. transition to team-based development.

Although we aimed to use concepts that had already been verified in previous research, we did not find any appropriate for the final two variables, i.e. *knowledge* and *need for*

Table 2 The table shows the questions used to compile the five variables in the model. The last column indicates whether the response is to be inverted when creating the index variables

Identifier	Variable	Question	Reversed
O1	Openness to change	I would consider myself to be ”open” to the changes that team based development will bring to my work role.	
O2	Openness to change	Right now, I am somewhat resistant to the proposed changes in work teams.	(R)
O3	Openness to change	I am looking forward to the changes in my work role brought about by the implementation team based development.	
O4	Openness to change	In light of the proposed changes regarding team based development, I am quite reluctant to consider changing the way I now do my work.	(R)
O5	Openness to change	I think that the implementation of team based development will have a positive effect on how I accomplish my work.	
O6	Openness to change	From my perspective, the proposed changes regarding team based development will be for the better.	
O7	Openness to change	The proposed changes regarding team based development will be for the worse in terms of the way that I have to get my work done.	(R)
O8	Openness to change	I think that the proposed changes in the work teams will have a negative effect on how I perform my role in the organization.	(R)
R1	Readiness for change	The programme or area in which I work functions well and does not have any aspects which need changing.	
R2	Readiness for change	There’s nothing that I really need to change about the way I do my job to be more efficient.	
R3	Readiness for change	I’ve been thinking that I might want to help change something about the programme or area in which I work.	(R)
R4	Readiness for change	I plan to be involved in changing the programme or area in which I work.	(R)
R5	Readiness for change	I am working hard to help improve aspects of the programme or area in which I work.	(R)
R6	Readiness for change	We are trying to make sure we keep changes/improvements my programme/area has made.	

Table 2 (continued)

Identifier	Variable	Question	Reversed
P1	Participation	I have been able to ask questions about the changes regarding team-based development.	
P2	Participation	I have been able to participate in the implementation of team-based development.	
P3	Participation	I have some control over the changes regarding team-based development.	
P4	Participation	If I wanted to, I could have input into the decisions being made about team based development.	
K1	Knowledge	I have sufficient knowledge about team-based development in order to determine how that will affect my work.	
K2	Knowledge	I believe that I have a good knowledge about team-based development.	
K3	Knowledge	I have experience in team-based development.	
K4	Knowledge	I can determine if my tasks are suited to be performed using a team-based development.	
N1	Need for change	I think that this department's current way-of-working is cost effective.	(R)
N2	Need for change	I think that this department develops systems with the appropriate quality.	(R)
N3	Need for change	The documents that this department delivers to the customers hold an appropriate quality.	(R)
N4	Need for change	I think that this department needs to change its way-of-work.	(R)

change. Consequently, for these, we compiled the items ourselves using the concepts definitions, which were based on information gathered in the literature review. As stated previously, the *knowledge* variable relates to the employees knowledge about the outcome of the change. If he/she has sufficient in-sights regarding the change in order to see how it will affect the company, but also how it will affect his/hers everyday work. This concept also holds a component related to the experience of the outcome. We used four items to capture these aspects, see Table 2.

Finally, four items were used to form the *need for change* variable. The first three were related to the software engineers' opinion of the departments current way-of-working and to the quality of the systems that department produced, while the forth question was more directly related to the need for change.

3.4 Data Collection Procedure

The data in this current study were collected at a department within a large (>10000 employees) Swedish software company that was planning to initiate an organizational change. The department, which developed safety critical software for the global market, wanted to (1) transfer from a project-driven development process to a product-driven development process, and (2) move away from having temporary project development teams towards having more stationary product development teams (see Fig. 3). These proposed changes affected the organizational structure and the software development processes.

Traditionally, the products that the department owned had, to a large extent, been developed by customer projects, i.e. projects responsible for developing, customizing and delivering the product to a single customer. A consequence of this was that the products' feature sets were determined by the needs of the current paying customers and the products therefore became tailored to the existing customers' needs, not to the needs of the potential market as a whole. In addition, the quality of the products was dependent on the projects' budget. If one project ran out of money, the product quality was affected negatively, which led to a gradual degrease in quality and made feature development increasingly more expensive.

The management wanted a transfer of power from the project managers to the product managers. Project managers are responsible for the successful delivery of a single project. They align resources, manage issues and risks, and basically coordinate all of the elements necessary to complete the delivery. The project managers can undertake to build a product, to add new features to a product, or create new versions or extensions of a product. However, after the delivery, they move on to new projects that might involve different products. The product managers, on the other hand, are responsible for the overall and ongoing success of a product. Once the project to build the product is complete and the project manager has moved on, the product manager remains to manage the product through the entire life-cycle.

Prior to the change, the project managers allocated resources and created temporary development teams for each delivery. The idea of the proposed change was to group the developers in stationary autonomous teams controlled by a product manager, who had the product's long-term goals as guidance when making operational decisions, not the goals of a single project.

The employees were working at three different sites in Sweden. Two of the sites were roughly the same size in terms of number of employees (20), while the third site was approximately half the size. The employees had different roles and responsibilities and

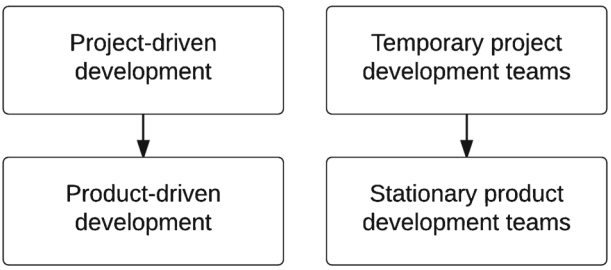

Fig. 3 Change overview

worked as software developers, project managers, team leaders or managers. The majority of the employees (90 %) had a master degree in engineering, either in software engineering, engineering physics or electronics.

The questionnaires were distributed to the employees at a biweekly department meeting in October of 2014, one week after the management had announced the organizational change. Before filling out the survey the participants were informed about the purpose of the study; that it was anonymous and that it was voluntary to participate. They were also informed that the researcher would not share the raw data with other researchers nor the management, and that no attempts would be made to identify who answered which questionnaire. During the meeting, it became clear that the employees were interested in the outcome of the study and, therefore, they were promised feedback from the researcher after the survey was completed and the data was analyzed.

Of the 65 employees at the department, 57 choose to participate in the study giving a response rate of 88 %. Approximately one per cent of the respondents were below the age of 25, and approximately 10 % were older than 45 years. The department had been growing for the last ten years, and about 40 % of the respondents had been working for the department for five year or less, while about 15 % had been working there for more than 15 years. About 55 % of the respondents had more than 10 years of IT work experience, 33 % between six and ten years experience and 12 % fewer than six years. Approximately 80 % of the respondents were male.

One of the 57 submitted questionnaires was not complete and had to be discarded. Therefore, 56 participants were finally included in the survey analysis.

3.5 Factor Extraction

We analyzed the structure of the observations and the variables to test whether the data fit a hypothesized measurement model shown in Fig. 2. Principal components analysis (PCA) was used since the primary purpose was to identify the factors underlying our measurements (Abdi and Williams 2010). The analysis was conducted using the statistical program IBM SPSS version 22. In addition, we used varimax rotation with Kaiser normalisation and listwise deletion.

First, we made an estimate of the sampling adequacy. We recognize the sample size importance and note that several guiding rules of thumb are cited in the literature (Osborne and Costello 2004). With 56 responses, our sample size is in the lower end; however, Sapnas et al. state that, for CFA, 50 cases are adequate (Sapnas and Zeller 2002).

We also tested the sampling adequacy using the Kaiser-Meyer-Olkin measure, which return a value of .74, above the recommend suitable value of .50 (Hair et al. 2006). Bartlett's test of sphericity was used to verify that our data is suitable for reduction. The test was significant ($\tilde{\chi}^2$ (231) = 779.23, p <.05). In addition, the diagonal values of the anti-image correlation matrix were all over .5, supporting the inclusion of each item in the analysis (Yong and Pearce 2013).

During several steps, a total of four items were eliminated (O1, R6, K4 and N4) because they did not contribute to a simple factor structure and failed to meet the minimum criterion of having a primary factor loading of .5 or above (Yong and Pearce 2013). These four items were therefore not included in the subsequent analysis.

The rotated component matrix and the communalities for the final 22 included items are presented in Table 3. For display purposes, loads less than .4 are suppressed. Descriptive data for the five variables are shown in Table 4.

Table 3 Principal component analysis (Abdi and Williams 2010), varimax rotation with Kaiser normalisation. For display purposes, loads less than .4 are suppressed. The first column refers to the items (questions) in Table 2

Item	Openness to change	Readiness for change	Knowledge	Need for change	Participation	Communality
O2	.74					.70
O3	.80					.78
O4	.58					.55
O5	.72					.68
O6	.80					.76
O7	.84					.75
O8	.85					.82
R1		.51				.43
R2		.53				.45
R3		.80				.72
R4		.74				.74
R5		.64				.48
K1			.81			.79
K2			.91			.86
K3			.73			.72
N1				.54		.50
N2				.83		.73
N3				.70		.75
P1					.77	.60
P2					.85	.79
P3					.80	.81
P4					.77	.76

3.6 Internal Consistency

Internal consistency is the degree to which every item measures the same concept. Cronbach's alpha, a statistical measurement calculated from the pairwise correlations between the items, was used as a lower-bound estimate of the internal consistency. The estimates, together with the mean values and standard deviations, are shown in Table 4. As can be

Table 4 The Cronbach's alpha value, mean value and standard deviation for the included variables

Variable	Cronbach Value	Mean Value (Standard Deviation)
Openness to change	.92	3.71 (.68)
Readiness for change	.71	3.70 (.51)
Knowledge	.85	3.31 (1.04)
Need for change	.68	2.57 (.67)
Participation	.86	3.01 (.88)

seen, the *need for change* variable has a somewhat lower value compared to the other variable; however, Streiner (2003) and Nunnally et al. (1967) suggested that a minimum alpha of .6 sufficed for early stage of research.

3.7 Data Analysis

In order to test the proposed model, multiple linear regression analysis was used with *openness to change* and *readiness for change* as dependent variable, while *knowledge*, *need for change* and *participation* were independent variables. The analysis was conducted using SPSS version 22 and based on the procedures outlined by Meyers et al. (2006).

Before conducting the analysis, we verified that the collected data actually could be analyzed using linear regression. A visual analysis of scatter plots for all variables indicated a linear relationship. Further, we checked the homoscedasticity and normality of residuals with the Q-Q-Plot. The plot indicated that in our multiple linear regression analysis there is no tendency in the error terms. Regarding autocorrelation, the Durbin-Watson values for the model were d = 1.73 (openness to change) and d = 1.54 (readiness for change). These are between the two critical values of $1.5 < d < 2.5$ and, therefore, we can assume that there is no first order linear auto-correlation in our multiple linear regression data. Finally, the data were analyzed in order to determine the presence of multicollinearity. The variance inflation factors (O'brien 2007) were all well below three (maximum VIF was 1.13), indicating a small risk for multicollinearity.

4 Results

Knowledge, *need for change* and *participation* were used in two separate standard multiple linear regression analysis (N=56) to predict *openness to change* (OTC) and *readiness for change* (RFC). The correlations of the variables, shown in Table 5, were overall low with a maximum value of .45 for *openness to change* and *knowledge*.

The analysis showed that the regression models for OTC and RFC are statistically significant ($F(3, 52) = 15.25$, $p < .001$; $F(3, 52) = 3.82$, $p = .015$). The former accounts for 44 % ($R^2 = .468$, Adjusted $R^2 = .437$) of the variance, while the latter accounts for considerable less, 14 % ($R^2 = .180$, Adjusted $R^2 = .136$). The explained variance of the OTC regression model is rather high compared to other studies in social science. This is, to a certain extent, the result of the relatively large number of participants in relation to a small number of variables; however, it also adds support that our hypothesized model is a good first-order approximation and captures important factors.

The results for the regression models are presented in Tables 6 and 7. As can be seen, *knowledge* is not significant in the RFC regression model, which somewhat clarifies the

Table 5 Pearson r correlations of the variables. '*' means that the correlation is significant at .10 level. '**' means that the correlation is significant at .05 level

Variable	Openness to change	Knowledge	Need for change	Participation
Readiness for change	.334**	.085	.314**	.243*
Openness to change	–	.449**	.247*	.339**
Knowledge	–	–	.033	.054
Need to change	–	–	–	−.108

Table 6 The raw and standardized regression coefficients of the predictors together with their correlations with *openness to change*, their squared semi-partial correlations (sr^2) and the significance level. The dependent variable was *openness to change*. '*' means that the variable is significant at .05 level

Model	B	SE-b	Beta	Pearson r	sr^2	Sig
(Constant)	.829	.500				.103
Knowledge*	.349	.068	.522	.449	.271	.000
Participation*	.265	.080	.340	.339	.114	.002
Need for change*	.277	.106	.266	.247	.070	.012

differences in explained variance between them. However, the *need for change* and the *participation* variables have the same order of magnitude, both in terms of their contribution to the model (Beta) and also in terms of the unique variance they explain, indexed by the squared semi-partial correlation in column sr^2.

The model, which is presented in Fig. 4, indicates that *knowledge* has a higher impact compared to *participation* (only valid for *openness to change*), and that *participation*, in turn, has a higher impact compared to *need for change*.

5 Discussion

The purpose of this study was to create, verify and validate a model that predicts software engineers' attitude towards organizational change. We aimed to identify and include concepts with a significant impact on the attitudes and which were relevant for the software engineering context.

Using a literature review, we identified three potentially significant underlying concepts, i.e. the software engineers' *knowledge* about the intended change outcome, their understanding of the *need for change*, and their feelings of *participation* in the change process.

The result of two separate multiple regression analysis, where we used industrial data (N=56), showed that the attitude concept *openness to change* is predicted by all three concepts, while the attitude concept *readiness for change* is predicted by *need for change* and *participation*.

Our findings contribute to the understanding of organizational change in several ways. First of all, it adds support to previous research. It confirms that *participation* is an antecedent to attitude towards organizational change (Choi 2011; Oreg et al. 2011). It also provides support that the two attitude concepts we used, *readiness for change* and *openness*

Table 7 The raw and standardized regression coefficients of the predictors together with their correlations with *readiness for change*, their squared semi-partial correlations (sr^2) and the significance level. The dependent variable was *readiness for change*. '*' means that the variable is significant at .05 level

Model	B	SE-b	Beta	Pearson r	sr^2	Sig
(Constant)	2.233	.450				.000
Knowledge	.029	.061	.059	.085	.003	.641
Participation*	.258	.095	.342	.314	.116	.009
Need for change*	.156	.072	.277	.243	.076	.033

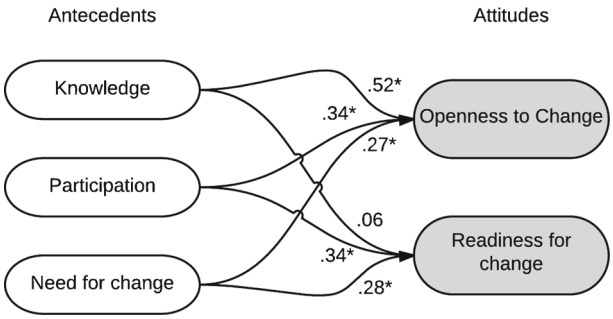

Fig. 4 Model used to predict *openness to change* and *readiness for change*. The connection line figures are the beta values from Tables 6 and 7. '*' means that the value was statistically significant at .05

to change, represent different aspects of employees' attitudes, and that lack of one concept does not simply represent the lack of another. However, worth noticing is that *knowledge* about the intended change outcome seems to be a vital component in *openness to change*, whereas it seems to be negligible in *readiness for change*, has not been shown before.

Moreover, on a more general level, our result adds some support to theoretical change theories, such as Rendahl's model for effective organizational change (Rendahl and Hart 1996) and Kotter's organizational change process (Kotter 1996).

Second, this study contributes by applying partially existing concepts to a previously unexplored context, i.e. software engineering. It indicates that *need for change*, *participation* and *knowledge* have a significant impact of software engineers' attitudes. It also provides some support for a hierarchy with respect to the three predictive concepts' degree of impact, where *knowledge* has a higher impact factor compared to *participation* (only valid for *openness to change*), and *participation*, in turn, has a higher impact factor compared to *need for change*.

Third and final, our findings add knowledge to the rich literature of attitudes towards organizational change by identifying and verifying two previously unexplored significant concepts, i.e. *knowledge* and *need for change*.

Taken together, results from this study provide directions for software engineering organizations to follow when aiming to increase support for proposed organizational changes. We believe that the simplicity of the proposed model from a practitioner's point-of-view has advantages. As we mentioned in the introduction, previous attitude research has identified a vast amount of concepts that affect employees' attitudes. For an organization to focus on all of them is very challenging, if not impossible. Our results help software engineering organizations to focus their efforts by identifying what significant concepts to primarily consider. Thus, organizations can raise their chances of successfully implementing change initiatives by targeting on increasing software engineers' *knowledge* about the change, their *participation* in the change process and, finally, their understanding of the *need for change*.

Our research provides an initial platform in an important area of software engineering, and the proposed model forms an awaited starting-point for future research. However, we acknowledge that our simplistic model cannot be considered complete. To better describe organizational life, future research should therefore focus on extending the model's complexity and also adding additional concepts.

We believe that there exist concepts unique to the software engineering context. As an example, software engineers often work together in teams and their behaviors are therefore,

to a certain extent, controlled by the team norms. Drawing on social identity and social categorization theories, Terry et al. (2000) argue that only the attitudes supported by in-group norms predict behavior. This implies that to establish a behavior change among software engineers, management needs to analyze if the changes are aligned with the group norms. If not, they need to find ways to alter them, otherwise the team members will not behave according to the attitudes and, in practice, no organizational change will occur.

In addition, using a longitudinal study we plan to evaluate if interventions can influence the factors in the attitude model and thereby also improve on the employees' attitudes towards the change.

5.1 Threats to Validity

A limitation in this study was the number of questions we were allowed by the company to use in the questionnaire, which restricted the study to include five variables. We acknowledge that such a first-order [2] model cannot be considered complete; rather, it is to be recognized as an initial approximation that captures the most significant effects.

Regarding the operationalization of two concepts *knowledge* and *need for change*, we recognize a threat to validity. In particular, the representativeness of the measurements for *knowledge*, i.e. the construct validity, is questionable. In this study, we have made the assumption that experience and knowledge together can be seen to form a psychological concept that relates to the understanding of a subject (team-based development in our case). We chose to name this psychological concept *knowledge*. The number of items used to define the concept was a trade-off against other constructs and the total time we could get from the industry practitioners. With only three items used to define the concept (one item was removed in the PCA), there is clearly room for improvement and refinement in the understanding of the concept.

In the factor extraction, we used principal component analysis (PCA). We recognize that this has sometimes been argued to not be a "true" method of factor analysis, but we also note that there is disagreement among statisticians in regards to the difference in result between PCA and CFA (O'brien 2007). This debate is, however, beyond the scope of the study.

Nonetheless, we recognize that there are alternatives to both PCA and CFA. In simulation conducted by Flora and Curran (2004), Robust Weighted Least Squares regression showed superior performance. Bayesian alternatives was proposed already in the early 1980's (Lee 1981) and allow for more flexible specification of models and less restrictive constraints on latent variables. For example, a recent approach of Conti et al. (2014) infers the number of factors along with other parameters and can utilize all available information without discarding measurements. In particular, Muthén and Asparouhov's (Muthén and Asparouhov 2012) Bayesian SEM approach replaces the parameter specification of exact zeros and exact equalities with approximate zeros and equalities‘ and can thus better represent substantive theories without multiple, often ad hoc, model rejection and retry steps as can happen when using CFA. In future work, we can consider analyzing our data with one or more of these alternative methods.

Moreover, the choice to use multiple linear regression analysis was based on the guidelines developed by Gefen et al. (2000). According to these guidelines, second generation data analysis techniques, such as partial least squares path analysis and LISREL, require a

[2]The order of approximation indicates how precise an approximation is. First-order approximation is the term used for a further educated guess at an answer (Wikipedia 2015).

sample size at least 10 times the number of latent variables in the model. We recognize that this is just a rule of thumb and that there is no general consensus on the appropriate method for determining adequate sample size (Westland 2006, 2010; Wolf et al. 2013). Nonetheless, with a sample size of 56, the choice of analysis method was by no means obvious but rather a border line case and we, therefore, acknowledge that using an alternative analysis method could have been a viable option that we will consider in future work.

Finally, in this study we have made the assumption that there is a correlation between attitude and behavior, and that a positive attitude towards organizational change ultimately will lead to a successful organizational change. This assumption needs to be verified.

6 Conclusions

In this study, we have identified three underlying concepts with an expected significant impact on software engineers' attitudes towards organizational change, i.e. their *knowledge* about the intended change outcome, their understanding of the *need for change*, and their feelings of *participation* in the change process.

We have shown that the attitude concept *openness to change* is predicted by all three underlying concepts, while the attitude concept *readiness for change* is predicted by *need for change* and *participation*.

Our research provides an empirical baseline to an important area of software engineering and the result can be a starting-point for future organizational change research. In addition, the proposed model prescribes practical directions for software engineering organizations to adopt in improving employees' responses to change and, thus, increase the probability of a successful change.

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