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221

Philipp Holtkamp

Competency Requirements of Global Software Development

Conceptualization, Contextualization, and Consequences

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UNIVERSITY OF JYVÄSKYLÄ

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ABSTRACT

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In today's market, globalization of the software industry is continuing and has reached a stage in which globally distributed development has become a normal practice. Through globalization, software organizations aim to leverage on benefits, such as access to highly skilled and competitive resources and the possibility of applying round-the-clock production, to address the competitive market and gain a competitive advantage. However, software organizations frequently fail to achieve their goals. Researchers have investigated the reasons behind such failures and have identified a variety of barriers that disrupt working processes. The available knowledge about overcoming these barriers is still sketchy. While researchers have developed different process models and managerial guidance to prevent and overcome barriers, they have neglected the role of individuals enacting these processes. Individuals are facing the consequences of these barriers on a daily basis. This dissertation addresses this research gap by investigating barriers that can be accounted for by a lack of competency and considering which competences are important for overcoming these barriers. Different methods, including quantitative and qualitative methods, are applied to investigate these competency requirements for software developers in global settings. This dissertation provides researchers and practitioners with valuable insight into which kinds of competences have the potential to support software developers in overcoming some of the critical barriers to global software development and the relation of these competences to the software development process. The findings point out that one-size-fits-all competency models are not suitable. This is based on the strong influence of the work context on the competency requirements. A contextualization of competences and their corresponding working styles and behaviors has to take place. This means software developers have to adapt their working styles and behaviors to the work context. This dissertation identified the application of soft competences, such as internationalization competences, as a suitable approach for software developers to self-assess and contextualize their competences in the work context. The results from the empirical studies provide evidence for this relation of soft competences and hard competences by confirming the existence of a negative moderation effect of intercultural competency on the effect of software development competency on job performance.

Keywords: global software development, barriers, competency requirements

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II. Pawlowski, J.M., Holtkamp, P. & Kalb, H. (2010). Globalization Competences in Information Systems and E-Learning. In ICSOB 2010: Proceedings of Workshop on Competencies for the Globalization of Information Systems in Knowledge Intensive Settings, Jyväskylä, Finland.

III. Pawlowski, J.M. & Holtkamp, P. (2012). Towards an Internationalization of the Information Systems Curriculum. In D.C. Mattfeld, S. Robra-Bissantz (eds.), MKWI 2012: Tagungsband der Multikonferenz Wirtschaftsinformatik (MKWI), 437-450. Braunschweig, Germany: GITO mbh Verlag.

IV. Hoel, T. & Holtkamp, P. (2012). Requirements modeling in International Information Systems Design—what competencies are needed and how to manage them? In J.G. Cegarra (ed.), ECKM 2012: Proceedings of the 13th European Conference on Knowledge Management. Cartagena, Spain: Academic Conferences & Publishing International.

V. Holtkamp, P., Lau, I. & Pawlowski, J.M. (2014). How do Software Development Competences change in Global Settings—An explorative study. Journal of Software: Evolution and Process, 27 (1), 50-72.

VI. Holtkamp, P., Jokinen, J. & Pawlowski, J.M. (2015). Soft Competency Requirements in Requirements Engineering, Software Design, Implementation and Testing. Journal of Systems and Software, 101 (March), 136-146.

VII. Holtkamp, P., Jokinen, J., Qiao, Z. & Pawlowski, J.M. (2015). Moderation Effect of Intercultural Competency on the Influence of Software Development Competency on the in-role Job Performance. Journal of Management Information Systems, under review.

Philipp Holtkamp was the first author of Articles I, V, VI and VII and did the majority of the work. Articles II and III are based on the ideas and previous research of Prof. Dr. Jan Pawlowski. Philipp Holtkamp did the majority of the work for these two articles. Article IV was a joint effort of Tore Hoel and Philipp Holtkamp for which both authors did equal amounts of work. Prof. Dr. Jan Pawlowski provided overall guidance for all articles and also provided reviews and comments. For Articles VI and VII, Jussi Jokinen provided his expertise on statistical data analysis and the presentation of empirical research. Ivan Lau supported the data collection and data transcription for Article V. Zhilin Qiao supported the data collection in China for Article VII.

1 INTRODUCTION

The software industry has become a highly competitive market. To survive and compete in this competitive market, software development companies are increasing their efforts to gain a competitive advantage through cost reduction and increased productivity (Sengupta et al., 2006). Globalization of the production process has the potential to achieve these goals, as it promises access to cost-competitive resources, round-the-clock development, and various other benefits (Herbsleb & Moitra, 2001). Accordingly, globalization of the production process has become increasingly popular in the software industry (Prikaldnicki et al., 2006). This trend has reached the point that global production in the software industry, also referred to as global software development (GSD), is becoming the standard practice in the field (Conchuir et al., 2009). Despite this uptake, a variety of barriers prevent software development organizations from reaching their goals (Ågerfalk et al., 2005). Therefore, overcoming these barriers is critical to ensure that software development companies can leverage the benefits of global production. Therefore, software development companies need support to reach their goals (Richardson et al., 2012).

To provide support, researchers have addressed managerial guidance for global software development in terms of processes (Prikaldnicki et al., 2006), global teaming strategies (Richardson et al., 2012), and collaboration models (Rocha et al., 2011). However, the majority of these approaches do not account for individuals who face barriers to globally distributed work on a daily basis. The importance of individual actors within software development is supported by Hazzan and Hadar (2008), who found that human aspects are the main source for barriers in software development projects. Additionally, Rivera-Ibarra et al. (2010) state that the quality of software products strongly depends on the competency — a term commonly used to describe the knowledge, skills, and abilities of individuals — of the development team members. This supports that addressing the competency of team members has the potential to enable individuals to overcome barriers and to significantly contribute toward reaching the aims of software development organizations.

Research and practical work address different aspects of individual competency, such as communication competency (e.g. Fernandez-Sanz, 2009) or business competency (e.g. Bassellier & Benbasat, 2004). However, the main focus of the research is on technical (software development) competency (e.g. Bacon & Fitzgerald, 2001; Magenheim et al., 2010). While technical competency is the focus of research and practical work, Lanubile et al. (2010) identified that soft competency—a term used to describe creative and behavioral competency (e.g. communication competency) as differentiated from hard competency describing analytical competency (e.g. technical competency)—is particularly important because it allows for productive collaboration, which leads to a decrease of barriers and an increase of product quality. In spite of these findings, soft competencies required for global software development have not been sufficiently researched (Colomo-Palacios et al., 2013). Accordingly, Ramasubbu and Krishna Balan (2008) state that the identification of competency requirements will be a significant step toward governance schemes for distributed software development projects.

Given the lack of research on competency requirements for global software development, in particular for soft competencies, and their potential impact, this dissertation examines the competencies that are seen as important for software developers in globally distributed development teams, the interdependencies of competencies and barriers preventing software development companies from leveraging the benefits of global software development, and the effect of competencies on the performance of software developers.

2 THEORETICAL FOUNDATION

In this section, the main concepts used in this dissertation will be presented and discussed. For this purpose, a short overview of research on associated topics is presented. The aim of the dissertation is to identify the competency requirements of global software development (GSD) and the influences these competencies have on the job performance of individuals and thus on organizational performance. Therefore, this section will provide a short overview of previous research on GSD, barriers for GSD, competency and related concepts, and individual job performance.

2.1 Global Software Development (GSD)

Software development companies are facing a competitive market. They are searching for a competitive advantage based on costs, quality, flexibility, and increased productivity and risk reduction (Sengupta et al., 2006). To achieve a competitive advantage, organizations often search for external solutions, which lead to distributed work environments (Prikaldnicki et al., 2006).

The distributed work environment is characterized by distance between the individuals within the environment. According to Carmel (1999), the core characteristic of global software development (GSD) is that the distance between individuals is global. While Carmel addresses solely the geographical distance between individuals, Ågerfalk et al. (2005) state that GSD involves three major types of distance: geographical, temporal, and socio-cultural. Based on these three distances, Ågerfalk et al. (2008) add that the distances between team members force software development teams to essentially become virtual teams. A virtual team is hereby defined as a group of individuals working across time, space, and organizational boundaries using communication technology (Lipnack, 1997).

According to Herbsleb and Moitra (2001), the following factors have accelerated the trend toward GSD:

- Access to the global workforce to use cost-competitive resources independent of their location
- Proximity to the market, including the knowledge of local customers and conditions and the benefits achieved through a positive image from the local investment
- Possibility to rapidly form virtual corporations and teams to exploit market opportunities
- Ability to improve time-to-market by applying round-the-clock development
- Flexibility for mergers and acquisitions independent of their location

The above factors accelerating the trend toward globalization are also commonly referred to as the benefits of GSD (c.f. Ågerfalk et al., 2008; Conchuir et al., 2009). Ågerfalk et al. (2008) refer to these factors or benefits as "The Known Benefits of GSD" and point out that these are organizational benefits. In their work, they add that there are "Unknown Benefits of GSD" on the organizational, team, and process/task levels. According to them, additional organizational benefits are innovation and shared best practices and improved resource allocations. In terms of team benefits, Ågerfalk et al. (2008) identified improved task modularization, reduced coordination cost, and increased team autonomy as unknown team benefits. In terms of process/task benefits, they identified formal records of communication, improved documentation, and clearly defined processes as further benefits of GSD.

Based on the multiple benefits of GSD, the trend of globalization in the software industry has reached the point that GSD is becoming a normal practice in the software industry (Conchuir et al., 2009). However, globalization strategies in the software industry also present barriers for organizations and individuals. These barriers are discussed in the next section.

2.2 Barriers and Interventions of GSD

GSD provides several benefits for organizations in the software industry. But as indicated before, GSD does not just offer a lot of benefits but also introduces a variety of barriers based on geographical, temporal, and socio-cultural distance (Åkerfalk et al., 2005). Ralyté et al. (2008) additionally address organization distance, technological distance, and knowledge distance as additional sources of barriers to GSD. The identified distances cause a work environment with virtual teams consisting of team members with various cultural and educational backgrounds. These barriers can be defined as "any challenge, risk, difficulty, obstacle, restriction or hindrance that might prevent a single person, a group or an organization from reaching an objective and success in a specific context when the barrier is related to acting or working in a collaborative cross-border setting" (Pirkkalainen, 2014, p. 17).

Various researchers have focused on barriers to GSD and virtual teams (c.f. Noll et al., 2010; Ågerfalk et al., 2005; Pallot et al., 2010). The main focus points were cultural differences, different working styles, and the loss of communication richness (Nunamaker et al., 2009). Huang and Trauth (2006) determined that a combination of socio-cultural distance and organizational distance can lead to different values, norms, and practices. These different values, norms, and practices might lead to incompatible views of problems and misunderstandings (Sclater et al., 2001). According to Herbsleb et al. (2000), the cultural distance and virtual nature of the work require extra effort to prevent the loss of communication richness. The virtual nature of the work and the loss of communication richness can be followed by a loss of team awareness as the ties among the team members are weakened (Sclater et al., 2001), which can lead to a lack of trust among team members (Ågerfalk et al., 2005).

Software companies and software developers engaging in GSD need support to overcome these barriers. Noll et al. (2010) noted that the focus is on technological solutions to overcome these barriers through the provision of communication and collaboration tools. This stands in contrast to the previous findings of Wright et al. (2001), who stated that people, the skills they individually and collectively should possess, and the behavior they must engage in to implement the process should be examined to overcome barriers.

An exemplary intervention addressing process, managerial, and individual aspects is the Global Teaming Framework presented by Richardson et al. (2012). The framework, based on the barriers identified by Noll et al. (2010) and the Capability Maturity Model Integration, introduces process improvements in terms of global task management, knowledge and skills management, global project management, operating procedures, and collaboration between locations. Another set of interventions was presented by Battin et al. (2001). For a number of selected barriers, they suggested procedural and managerial solutions including continuous communication, liaison to share knowledge, rational task distribution, and several others. Additionally, previous research addressing the success of virtual teams has the potential to provide insight into strategies to overcome barriers in GSD. Here, in particular the role of trust and mechanisms to build trust among the members of a virtual team has been the focus of researchers (Sarker et al., 2011).

For a more detailed view on barriers and interventions for GSD, see Article I and Article V of this dissertation.

2.3 Competency, Competence, and Related Concepts

Competency and competence are widely used concepts from enterprise and individual perspectives. Multiple additional concepts are used to describe similar aspects, such as capabilities from an enterprise or individual perspective and KSA (knowledge, skills, abilities/attitudes) from an individual perspective. Hereby, the enterprise perspective is mainly addressed in publications related

to the resource-based view of the firm (Wernerfelt, 1984). The individual perspective of competency and competence is mainly addressed in the field of education (e.g. Grant & Young, 2010; Winterton, 2006; Winterton, 2009) and human resource management (Boyatzis, 1982). As the terms and concepts are often used ambiguously and independent of the level of analysis, misunderstandings and misconceptions arise. In this section of the dissertation, the different concepts are discussed and defined and the relation between the concepts is clarified.

2.3.1 Enterprise vs. Individual Perspective of Competency

The origin of the different terminology on the enterprise level is the resource-based view (Peppard & Ward, 2004). Here, capabilities are understood as the transformation of input into output of greater worth (Schoemaker & Amit, 1994; Capron & Hulland, 1999) through processes (Wade & Hulland, 2004). Differentiation between capabilities and competencies is made based on the added value of processes (Sanchez et al., 1996) and on their strategic application (Kangas, 1999). However, a variety of different terms are used to describe the same concept. To avoid different terminologies, in this dissertation, capabilities are understood to be value-added transformations on the enterprise level.

On the individual level, competency is commonly referred to as the characteristics of an individual that lead to superior performance (Boyatzis, 1982; Winterton, 2009). The characteristics are commonly addressed through knowledge, skills, and abilities (Cheney et al., 1990). In this context, knowledge addresses content or technical information that is obtained through education or information media and is required to perform the job (Renck et al., 1969). Skills are psychomotor processes manifested in behaviors, including the selection of appropriate actions and processes for a particular situation (Cheney et al., 1990). In contrast, abilities refer to cognitive factors (Renck et al., 1969), or behaviors that are not achieved through education but can be seen as personality traits. Due to the ambiguous use of the terms *skills* and *abilities* and frequent misunderstandings, several researchers prefer the definition of KSA as knowledge, skills, and attitudes (c.f. Peppard & Ward, 2004; Winterton et al. 2006). Based on this, competency can be preliminarily explained as the set of knowledge, skills, and attitudes of an individual that are necessary to achieve superior job performance. Building on this, a competence of an individual refers to a single instance of competency. This means competence can be described as a specific KSA item, a single knowledge item, skill, or attitude necessary to fulfill a single task belonging to the job (Winterton, 2009).

The main criticism of the definition of competency and competence is the ignorance of context (Sandberg, 2010) and the lack of target orientation (Boyatzis, 1982). Therefore, in this dissertation, competency is defined as a set of knowledge, skills, and attitudes to solve a problem in a given context. Accordingly, competence is defined as a specific knowledge item, skill, or attitude necessary to fulfill a single task in a given context.

2.3.2 Hard vs. Soft Competency

In literature regarding competency and competence, a differentiation between hard competency and soft competency—similar to the common differentiation between hard skills and soft skills—can be found. This differentiation was first introduced by Jacobs (1989) to show the difference between analytical competency and more creative, interpersonal, and behavioral competency.

The differentiation between hard and soft competencies was criticized by Woodruffe (1993), who states that there is no difference between soft and hard competencies because both describe regularities in behaviors and don't explain behaviors. Despite this criticism, the differentiation between hard and soft competencies is commonly used in research and practice (Rainsbury et al., 2002).

In this dissertation, the differentiation of hard competency and soft competency is used to classify competencies with different purposes. Hard competency hereby refers to technical or software development competency necessary to fulfill the core tasks of the job. Soft competency describes competencies related to the behavior, creativity, and innovativeness of an individual.

2.3.3 Software Development Competency

Software development competency, as an example for hard competency, describes the knowledge, skills, and attitudes of software developers to fulfill the technical tasks in software development projects. Hereby, software development competency covers the entire software development process, as the competences required to fulfill tasks can differ for various projects (Bassellier & Benbasat, 2004). This means that for the definition of a software development competency construct, the tasks and related competencies for software developers have to be analyzed. Based on the approach of Davis (1989), the analysis was conducted with 100 job advertisements for software developers. The analysis of tasks and related competences is described in Article VII. Based on the analysis, in this dissertation, software development competency should be understood as the combination of competences related to architecture design, database management, programming, integration, deployment and maintenance, software development process management, network administration, requirements analysis and specification, software security, software design, and testing.

2.3.4 Internationalization Competency

Based on the notion that the quality of software strongly depends on the competences of development team members (Rivera-Ibarra et al., 2010) and the notion that soft competency is not addressed sufficiently in GSD (Colomo-Palacios et al., 2013), a framework describing the soft competencies necessary to address requirements of globally distributed work was developed in this dissertation. The resulting internationalization competency framework was developed initially in the domain of technology-enhanced learning and validated in GSD. The framework consists of competences related to information and communica-

tion technology (ICT), coordination, collaboration, communication, and intercultural work. A more detailed description of the internationalization competency framework, its conceptualization process, and the included competencies and competences is presented in Article II and Article III of this dissertation.

2.3.5 Intercultural Competency

Intercultural competency, as a subset of internationalization competency, describes a multi-dimensional construct addressing the knowledge, abilities, and attitudes required to handle intercultural aspects of globally distributed work. However, while intercultural competency is widely addressed in different research domains, no agreement on a definition has been reached (Deardorff, 2006).

To achieve a comprehensive perspective on intercultural competency, Graf and Mertesacker (2009) performed an interdisciplinary literature review to identify the components of intercultural competency. The literature review included the disciplines of communication science, psychology, pedagogy, and business. The results of this literature review showed that intercultural competency can be differentiated into three different constituent parts: cognitive, affective, and behavioral aspects (Graf & Mertesacker, 2009).

The cognitive aspects of intercultural competency describe the intercultural self-awareness of an individual (Graf & Mertesacker, 2009). Intercultural self-awareness is described by one's situational self-awareness and awareness of one's own culture, which include the understanding of norms, behaviors, and values imposed by the individual as well as reputation awareness, which describes the reputation of one's own culture in other cultures (Kupka et al., 2007).

The affective aspects of intercultural competency include the intercultural sensitivity and open-mindedness of an individual (Graf & Mertesacker, 2009). Intercultural sensitivity can hereby be defined as one's "sensitivity to the importance of cultural differences and to the points of view of people in other cultures" (Bhawuk & Brislin, 1992). Open-mindedness describes one's attitude toward other cultures and other opinions and ideas and one's interest in other cultures (Arthur & Bennett, 1995).

The behavioral aspects of intercultural competency address flexibility, non-verbal communication, and foreign language skills (Graf & Mertesacker, 2009). Flexibility can hereby be defined as "the willingness to engage in different behaviors" (Bhawuk & Brislin, 1992) and includes aspects of adjusting one's behaviors to the demands of changing situations (Zee & Oudenhoven, 2001). Non-verbal communication addresses the understanding and appropriate usage of gestures, facial expressions, and other non-verbal signs (Molinsky et al., 2005). Foreign language skills are necessary to communicate in an international environment, to find a common language, and to build trust among team members (Kupka & Everett, 2007).

2.3.6 Relations of Concepts

As described above, multiple different concepts and terms are used from different perspectives. In this section, the relation of the concepts will be presented based on the previously provided definitions.

Within the information systems (IS) domain, Peppard and Ward (2004) analyzed the relation of the enterprise level and the individual level through an in-depth review of literature related to the IS capabilities of organizations. Their results indicate that an organizational level consisting of processes, structures, and roles connects the capabilities of an enterprise with individual knowledge and skills. These knowledge and skills represent traits of individuals that directly influence organizational capabilities and thus organizational performance.

The model presented by Peppard and Ward (2004) provides a suitable basis for the relation of concepts discussed in this dissertation. Similarly to Peppard and Ward (2004), we differentiate between the enterprise level and the individual level with an organizational level consisting of processes and roles that connects these two levels. Within the enterprise level, capabilities describe the value-added processes that are based on the strategy of the enterprise. These are enabled through processes and individuals in their specific roles. For each role within each process, specific competencies are required on the individual level. These can be differentiated as hard competencies or soft competencies. In this dissertation, hard competencies refer to software development competencies. In terms of soft competencies, Article II and Article III introduce internationalization competency, a set of soft competencies relevant for international and virtual work. The internationalization competency framework is applied in Article V and Article VI. Article VII addresses intercultural competency, a subset of internationalization competency. The relation of the enterprise level, organizational level, and individual level and the related concepts is presented in FIGURE 1.

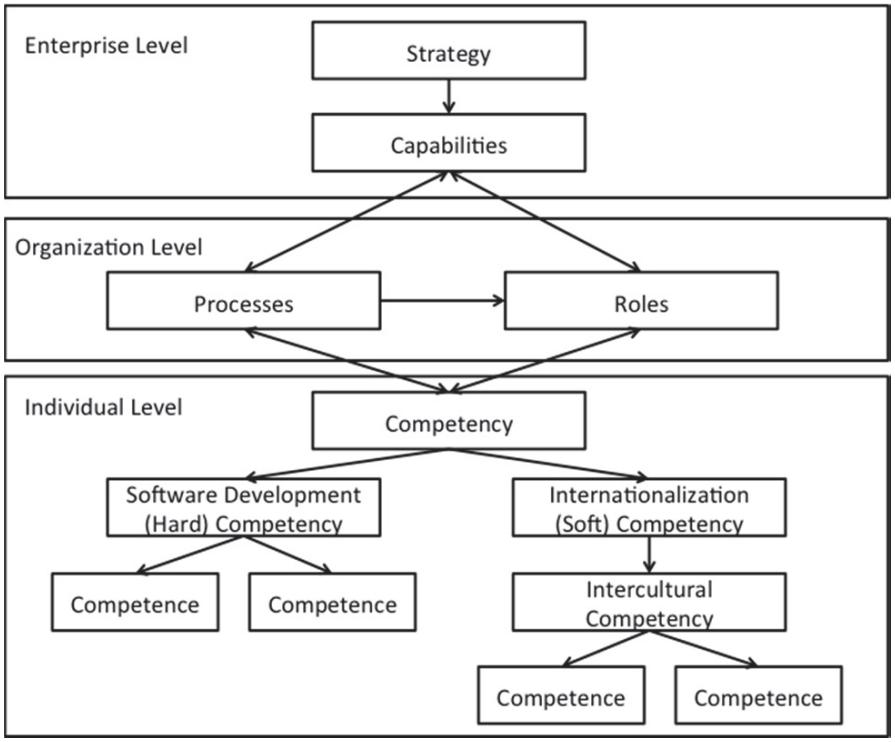

FIGURE 1 Relation of Concepts (Based on Peppard & Ward, 2004)

2.4 Individual Job Performance

Individual performance is commonly understood as a multi-dimensional model including different aspects such as technical performance, contextual/pro-social performance, managerial performance, and expatriate-specific dimensions (Caligiuri, 2000). Hereby, individual performance refers to how well an individual handles tasks at work. Motowidlo (2003, p. 53) defines job performance as "the total expected value to the organization of the discrete behavioral episodes that an individual carries out over a standard period of time."

To describe job performance, Campbell (1990) defines eight behavioral dimensions: task proficiency, non-job-specific task proficiency, written and oral communications, demonstrating effort, maintaining personal discipline, facilitating team and peer performance, supervision, and management and administration. Based on this, Schmitt et al. (2003) differentiate between task performance, contextual performance, and adaptive performance.

Hereby, task performance describes behaviors' direct contribution to value-added transformations of materials to products (Borman & Motowidlo, 1993). Katz and Kahn (1993) describe these behaviors as prescribed by one's role. Schmitt et al. (2003) add that every definition of job performance includes the

notion of task performance and that task performance is the traditional understanding of job performance. They add that the changing nature of work and the realization that task-related behaviors are not the sole component of jobs have fostered the consideration of contextual performance and adaptive performance.

While task performance describes behaviors directly linked to work tasks, contextual performance addresses behaviors supporting the work environment (Borman & Motowidlo, 1993). MacKenzie et al. (1991) define contextual performance as behaviors of an employee that are believed to directly promote the effectiveness of an organization without directly influencing the employee's productivity. Van Scotter and Motowidlo (1996) differentiate job dedication and interpersonal facilitation as important parts of contextual performance. Job dedication includes behaviors such as motivation and self-discipline, while interpersonal facilitation addresses behaviors related to cooperation and support of others (Van Scotter & Motowidlo, 1996). Schmitt et al. (2003) state that it is likely that behaviors related to contextual performance are consistent across jobs.

Adaptive performance addresses versatility and the tolerance for ambiguity required by many jobs (Schmitt et al., 2003). Pulakos et al. (2000) introduce eight factors to describe adaptive performance: handling emergencies or crisis situations; handling work stress; solving problems creatively; dealing with uncertain and unpredictable work situations; learning work tasks, technologies, and procedures; demonstrating interpersonal adaptability; demonstrating cultural adaptability; and demonstrating physically oriented adaptability. Thus, adaptive performance describes how an individual addresses changes to structure, technology, and job assignment or how well an individual adapts to new roles and can adjust his competences (Jundt et al., 2014). Jundt et al. (2014) define adaptive performance as "task-performance-directed behaviors individuals enact in response to or anticipation of changes relevant to job-related tasks."

2.5 The Relationships among Competency and Individual Job Performance

Ensuring high individual performance and accordingly high contribution toward organizational goals is a key aspect of human resource management. To be able to predict performance and understand differences in performance, Korossy (1997; 1999) developed the Competence Performance Theory (CPT). CPT is based on research on knowledge spaces and creates structures between a competence space and performance space (Ley & Albert, 2003). The performance space consists of tasks. If relations between competences and tasks can be identified, structures can be derived that represent prerequisite relations or learning paths (Ley & Albert, 2003). Based on these structures, it is possible to analyze which competences are required for different tasks, and failure can be

explained through a missing competence. Through this approach, competency requirements can be derived based on the tasks to be performed.

When addressing the different types of job performance—task performance, contextual performance, and adaptive performance—researchers have focused on explaining differences in performance and on finding predictors for performance. Schmitt et al. (2003) state that various researchers have shown that task performance can be predicted well by abilities, experiences, and scores from structured interviews. Van Scotter and Motowidlo (1996) add that job dedication as a part of contextual performance can be predicted using the same variables. In terms of interpersonal facilitation and in particular adaptive performance, cognitive abilities such as behavioral flexibility, emotional stability, and situational awareness are possible predictors (Schmitt et al., 2003). In their review on adaptive performance, Jundt et al. (2014) identified personal and situational factors, or distal factors, and motivational and knowledge-based factors as predictors of adaptive performance. Distal factors include factors related to individual differences, such as cognitive abilities, personality traits, goal orientation, training techniques, and learning strategies, including error-management training, adaptive guidance, and job, task, and contextual factors such as leader support and transformational leadership. In terms of motivational and knowledge-based factors, Jundt et al. (2014) include motivation and self-regulation such as self-efficacy and metacognition, as well as cognitive processes and behavioral strategies, including declarative knowledge and adaptive experience.

Within the frame of this dissertation, abilities are understood as hard competencies defining the knowledge, skills, and attitudes an individual has to possess to sufficiently fulfill the tasks associated with the job. In contrast to this, soft competencies could refer to cognitive abilities as they address aspects of situational awareness, interpersonal awareness, and adaptation to new work contexts.

2.6 Competency in Global Software Development

Within the software industry, the importance of a competent team was noted already in the 1980s by Brooks (1987) and Curtis et al. (1988). However, while some researchers have highlighted the importance of competent employees and identified that the development team members have a major role in the quality of software (Lanubile et al., 2010; Ribera-Ibarra et al., 2010), others have focused mainly on barriers to GSD (Ågerfalk et al., 2005; Noll et al., 2010; Pallot et al., 2010), processes for GSD (Prikladnicki et al., 2006), and managerial guidelines (Richardson et al., 2012). This leads to a situation in which competency requirements, particularly for soft competencies, are not researched sufficiently (Colomo-Palacios et al., 2013). Researchers have focused on technical competency (e.g. Bacon & Fitzgerald, 2001; Magenheim et al., 2010) or high-level competencies such as communication competency (e.g. Fernandez-Sanz, 2009) or

business competency (e.g. Bassellier & Benbasat, 2004). A short review of addressed competencies can be found in Article I.

Through the globalization of software development projects, there arises a situation in which lessons learned in one context might not be applicable in another context (Smite et al., 2008). When analyzing competences for requirements elicitation, Romero et al. (2008) identified that some competences have to be adapted and new competence requirements emerge from globalization, while few competences are not affected by globalization.

In summary, competency requirements for software developers and other IT professionals change when organizations apply GSD. While barriers preventing companies from leveraging the benefits of GSD are researched extensively and competencies are understood to be important to the success of an organization and product quality, no relation has been identified between barriers to GSD and competencies. Additionally, the knowledge of competency requirements for GSD is lacking. This holds true in particular for soft competencies. This leads to the situation that the knowledge about the influence of competencies on individual and organizational performance is shallow. These identified research gaps are the basis for the development of the research objectives and research questions addressed in this dissertation. The following section presents the research objectives and scope in more detail. A more detailed view on research gaps is presented in Article I.

2.7 Research Objectives and Scope

Given the importance of individual competency in the context of GSD as well as the lack of research addressing competency requirements and the potential impact of understanding them, it is important to analyze the current state of competence-related research in the field of GSD. This will allow the identification of weaknesses and gaps in the research and thus steer the research (RQ1; Article I).

- RQ1: What is the current state of competence-related research in the field of GSD, and what are the research gaps?

The analysis of the current state of competence-based research in GSD and IS confirmed the findings by Colomo-Palacios et al. (2013) that soft competencies are not addressed sufficiently in GSD and IS literature. While various competencies such as technical competency (Bacon & Fitzgerald, 2001; Iivari et al, 2004), project management competency (Fernandez-Sanz, 2009), communication competency (Paretti et al., 2006), collaboration competency (Levina, 2005), and intercultural competency (Paretti et al., 2006) were identified, only for technical competency did researchers and practical work address underlying competences (knowledge items, single skills, and attitudes). However, following the notion of the importance of soft competency in GSD (Lanubile et al., 2010), it is

critical to also analyze underlying competences for the relevant soft competencies. Only the understanding of the underlying competences will allow for the assessment of competences of individuals and the development of targeted interventions. For this purpose, the analysis of relevant soft competencies and competences forming these competencies in GSD was crucial (RQ2; Article II, Article III, Article IV).

- RQ2: Which soft competencies are important in GSD?

Previous studies have identified a vast variety of barriers to GSD from multiple different perspectives (Ågerfalk et al, 2005; Noll et al., 2010; Pallot et al., 2010). In particular, geographical distance, temporal distance, and socio-cultural distance are mentioned as reasons for the occurrence of these barriers (Ågerfalk et al., 2005). While barriers to GSD are widely discussed, potential interventions to overcome barriers are not addressed to the same level. Here, researchers have focused on managerial guidelines such as GSD processes (Prikaldnicki et al., 2006) and global teaming strategies (Richardson et al., 2012). Hazzan and Hadar (2008) found that human aspects are the main source of barriers in software development projects. It is therefore important to analyze which barriers can be accounted for by a lack of competences and how previous research proposes to overcome these barriers. The identification of these barriers will allow for the development of suitable interventions (RQ3, Article V).

- RQ3: Which barriers to GSD can be accounted for by a lack of competences, and which competence-based interventions can be taken to address these barriers?

Within GSD, software developers are faced with differing work contexts, as project teams and team distribution can differ between projects. This leads to a situation in which lessons learned in one context might not be applicable in another context (Smite et al. 2008). This also indicates that competences might be suitable for one context but not for another. When analyzing competences for requirements elicitation, Romero et al. (2008) identified that some competences have to be adapted, and new competence requirements emerge from globalization, while few competences are not affected by globalization. This shows that the work context might have a direct influence on the competency requirements of individuals. It is therefore critical to identify if and how context influences soft competency requirements in GSD (RQ4, Article IV, Article V).

- RQ4: How does context influence soft competency requirements in GSD?

Given the importance of the work context on the competency requirements (identified in Articles V and VI) and the findings of Romero et al. (2008) that some competences have to be adapted to the global work context, the question

arises how this competence adaptation process can be handled by individuals. It is therefore important to identify what influences the need to adapt competences and how the adaptation can take place. By identifying influence factors for the adaptation need of competences and possibilities for the adaptation, guidelines for individuals and targeted training programs can be developed. For this reason, it is critical to identify the factors influencing the need to adapt competence when changing work contexts and to provide insight into how the adaptation can be addressed by individuals (RQ5, Article V).

- RQ5: What kinds of factors influence the need to adapt competences based on a changing work context, and how can individuals handle the corresponding competence adaptation?

A variety of research addresses the difference of working styles and collaboration models between the different phases of GSD (Smite & Borzovs, 2009; Rocha et al., 2011). The different phases of GSD hereby refer to a collection of tasks related to various aspects of software development, such as requirements engineering, design, coding, and testing. Even though substantial research on the different tasks and phases of GSD has taken place, analyses from a competency perspective are lacking. Given the influence of context on the competence requirements (identified in Article V) and the differing nature of work within the phases—for example, tasks related to requirements engineering require a higher amount of communication with clients and users than tasks related to coding—competency requirements might differ among the different phases and tasks. Understanding the competency requirements for the different phases and tasks and the major differences between the phases allows for targeted staffing decisions and has the potential to decrease the impact of barriers and improve the quality of results. It is therefore important to analyze how soft competency requirements differ throughout the GSD process (RQ6, Article VI).

- RQ6: How do soft competency requirements change throughout the GSD process?

The aim of understanding competency requirements and the influence of the work context on competency requirements is to understand, explain, and possibly predict differences in individual performance. Theories such as the competence-performance theory (Korossy, 1997; Korossy, 1999) link competences and performance. Thus, we can assume that competences have a direct influence on the job performance of individuals. To understand the competency requirements in GSD better and to explain performance differences based on competences, it is important to analyze the effects of different competencies on the job performance of individuals. Additionally, the research has shown a relation between intercultural competences and software development competences (Article V) in terms of adapting software development competences to the work context. To analyze this relation, it is important to analyze the effect of intercul-

tural competency and software development competency on an individual's job performance and to analyze whether a moderation effect between these two competencies exists (RQ7, Article VII).

- RQ7: How do software development competency and intercultural competency affect the job performance of software developers in GSD, and what is the relation between the two competencies?

The seven research questions were addressed by the seven articles included in this dissertation. As described above, each article could address various research questions, and each research question could be addressed by several articles. FIGURE 2 presents the relation of the research questions and the corresponding articles. The input can reach from concrete artifacts such as the internationalization competency framework to the deep understanding of theoretical constructs and their relations.

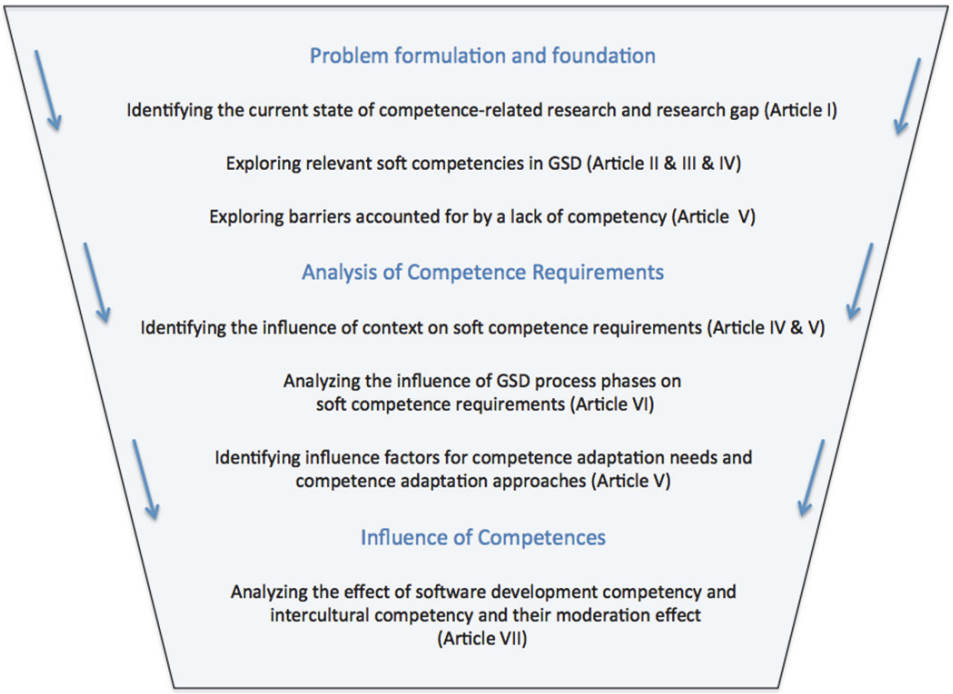

FIGURE 2 Relation of the research questions and articles

3 METHODOLOGY

The following section describes the methodological aspects of this dissertation. The section first introduces the research approach before addressing the appropriateness of the approach, the strategy for the research design, and the strategy for analyzing the data.

3.1 Research Approach

The aim of the dissertation is to identify the competency requirements of global software development (GSD) and the influences these competencies have on the job performance of individuals and thus on organizational performance. Due to the exploratory nature of the research within this context, the research presented represents a sequential approach to create and test theoretical knowledge. Thus, this dissertation can be classified as aiming to explain a certain phenomenon (Gregor, 2006).

Based on the research objectives that were explained previously in this dissertation, this dissertation addresses exploratory and confirmatory research simultaneously. Commonly, exploratory research is addressed through qualitative research, which aims to explore, investigate, and understand new concepts and issues (Creswell, 2004). In contrast to this, confirmatory research commonly applies quantitative research methods. Quantitative research aims to measure the views of concepts and generalize the results through large amounts of quantifiable data representing the population under study (Creswell, 2004). To address multiple research questions simultaneously, a multiple method approach was required (Teddlie & Tashakkori 2009). Through the combination of multiple methodological perspectives, a better understanding of the research domain and higher validity of the findings can be achieved (Creswell, 2003). Tashakkori and Teddlie (2003) identified mixed methods and multimethod research as two major types of multiple methods approaches. Multimethod research applies two or more research methods that can be from the same research approach (Mingers & Brocklesby, 1997). This means that mutimethod research can in-

clude multiple qualitative approaches. In contrast to this, Tashakkori and Teddlie (2003) define mixed methods research as a research design that uses more than one different research approach. Venkatesh et al. (2013) state that mixed methods research always applies qualitative and quantitative approaches in the same research inquiry.

According to Venkatesh et al. (2013), the strength of mixed methods research is the possibility to understand and explain complex organizational and social phenomena by using multiple methods either concurrently or sequentially (Venkatesh et al. 2013). To support researchers in their attempts to conduct high-quality mixed methods research, Venkatesh et al. (2013) provide guidelines for mixed methods research in IS. Venkatesh et al. (2013) suggest the following guidelines:

1. Decide on the appropriateness of a mixed methods approach.
2. Develop a strategy for mixed methods research design.
3. Develop a strategy for analyzing mixed methods data.
4. Draw meta-inferences from mixed methods results.

In terms of validation, Venkatesh et al. (2013) propose that in addition to the validation of quantitative and qualitative studies of research, the mixed methods should also be validated in terms of research design, meta-inferences, and potential threads and remedies.

As both qualitative and quantitative approaches are applied in this dissertation, a mixed method approach was selected. According to the guidelines of Venkatesh et al. (2013), the following section analyzes the appropriateness of the mixed method approach for the presented research. In the following section, the mixed method research design and the data analysis for each of the steps of the research are presented. Meta-inferences from the mixed methods results are drawn in the conclusion section of this dissertation.

3.2 Appropriateness of a Mixed Method Approach

According to Venkatesh et al. (2013), researchers should carefully consider the appropriateness of applying a mixed methods approach. Hereby, research questions, objectives, and the research context should be the main driver for selecting a mixed methods approach (Creswell & Clark, 2007; Teddlie & Tashakkori, 2009; Venkatesh at al., 2013). To support researchers in assessing the suitability of a mixed methods approach, Venkatesh et al. (2013) identified seven distinct purposes for using a mixed methods approach. These are complementarity, completeness, developmental, expansion, corroboration/confirmation, compensation, and diversity. The following table gives an overview of the purposes and how they are addressed in this dissertation.

TABLE 1 Purposes for applying mixed methods research according to Venkatesh et al. (2013) and their applicability for the presented research

Purpose	Description	Application for the presented research
Complementarity	Aiming to gain complementary views about phenomena or relations	Through the application of different analyses, complementary perspectives on the issues such as contextual influence factors on competency requirements, competency adaptation needs, and the importance of competence adaptation (Article IV–VII) were gained.
Completeness	Aiming to provide a complete picture of a phenomenon	Only through the combination of quantitative and qualitative methods was it possible to analyze the impact of work context on the competency requirements.
Developmental	The results of one strand of the research raise new questions or hypotheses	The initial literature review (Article I) was the basis for the research and opened several new research questions. Through the identification of the contextual influence factors and the importance of adapting competence (Article V), the questions of how the competency requirements differ throughout the software development process (Article VI) and what impact the interaction of competencies has on the performance (Article VII) arose.
Expansion	Aiming to explain and expand the results of a previous strand of research	The initial results in terms of competency identification (Article II) were expanded by contextualization for the domain (Article III) and consequently for different phases of software development (Article VI). Additionally, the notion of competence adaptation (Article IV) was taken up and further elaborated by identifying influence factors and approaches for adaptation (Article V).
Corroboration/ Confirmation	Aiming to assess the credibility of the contributions of another strand of research	By analyzing the impact of the moderation effect on job performance (Article VII), the previous findings regarding the importance of competence adaptation are tested (Article IV, Article V). Also the analysis of differences in terms of competency requirements (Article VI) assesses the results regarding the importance of internationalization competences (Article III) and the identified contextual influence factors (Article V).

Purpose	Description	Application for the presented research
Compensation	Compensate for weaknesses of one approach by combining with another.	Through the combination of quantitative and qualitative methods, the weaknesses of each approach can be compensated. For example, through the qualitative approach contextual influence factors were identified but not validated (Article V). By applying quantitative approaches, parts of the influence factors could be confirmed and validated (Article VI and Article VII).
Diversity	Aiming to obtain divergent views of the same phenomenon.	The adaptation of competency is seen from a managerial perspective with the aim to adapt competences from a Universe of Competence to the application needs (Article IV) and from an individual perspective addressing how competences are adapted on the fly (Article V).

The short analysis of the applicability of the purposes to apply mixed methods research shows that in particular, developmental and expansion purposes are used in the presented research.

3.3 Research Design and Data Analysis

The main driver for selecting a mixed method research approach is of a developmental and expansional nature, which means that the findings from an earlier study will theoretically or empirically inform a later study. Venkatesh et al. (2013) describe developmental and expansion purposes as the key for sequential mixed methods research. The aim of a sequential research design is "to leverage the findings from the first study to inform the second study and add richness to the overall study" (Venkatesh et al., 2013, p. 18).

Based on the nature of the research questions presented in this dissertation, the research design was differentiated into three distinct sequences:

- Problem Formulation and Foundation,
- Analysis of Competency Requirements, and
- Analysis of the Influence of Competencies.

These sequences represent different aspects of the research, in terms of the addressed research questions, applied approaches and used methods. TABLE 2 gives an overview of the three sequences and following subsequences, according to the evidence collection method, analysis method, and approach applied.

TABLE 2 Methodological aspects of each research phase

Sequence	Collection of evidence	Analysis Method	Approach
Problem Formulation and Foundation	Systematic Literature Review	Content Analysis	Creating theoretical knowledge
	Survey	Statistical analysis	Testing theoretical knowledge
Analysis of Competency Requirements	Delphi Study (Interviews)	Qualitative Content Analysis	Creating theoretical knowledge
	Delphi Study (Survey)	Statistical Analysis (Friedman Test and Discriminant Function Analysis)	Applying and deepening theoretical knowledge
Analysis of Influence of Competencies	Survey	Structural Equation Modeling (PLS)	Testing theoretical knowledge

Each of the sequences, as well as their aim and data collection and analysis methods, are addressed in more detail in the following section.

3.3.1 Problem Formulation and Foundation

The importance and influences of soft competencies in GSD is often discussed, yet research on the topic is usually filled with assumptions and lacks a clear theoretical foundation based on rigorous evidence; hence, it was important to first analyze the problem field. During this analysis, evidence pointed to no coherent theoretical foundation on competence and competence management being identifiable in the literature. Instead, different schools and definitions can be identified. Therefore, it is important to establish a theoretical foundation by harmonizing the various definitions and concepts.

For this purpose, an in-depth literature review was conducted using the systematic approach of Fink (2005) and following the guidelines suggested by Kitchenham (2004). The aim of the literature review was to identify the current state of competence-related research in the GSD domain as well as to identify the concepts used.

The literature review revealed various gaps in the research regarding global software development and related barriers. While barriers to GSD were a dominant topic in previous literature, few researchers have attempted to analyze the reasons behind the barriers or propose interventions to overcome the barriers (c.f. Richardson et al., 2012). When addressing barriers, researchers commonly focused on managerial aspects (cf. Richardson et al., 2012) or processes to overcome barriers (c.f. Prikladnicki et al., 2006). However, underlying human aspects were rarely addressed in previous literature. When addressing individuals in the GSD process, researchers commonly analyzed collective-level constructs such as technical competency and communication competency. However, these collective-level constructs are not suitable for interferences such

as competence management, as the underlying competences stay unknown. The underlying competences were rarely addressed in previous research, particularly soft competences. For more information regarding the literature review and the identified gaps, see Article I.

As a consequence, the literature review was extended to identify relevant soft competences in the GSD domain. Based on the literature review, the internationalization competency framework—a set of soft competences relevant in GSD—was established. The internationalization competency framework is presented in Article II. A small-scale evaluation was used to validate the applicability of internationalization competencies in the field of global software development and information systems. The evaluation of the internationalization competency framework is presented in Article III.

During the literature review, the problem of different work styles and work behaviors emerged as a potential driver for barriers in GSD. Therefore, this phenomenon was analyzed more deeply. Based on the literature, inductive and deductive approaches to conceptualizing the competency requirements for the example of requirements elicitation were developed. The approach is visualized using two different practical cases and introduces the necessity of adapting working styles and behaviors to the work context.

3.3.2 Analysis of Competency Requirements

The results of the literature review and initial studies showed the need to understand competency requirements. Additionally, it was identified that the work context could have an immense influence on the competency requirements. For this purpose, a qualitative study was designed to understand the relationships among barriers and competences, competency requirements, and influence factors on the competency requirements. Furthermore, a quantitative study was planned to address the competency requirements for different phases and tasks of GSD. The aim of this quantitative study was to verify and validate the contextual influence factors and to move toward the contextualization of competency requirements. Instead of using two distinct studies, the Delphi method was applied as a guiding research method to ensure the commitment of the participants before the data collection. This ensured a high level of communication and feedback in the qualitative study to avoid misinterpretations of the results. Multiple informal feedback rounds were realized to ensure that the opinions of all of the experts were included and a consensus was reached. For the quantitative study, the Delphi method ensured the previous knowledge and suitability of all of the participants.

The Delphi method was developed to obtain reliable results and a consensus from a group of experts (Dalkey & Helmer, 1963). According to Linstone and Turoff (1975), the Delphi method is a structured process of communication that enables anonymous experts to work collaboratively and efficiently on a complex problem. The Delphi method was initially used for forecasting and scenario development but is nowadays also widely applied to develop specific concepts and frameworks (Okoli & Pawlowski, 2004).

In the Delphi method, the researcher sets up one or several panels of experts (for example, one panel for each stakeholder group, if significant differences are foreseen or the difference between the stakeholder groups has significant relevance, based on the research questions). Each panel usually consists of up to 50 experts (Witkin & Altschuld, 1995). However, each panel most often consists of 15 to 20 participants (Ludwig, 1997). The members of a panel are anonymous in the group, which means that the experts do not know who the other experts in the panel are. The research design usually follows a two-step process. The first step addresses the identification of and elaboration on the problem and related issues. The researcher analyzes the results and prepares for the second step after a validity check. In the second step, the previously identified aspects are analyzed in more detail, and a classification or a ranking is usually developed. Based on this, a consensus among experts is achieved.

To apply the Delphi method as a guiding research method, suitable participants were identified prior to the first data collection. In the following, the recruitment process for participants, the selected two-step research process, and the data analysis methods for each step are presented in more detail.

Selection of Participants

Based on the guidelines for how to build a group of experts for a study by Delbceq et al. (1975), Okoli and Pawlowski (2004) developed a process to identify suitable participants for their specific Delphi study. The process includes the following phases (Okoli & Pawlowski, 2004):

- Preparation: This step includes the categorization of experts and the identification of possible outlets to identify possible experts.
- Populate: In this step, possible experts are identified for each of the previously established class of experts based on the identified outlets. Additionally personal contacts are used to fill the classes with experts.
- Nominate: The identified experts are contacted and asked to nominate further experts for the presented Delphi study. As much information as possible is gathered for each identified expert regarding their qualifications and background.
- Rank: Experts are classified into the classes and compared to each other based on their qualifications. The experts are then ranked within each class.
- Invite: Based on the rankings, the panel is created and experts are invited to the study. Also, a substitute list is established that includes the experts with the next-highest rank.

The steps presented above were adapted to identify suitable experts and obtain their commitment to the entire study. The classes or categories of experts are our different stakeholder groups, which ensured an even distribution of participants for all stakeholder groups. Experts were identified based on personal contacts, as well as from relevant literature and relevant organizations, such as companies and universities.

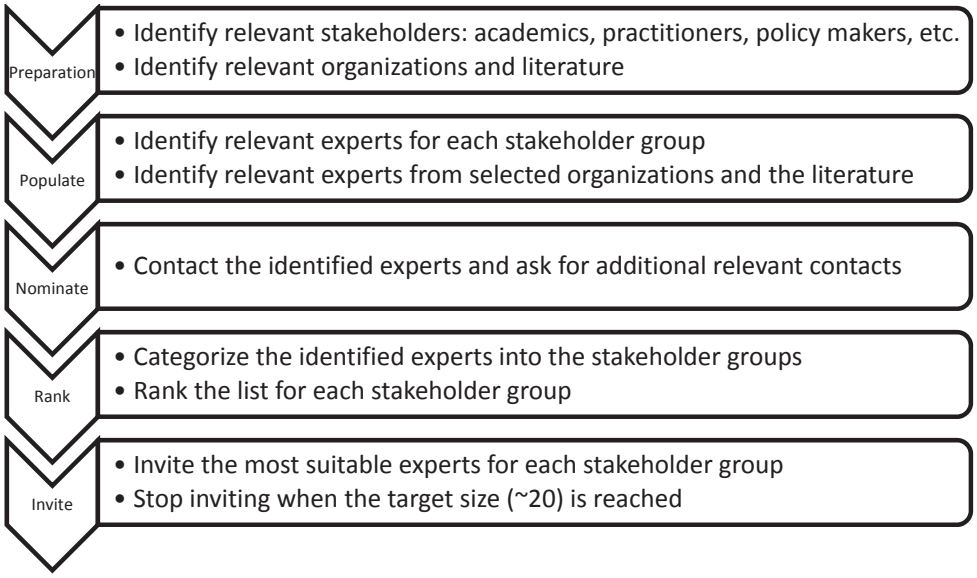

FIGURE 3 Procedure for selecting experts (based on Okoli & Pawlowski (2004))

After applying this process, 19 participants were identified and committed to participating in the entire study. However, two participants dropped out during the first round of the study, leaving 17 participants. All of the participants were experienced in GSD projects. The 17 participants consisted of 10 practitioners and seven academics. The practitioners had, on average, more than 5 years of experience in GSD and held professional or managerial positions in their organizations. The academics were selected based on their research in GSD, competency requirements, or intercultural issues. All of the academics also had practical working experience in intercultural development projects. Addressing practitioners and academics in this research allowed practice, research, and education perspectives to be combined.

Research Process

The Delphi method applied in this dissertation was composed of two rounds. The first round applied interview techniques to identify which barriers to GSD are based on a lack of competences and which competence-based interventions can be taken to overcome these barriers. As an exemplary intervention, the first round focused on the adaptation of hard competences according to the work context. The second round of the Delphi study was concerned with the context dependency of competency requirements. In this round, differences in the competency requirements throughout the software development process were identified.

The research process was organized based on the structure proposed by Schmidt et al. (2001). To minimize the effort of the participants, only a single panel of experts was used. The two phases can be classified as exploration and specification. Exploration combines the two phases of brainstorming and nar-

rowing down. The exploration phase included two feedback rounds. The participants received their individual answers, extracted from the interview, and the aggregated results. The participants were asked to provide feedback and ensure that no misinterpretations took place. Based on the findings of the first round, the second round was conducted. During the second round the competences for different phases of software development were ranked. An abstraction of the research process and the outcomes of the phases are presented in FIGURE 4.

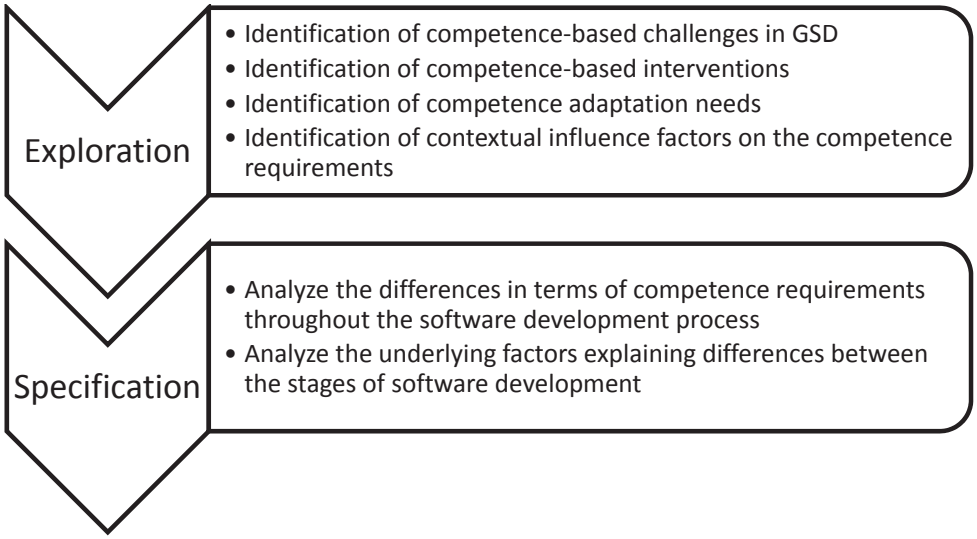

FIGURE 4 Delphi study process (adapted from Schmidt et al. (2001))

Data Collection and Data Analysis

The data collection and data analysis can be differentiated based on the Delphi round. In the first round, the data were collected through interviews. While the majority of interviews were handled via Skype, some of the participants had the opportunity to use an online questionnaire. However, for the online questionnaire, follow-up questions and questions for clarification could also be posted through email. The resulting data were analyzed using qualitative content analysis (Mayring, 2000). For more information about the data collection and data analysis, see Article V.

The data for the second round were collected through an online survey. Additional GSD experts were included as participants to ensure a large enough sample to analyze the data. Non-parametric Friedman tests followed by Wilcoxon signed rank tests were used to analyze the differences between the phases of software development for each competence. Additionally, discriminant function analysis was applied to identify underlying functions representing the differences between the phases. For more information about this data analysis, see Article VI.

3.3.3 Analysis of the Impact of Competencies

The analysis of competency requirements for GSD indicated a strong contextual influence on the competency requirements. Additionally, it was identified that changes in the work context can lead to the need to adapt competences. For this adaptation, an approach evaluating hard competences through internationalization competences was proposed.

Based on these previous findings and on CPT, a research model was created, focusing on the effect of software development competency and intercultural competency on job performance and the moderation effect of intercultural competency on the influence of software development competency on job performance. Structural equation modeling using partial least squares was used to estimate the model. Structural equation modeling (SEM) has become one of the most important empirical research methods in various different research fields (Reinartz et al., 2009). SEM allows the modeling of relationships between multiple independent and dependent constructs (Gefen et al., 2000) and allows unobservable variables to be measured through indicators (Chin, 1998).

Two different approaches to estimate SEM can be differentiated: the covariance-based approach and the variance-based approach. The approaches follow different assumptions and have different procedures (see Haenlein & Kaplan, 2004; Reinartz et al., 2009). As a normal distribution of the observations cannot be assumed, and based on the small sample size, the variance-based partial least squares (PLS) approach is used within this dissertation.

The aim of the PLS approach is to minimize the variance of all of the dependent variables (Urbach & Ahlemann, 2010). It can be used for both theory confirmation and theory development (Chin, 1998). Additionally, PLS takes measurement errors into account, which allows the analysis of latent variables (Wold, 1985). PLS was selected as the analysis method for the following reasons (based on Hair et al. (2011, p. 144) and Gefen et al. (2011)):

- The presented research is exploratory and extends the existing structural theory.
- The presented model is highly complex, with many constructs and indicators.
- We cannot assume that the results are normally distributed, as we expect high skewness and kurtosis of the data.
- The model includes formative constructs as part of the structural model.
- The data set is small, based on the complexity of the structural model.

Data Collection and Selection of Participants

For the operationalization of the research model, the three constructs—intercultural competency, software development competency, and job performance—had to be operationalized. The intercultural competency construct was realized as a reflective-formative, higher-order construct, following the suggestions of Graf and Mertesacker (2009). As no suitable software develop-

ment competency construct was available in previous research, the construct was created following the approach presented by Davis (1989). Job performance was operationalized through the in-role job performance measure developed by Podsakoff and MacKenzie (1989). For more information about the measures, see Article VII. All of the constructs were measured through a measurement model using Likert scales and thus can be described as perceptually anchored measurements (Sharma et al., 2009). According to Sharma et al. (2009), perceptually anchored measurements for the dependent and independent variable create very high risks of common-method bias. To reduce the risk of common-method bias, the study was designed with two dependent questionnaires answered by two different people. In the first step, a software developer working in an international work environment performed a self-assessment of her competences by completing the corresponding questionnaires. Afterwards, her direct supervisor or team leader judges the developer's job performance with the corresponding questionnaire. By using online questionnaires, the connections and notification processes needed for this kind of design were automated.

Based on this design decision, pairs of software developers and their supervisors were needed for each applicable answer. For this purpose, GSD organizations and teams were contacted to gain a high level of support for the study. Participation by entire development teams was highly encouraged, as one team leader was able to fill the supervisor role for the entire team. The data collection started with two parallel processes. Firstly, the email addresses of software developers were collected from open source projects. These contacts were directly addressed by mail. In parallel, software development organizations were contacted to gain their interest and commitment to the study. The companies were selected from business dictionaries, such as LinkedIn.

The first attempts had little success, as the software developers were willing to fill out the questionnaire but not to contact their supervisors and ask for their evaluation. Similar, the contacted organizations saw no immediate benefit in participating and using the work time of several of their employees.

As a consequence, the process of directly contacting software developers was abandoned, and incentives for organizations to participate in the research were created. A workshop format and a small-scale consulting offer were developed to provide an immediate benefit for participating organizations. The consulting offer included individual data analyses for each organization based on their individual requirements. This ranged from an analysis of employees' competence levels to team comparisons and competence benchmarking studies. The workshop format included the consulting offer for participating organizations, as well as a one-day seminar offered on competence management in GSD. The aim of the workshop was to raise awareness and train HR managers and team leaders in managing soft competences and their importance. The work-

shop organized in Finland was hosted by Profit[1]; in Germany, it was hosted by BITKOM[2]. In total, the workshops attracted about 20 participants from seven different organizations. In parallel with the workshops, further organizations were contacted by phone and were offered consulting services for their participation in the study.

As a final step and through collaboration with colleagues from China, the questionnaires and all additional documents were translated into Mandarin, so that the study could also be run in China. Three researchers, including two native Mandarin speakers, were involved in the translation process to ensure the highest possible level of correctness. In the first step, a native Mandarin speaker translated the questionnaire from English to Mandarin. The second Mandarin native speaker translated this version back to English. The two English versions were then checked for differences, and all of the differences were marked down. Both Mandarin speakers then checked the differences and made adjustments until a consensus was reached. Chinese software developers then checked the pre-final Mandarin version to ensure the correctness of all of the questions.

Data Analysis

The presented research analyzes the effect of software development competency and intercultural competency on job performance and the moderation effect of intercultural competency on the influence of software development competency on job performance. The analysis was conducted using partial least squares (PLS). A multiple-step approach was taken to estimate the higher-order constructs (Wilson, 2009). First, the measurement models of the second-order constructs were estimated independently. Standardized latent variable scores were saved and used in the second step as indicators for the first-order constructs (Wilson, 2009).

Both the theory and theoretical assumptions regarding the influence of competency on job performance indicate a non-linear relationship. Thus, as we can expect non-linearity, a non-linear model was used without testing for the assumption of linearity (Edwards, 2009). Therefore, WarpPLS was selected as the analysis tool, as it allows for non-linear analysis of the inner model. WarpPLS provides two alternatives for non-linearity in PLS: the warp2 algorithm, which analyses relationships based on a U-curve function, and the warp3 algorithm, which analyses relationships represented through an S-curve function such as a sigmoid, hyperbolic sine, or hyperbolic tangent. As diminishing effects in the relations were expected, and based on the possibility of also analyzing linear and U-curve functions through the warp3 algorithm (Kock, 2015), the

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1 Profit is a program organized by the Faculty of Information Technology at the University of Jyväskylä providing training to support the growth and development of companies in the ICT sector in Central Finland. For more information, see https://profit.cc.jyu.fi (in Finnish).

2 BITKOM is the digital association of Germany, representing over 2,300 companies in the digital economy, including over 1,000 SMEs, 300 start-ups, and the majority of global players. More information can be found at https://www.bitkom.org.

warp3 algorithm was selected for the analysis of the inner model. Wold's original PLS algorithm was used to analyze the outer model.

Factor loadings, average variance extracted (AVE), discriminant validity (according to Fornell & Larcker, 1981), collinearity (Myers, 1990), composite reliability (Fornell & Larcker, 1981), and Tenenhaus GoF (Tenenhaus et al., 2005) were used to assess the validity, reliability, and explanatory value of the research.

To summarize, the presented methodology includes a literature review, qualitative methods, and quantitative methods. The literature review helped to identify the current state of the research and research gaps, as well as build the foundation of the qualitative and quantitative approaches. The main outcome of the literature review was the internationalization competency framework, which includes relevant competencies and competences for individuals working in international and intercultural settings. The qualitative part of this dissertation explored the relationships among barriers and competence-based interventions and corresponding competency requirements. The main outcome of the qualitative study was the identification of contextual influences on the competency requirements and the necessity of adapting competences to the work context. The quantitative studies in this dissertation were used to validate, verify, and confirm the findings of the literature review and the qualitative study, as well as to gain a deeper understanding of the competency requirements of GSD and the influence of competencies on individuals' performance. The main outcomes of the quantitative studies were the validation of the internationalization competency framework for GSD, the identification of differing competency requirements in the various phases of GSD, and the identification of a moderation effect of intercultural competency on the influence of software development competence on in-role job performance. The results of the studies included in this dissertation and their implications are discussed in the following sections.

4 OVERVIEW OF THE ARTICLES

This section summarizes the key research objectives and findings of the seven attached articles. For each paper, the contributions toward the overall aim of the dissertation are also presented.

4.1 Article I: A Competence-based View on the Global Software Development Process

Holtkamp, P. & Pawlowski, J.M. (2015). A Competence-based View on the Global Software Development Process. *Journal of Universal Computer Science*, Forthcoming.

Research Objectives
The first article analyzed a variety of different competence-based barriers and proposed interventions in GSD. While barriers for GSD have been widely discussed in the literature (Ågerfalk et al., 2005; Noll et al., 2010; Pallot et al., 2010), no studies have applied a competence perspective on the barriers and interventions of GSD.

Based on the systematic literature review of 378 articles, the study aims to identify barriers with a clear connection to a lack of competences and relevant research on competence requirements in GSD. In addition, the paper provides a short overview of applied GSD processes and summarizes the main functions of these processes.

Findings
The analysis of the included research papers shows that researchers have identified a variety of barriers for GSD, based on temporal distance, geographical distance, and socio-cultural distance (Ågerfalk et al., 2005), that deal with communication, collaboration, coordination, and culture (Noll et al., 2010). However, the analysis also shows that while barriers were identified, the reasons for

these barriers were not explicitly addressed. This was reflected in the identified interventions, which mainly addressed managerial issues. A competence-based view on the GSD process was developed by mapping the barriers through relevant competencies and the GSD process. This competence-based view integrates competence management activities into the GSD process. The competence-based view of the GSD process should be understood as a prototype process to overcome competence-based barriers in GSD. A variety of research gaps were identified by comparing this prototype process with the current state of competence-related research in GSD. The most significant gaps in the research were the lack of a human-centric perspective of GSD, the lack of a clear understanding of competency requirements in GSD, and abstraction from the individual resources on the organizational or project success.

Response to the Research Questions and Relation to the Whole Dissertation
Article I answers RQ1: What is the current state of competence-related research in the field of GSD, and what are the research gaps?

The literature review described above combines a process and competence perspective on GSD. This allows the identification of several research gaps related to competence management in GSD. The results of this article were used as guidance for the research and studies presented in this dissertation. They were used to identify the most critical contributions in order to advance both research and practice in the field. Here, in particular, soft competency requirements were identified as a crucial construct to advance research but also as an important tool to structure competence management in practice.

4.2 Article II: Globalization Competences in Information Systems and E-Learning

Pawlowski, J.M., Holtkamp, P. & Kalb, H. (2010). Globalization Competences in Information Systems and E-Learning. In ICSOB 2010: *Proceedings of Workshop on Competencies for the Globalization of Information Systems in Knowledge Intensive Settings*, Jyväskylä, Finland.

Research Objectives

This article addresses the importance of the internationalization of curricula. In the IS domain, pleas to internationalize the curriculum had already been made at the end of the last century (Deans & Loch, 1998). However, an analysis of current model curricula (e.g. Topi et al., 2010; WKWI, 2007) showed that international aspects are not being sufficiently addressed.

Based on work on international projects in GSD and IS, the study's aim was to develop a generic competency framework representing the competencies required in international work. The framework is specifically contextualized for

e-learning to showcase the applicability of a generic framework and the contextualization process.

Findings
The presented article shows that we can differentiate between domain specific competencies and internationalization competencies for the internationalization of curricula. Internationalization competencies represent the soft competencies necessary to succeed in international and intercultural contexts. The internationalization competencies consist of project management, communication, collaboration intercultural, and ICT competencies. These competencies enable individuals to handle distributed, intercultural group work.

Through the exemplary application of the framework in the e-learning domain, the authors identified that intercultural competency can have a strong impact on the domain-specific competences based on different work styles and methods.

Response to the Research Questions and Relation to the Whole Dissertation
This article addresses RQ2: Which soft competences are important in GSD?

The internationalization competency framework was created through a literature review. The framework is the foundation for the analysis of required soft competences in an international setting, as it provides the scope and frame for the analysis. Within this paper, a generic framework was developed within the context of information systems and contextualized for e-learning. This paper focuses on gaps in curricula, in terms of competences for global working environments. Due to the generic nature of the internationalization competency framework, it can be applied to multiple different domains. Article III adapts the internationalization competency framework and identifies the relevant competences to internationalize the IS curriculum. Article VI validates the framework in the context of GSD. Accordingly, this paper provides the first insight into RQ2.

4.3 Article III: Towards an Internationalization of the Information Systems Curriculum

Pawlowski, J.M. & Holtkamp, P. (2012). Towards an Internationalization of the Information Systems Curriculum. In D.C. Mattfeld & S. Robra-Bissantz (eds.), MKWI 2012: *Tagungsband der Multikonferenz Wirtschaftsinformatik (MKWI)*, 437-450. Braunschweig, Germany: GITO mbh Verlag.

Research Objectives
The third article addresses the contextualization of the generic internationalization competency framework to the IS domain. The aim of this article was to identify and initially validate relevant competences for each of the categories included in the internationalization competency framework.

For this purpose, a literature review of curricula from various domains, research articles, and competency frameworks took place. Based on the identified competences, a quantitative study was used to identify and rate the most importance competences for each of the competency categories included in the internationalization competency framework. Additionally, the participants were asked to provide additional important competences.

Findings

Based on the literature review, a total of 98 competences (24 communication competences, 26 collaboration competences, 17 project management competences, 17 intercultural competences, and 14 ICT competences) were identified. The number was reduced to 56 unique competences through clustering. The analysis of the quantitative study showed that the participants rated the competencies included in the internationalization competency framework as more important than or equally as important as the domain-specific competency. This is in line with the findings of Zaffar and Winter (2008), who identified that soft competences were at least as important for a project's success as technical competences, in the majority of cases.

The importance rating of competences for each category allowed for the creation of the IS internationalization curriculum, which represents the internationalization competency framework contextualized for the IS domain. Additionally, the participants noted the importance of related subject competencies, such as business competency.

The internationalization curriculum thus represents a soft competency framework for the IS domain, which should be understood as a reference framework for the creation of organizational competency frameworks and models.

Response to the Research Questions and Relation to the Whole Dissertation

The third article provides a response to RQ2: Which soft competences are important in GSD?

By building on the internationalization framework established in Article II, this article provides an overview of potentially relevant competences for each of the categories included in the internationalization framework, contextualized to the IS domain. Through this, the use of the internationalization competency framework in information technology was validated. This paper refines the findings of Article I by providing relevant competences for each competency included in the framework. Applying the most important competences identified in Article III, Article VI validates the findings for GSD and shows different competency requirements for the different phases of GSD. Article IV looks into how the generic internationalization competences can be further contextualized to the concrete requirements of an organization or project. By identifying relevant competences for each category included in the framework in IS as an example for information technology, the paper provides further insight into RQ2.

4.4 Article IV: Requirements Modeling in International Information Systems Design—What Competencies Are Needed and How to Manage Them?

Hoel, T. & Holtkamp, P. (2012). Requirements modeling in International Information Systems Design—what competencies are needed and how to manage them? In J.G. Cegarra (ed.), ECKM 2012: *Proceedings of the 13th European Conference on Knowledge Management*. Cartagena, Spain: Academic Conferences & Publishing International.

Research Objectives
The fourth article addresses competency requirements and competence management in requirements elicitation and modeling. In particular, the relevant competences for specific tasks, how these competency requirements can be derived, and how competences should be orchestrated in teams are the guiding factors of this paper. The paper uses requirements elicitation and modeling as an example process within information technology and software development. Requirements elicitation and modeling were selected based on the high amount of collaboration and communication required with different stakeholders, such as clients and end users. Based on the high amount of interaction with various different stakeholders required in this process, the importance of internationalization competences was assumed to be high. Based on previous literature, a model for the competency requirement development process was created. This model was applied to two different cases, in order to validate its appropriateness.

Findings
Based on the importance of context on competency enactment ((Sandberg, 2000; Tessmer & Richey, 1997), a two-stage model was developed for the creation of competency requirements for specific roles. A deductive approach of selecting and adapting competences from a generic universe of competency and an inductive approach to learning from previous experiences and observations were constructed and combined.

In the combined approach, competency requirements are extracted from previous experiences and then filled by adapting competences from a generic universe of competency. Through this approach, we can ensure learning and a dynamic model for competence requirements.

Response to the Research Questions and Relation to the Whole Dissertation
This article addresses RQ2 (Which soft competences are important in GSD?) and RQ4 (How does context influence soft competency requirements in GSD?).

Based on the identification of internationalization competency in Articles II & III), this article describes an exemplary process for identifying competency requirements for a specific organization or process. Competency requirements

describe which competences are relevant to fulfilling the essential tasks for the job. Through a combination of competency requirements and processes, organizations are able to determine which soft competences are relevant in their context. The paper shows the importance of internationalization competency for GSD, particularly for requirements elicitation and modeling, and indicates that the generic competency framework is suitable for deriving relevant competencies for the different tasks and phases of GSD. This is addressed in Article VI, which shows the differences in competency requirements for tasks and phases of GSD.

Within the discussion of the identification process for competency requirements, the notion that the work context influences the competency requirements is introduced. The article indicates initial methods for adapting competences to the context. This is addressed in Article V by looking into competence adaptation as a possibility for overcoming barriers to GSD and in Article VII by addressing the moderation effects of software development competency and intercultural competency.

4.5 Article V: How Do Software Development Competences Change in Global Settings—An Explorative Study

Holtkamp, P., Lau, I. & Pawlowski, J.M. (2014). How Do Software Development Competences Change in Global Settings—An Explorative Study. *Journal of Software: Evolution and Process*, 27 (1), 50-72.

Research Objectives

This article addresses the identification of competence-based barriers and interventions to overcome these barriers. As previously stated, barriers to GSD are a widespread topic in recent research (Ågerfalk et al., 2005; Noll et al., 2010; Pallot et al., 2010). However, to identify suitable and manageable interventions, we have to understand the reasons and influences for those barriers.

Based on the notion of contextual change—a change in the work context of individuals—the paper analyzes which competence-based barriers follow the contextual change and which interventions can be taken to overcome these barriers. A competence-based barrier refers to a barrier that mainly occurs due to a lack of competences. Following the identification of competence-based barriers and interventions, the influence of context on the competency requirements is further analyzed, with a special focus on the need to adapt competences as one possibility to overcome barriers.

The results are based on 19 qualitative interviews. The data were analyzed using qualitative content analysis (Mayring, 2000). To prevent wrong interpretations of statements, the aggregated data were presented to all of the participants to check if their statements were understood correctly.

Findings

The results of this paper show that a lack of competences can account for major barriers that are commonly discussed in the GSD domain. Here, in particular, miscommunication, management style, and working style and behavior were mentioned. Technical knowledge and domain knowledge, often emphasized in the GSD domain (Iivari et al., 2001), were seen as less of a problem.

In terms of interventions, training was not seen as the most suitable solution to overcome the competence-based barriers. Instead, team-building activities and mentoring were mentioned as suitable interventions. The participants stressed team building as a tool to achieve greater team spirit and trust among team members, which would lead to better acceptance of barriers and thus improved collaboration. For mentoring, cultural mentoring was especially mentioned by the participants.

The participants stressed that competences are strongly context dependent and have to be adapted to the work context. An analysis of the statements regarding the adaptation of competences showed that the expected levels of the task's technicality, collaboration, and innovativeness have a strong influence on the competency requirements and the need to adapt competences. Following this, the participants suggested that individuals adapt their hard competences to the context by evaluating their working style and methods through applying intercultural competences.

Response to the Research Questions and Relation to the Whole Dissertation

The fifth article addresses RQ3 (Which barriers to GSD can be accounted for by a lack of competences, and which competence-based interventions can be taken to address these barriers?), RQ4 (How does context influence soft competency requirements in GSD?), and RQ5 (What kind of factors influence the need to adapt competences based on a changing work context, and how can individuals handle the corresponding competence adaptation?).

The article was based on the discussion of common barriers in GSD and the lack of reasons being provided in the literature for the barriers (see Ågerfalk et al., 2005; Noll et al., 2010; Pallot et al., 2010). The previous articles indicated that a lack of competences might be a major influence for barriers in GSD—this was validated in this article. Additionally, potential interventions such as mentoring, as well as the adaptation of competences, were addressed.

RQ4 and RQ5 were addressed in the article through a discussion of interventions and, in particular, the adaptation of competences. The technicality of tasks, the expected level of collaboration, the expected level of innovation, and the application domain were identified as the main contextual influences on competency requirements. It was shown that these factors, in particular, affect the importance of the internationalization competency and the need to adapt competences to the work context. For this adaptation process, the results of the analysis suggested that individuals apply internationalization competences when evaluating their software development competences in their work context and adapt according to the results of this evaluation. This relationship between software development competences and intercultural competences was the

foundation for the analysis of the moderation effect of intercultural competency on the influence of software development competency on job performance in Article VII.

4.6 Article VI: Soft Competency Requirements in Requirements Engineering, Software Design, Implementation and Testing

Holtkamp, P., Jokinen, J. & Pawlowski, J.M. (2014). Soft Competency Requirements in Requirements Engineering, Software Design, Implementation and Testing, *Journal of Systems and Software*, 101 (March), 136-146.

Research Objectives

The sixth article addresses the previously identified differences in the context of the competence requirements. Previous research indicates differences in the collaboration models (Smite & Borzovs, 2009; Roche et al., 2011), in terms of applied processes (Galvina & Smite, 2011) and expected tasks. The questions addressed by this article are whether the described differences have a direct influence on the competency requirements and what explains these differences.

The analysis focuses on the requirements engineering, software design, implementation, and testing phases of the software development process. Participants of the study rated the importance of a fixed set of internationalization competences. The data analysis uses a Friedman test to analyze if competence differences can be identified. This was followed by a Wilcoxon signed tank test for a pairwise analysis. An explorative analysis using discriminant function analysis was conducted to analyze the underlying factors of the differences between the phases.

Findings

The first analysis using a Friedman test showed that statistically significant differences between the phases could be identified for nine of the 12 analyzed competences. Only competences related to knowledge sharing, using other peoples' expertise, and information sources did not show significant differences. Instead, these competences were seen as equally important among the different phases.

The pairwise analysis using a Wilcoxon signed-rank test indicated that requirements engineering had the highest amount of differences from the other phases. The result indicated that requirements engineering and software design, as the tasks closer to the customer, were significantly different from testing and implementation, which represent more technical tasks.

A discriminant function analysis was conducted to analyze these underlying factors for differences between the phases. After eliminating various competences, two significant functions differentiating the four phases could be identified: adaptability and cultural awareness. Adaptability describes the competence to adjust strategies, goals, and plans and to manage diversity. Cultural

awareness includes the understanding of other peoples' perspectives, influences of culture on work life, and taking other peoples' opinions into account. The analysis showed that implementation and software design required a higher level of adaptability than requirements engineering and especially testing. Requirements engineering required the highest cultural awareness, followed by software design.

Response to the Research Questions and Relation to the Whole Dissertation
Article VI addresses RQ6: How do competency requirements change throughout the GSD process?

Through the pairwise analysis of requirements engineering, as well as software design, implementation, and testing for selected internationalization competences, this article identifies significant differences between the phases of GSD, in terms of competency requirements. The results showed that tasks in the proximity of the user, such as requirements engineering and software design, require a higher level of internationalization competences than the more technical tasks related to implementation and testing. Additionally, "adaptability" and "cultural awareness" represent significant differences between the four analyzed phases. "Adaptability," in particular, is important for software design and implementation but less important for testing. "Cultural awareness" is more important for requirements engineering and software design than for testing and implementation. These findings also have an impact on RQ2, as the internationalization competency framework has been validated in GSD, and on RQ4, as previous findings regarding the contextual influence factors (Article V) can be confirmed, and thus context-dependent competency requirements can be created.

4.7 Article VII: Moderation Effect of Intercultural Competency on the Influence of Software Development Competency on the In-role Job Performance

Holtkamp, P., Jokinen, J., Qiao, Z. & Pawlowski, J.M. (2015). Moderation Effect of Intercultural Competency on the Influence of Software Development Competency on the In-role Job Performance, *Journal of Management Information Systems*, under review.

Research Objectives
The last paper of this dissertation addresses the influence of software development competency and intercultural competency on the in-role job performance of individuals. Additionally, the moderation effect of intercultural competency on the influence of software development competency on in-role job performance is addressed.

Previous research indicates that the influence of competences on job performance is well acknowledged in recent literature (Rivera-Ibarra et al., 2010: Colomo-Palacios et al., 2013). Within organizational psychology, competences are discussed as explaining and predicting individuals' performance (Schmitt et al., 2003). Theories, such as the competence-performance theory (Korossy, 1997; Korossy; 1999), were introduced to explain and predict the link between competences and performance. Additionally, Articles IV and V of this dissertation found a potential interaction between intercultural competency and software development competency. Therefore, the aim of this article is to confirm the influence of competences on job performance as well as the existence of interactions between intercultural competency and software development competency. Based on the CPT and the theoretical relationship between competence and performance, a non-linear effect was expected for the relations.

The intercultural competency construct proposed by Graf and Mertesacker (2009) was applied to operationalize the research model. As no holistic software development competency construct could be found in previous literature, a software development competency construct was created, following Davis (1989). Job performance was measured using a scale for in-role job performance developed by Podsakoff and MacKenzie (1989). The items addressed the fulfillment of duties, formal performance requirements, and responsibilities. The hypotheses of the study were tested using a partial least squares (PLS) structural equation model. Based on the expected non-linear nature of the effects, WarpPLS—a software providing algorithms for the analysis of non-linear inner effects—was used for the modeling and analysis.

Findings

The results of the analysis indicated a statistically significant effect of software development competency on the job performance ($\beta = 0.21$, $p < .01$) but not statistically significant effect of intercultural competency on job performance. Additionally, a statistically significant negative moderation effect of intercultural competency on the influence of software development competence on job performance was found ($\beta = -0.20$, $p < .01$).

The analysis of the effect of software development competency on job performance showed a non-linear growth of job performance for software developers with average software development competency. For software developers with below average software development competency, the results showed a negative non-linear relationship, and for software developers with above average software development competency, an almost linear increase of performance with increasing software development competency was identified.

The analysis of the moderation effect showed that high intercultural competency lowers the effect of software development competency on job performance. Here, for average software developers with low intercultural competency, a non-linear positive effect of software development competency on job performance was observed. In contrast, for average developers with high intercultural competency, the effect of software development competency on job per-

formance was diminished. For software developers with below average software development competency, a non-linear effect of software development competence on job performance was identified. The results indicate that the effect was greater for the developers with high intercultural competency, compared to the developers with low intercultural competency. For software developers with above average software development competency, the effect of the software development competency on job performance was higher with below average intercultural competency.

Response to the Research Questions and Relation to the Whole Dissertation
This article responds to RQ7 (How do software development competency and intercultural competency affect the job performance of software developers in GSD, and what is the relation between the two competencies?)

The identification of the negative moderation effect of intercultural competency on the influence of software development competency on in-role job performance confirmed the findings of Article V regarding the existing relationship between these two competencies. It was identified that high intercultural competency lowers the association between software development competency and in-role job performance. Additionally, the analysis indicated that software development competency can be used to explain differences in the variance of in-role job performance. Here, the analysis showed that a non-linear relation describes the effect.

5 CONTRIBUTIONS, LIMITATIONS, AND FUTURE RESEARCH TOPICS

In the following sections, the key contributions of this dissertation are presented and discussed from both theoretical and practical perspectives. Furthermore, the limitations of the presented research and future research topics are summarized.

The results of this dissertation have implications on both research and practice in the field of GSD. The results extend the current status of the theoretical knowledge and create new areas of research by providing insight into the competency requirements and the influence of competency on the job performance of individuals in GSD. As the main aim of the dissertation is to explore and explain competency requirements and the influence of competencies, the results present a new "understanding of how things are" and "why they are as they are" (Gregor, 2006, p. 624).

The research questions, related results, and contributions are summarized briefly in Table 3. The theoretical contributions and practical implications will be discussed in more detail in the following sections.

TABLE 3 Research questions and summary of results and contribution

Research Question	Summary of results and contribution
RQ1 **What is the current state of competence-related research in the field of GSD, and what are research gaps?**	Software development competency is widely addressed, while soft competencies are not or not sufficiently addressed in recent research. However, the lack of soft competences is identified as a major driver for barriers to GSD. Research gaps such as the identification of soft competence requirements are identified. The identified research gaps may help to identify which research topics are more important than others.

Research Question	Summary of results and contribution
RQ2 **Which soft competencies are important in GSD?**	The internationalization competency framework was developed as a set of important soft competences for globally distributed work. The internationalization competency framework consists of competences related to information and communication technology (ICT), coordination, collaboration, communication, and intercultural work. The results may assist researchers and practitioners analyzing competence requirements in GSD.
RQ3 **Which barriers to GSD can be accounted for by a lack of competences, and which competence-based interventions can be taken to address these barriers?**	A variety of barriers, particularly barriers related to miscommunication, management style, and working style and behavior, can be accounted for by a lack of competences. Different interventions such as mentoring or team building are found to be suitable approaches to overcome the barriers. The adaptation of technical competences and corresponding working styles and behaviors to the work context was identified as another important intervention for potential barriers. Having the right competences and being able to adapt them to the work context can allow individuals to overcome these barriers. The results provide insight into important issues of competence management and may assist in the development of targeted interventions for common barriers in GSD.
RQ4 **How does context influence soft competency requirements in GSD?**	Changes in the work context, such as changes of location or the introduction of new team members, can lead to situations in which the previously successful working styles and behaviors are no longer suitable. Individuals are faced with a variety of barriers and might have to adapt their competences or achieve new competences to overcome these barriers. The results point that one-size-fit-all solutions for competence requirements are not suitable in GSD, and a contextualization of the competence requirements has to take place.
RQ5 **What kind of factors influence the need to adapt competences based on a changing work context, and how can individuals handle the corresponding competence adaptation?**	The task's expected levels of technicality, collaboration, and innovativeness were identified as main influences on the importance of internationalization competency and on the need to adapt competences. By applying soft competences, individuals can adapt their hard competences to the work context. The results may assist researchers and practitioners in identifying the competence requirements for a specific task and provide initial insight into the cognitive process of competence adaptation.

Research Question	Summary of results and contribution
RQ6 **How do soft competency requirements change throughout the GSD process?**	Differences in terms of internationalization competency requirements between the various stages of the software development process have been identified. In tasks with close proximity to the user, such as requirements engineering and software design, a higher level of internationalization competency is required than in more technical tasks, such as implementation and testing. This confirms the findings related to RQ5. The results point out that soft competency requirements should be addressed based on the relevant phases and tasks.
RQ7 **How do software development competency and intercultural competency affect the job performance of software developers in GSD, and what is the relation between the two competencies?**	A non-linear effect between software development competency and intercultural competency was identified, and a non-linear negative moderation effect of intercultural competency on the effect of software development competency on in-role job performance was identified. In total, about 12% of the variance of in-role job performance was explained. The development of quantifiable competency constructs (i.e., a software development competency construct, an internationalization competency framework, and an intercultural competency construct) allows researchers to conduct further studies on the impact of competencies on individual and organizational performance.

5.1 Theoretical Contributions

This dissertation shows the importance of soft competencies and, in particular, internationalization competencies in GSD and describes how the context influences competency requirements and how competencies influence individual performances.

Based on the focus on individuals and their competences, a competence-based view on GSD was developed, which indicated a variety of research gaps. Several of these research gaps have been addressed in this dissertation and serve as the major theoretical contributions. The theoretical contributions can be classified into the conceptualization of competency requirements, the contextualization of competency requirements, and the impact or consequences of competencies. Below, the major theoretical contributions of this dissertation are presented based on the overall theme of the contribution. A more detailed view of this dissertation's contributions and a discussion on the relationships between these contributions and previous research are presented in the included articles.

5.1.1 Conceptualization of Competency Requirements in GSD

The globalization of software development processes has created significant changes to the working environment and working processes. These changes have had a vast influence on the requirements of individuals enacting these work processes. A systematic literature review was conducted to analyze the current state of competence-related research in GSD. The literature review has shown that software development competency is widely addressed, particularly in competency frameworks developed by industry experts, organizations, and special interest groups. However, the systematic literature review also shows that soft competencies were not or not sufficiently addressed in recent research (Article I), which confirms the findings of Colomo-Palacios et al. (2013). Additionally, Article V shows that experts of GSD identified the lack of competences as a main influence factor for commonly discussed barriers in the GSD domain. When addressing competencies, researchers focused on collective constructs such as communication competency and software development competency, instead of analyzing the underlying competences. While the understanding of these collective constructs and their influence on organizational factors such as competitiveness and capabilities is highly important, it does not allow for the development of targeted interventions to manage individuals' competences. An understanding of the underlying competences will enable the development of interventions.

Accordingly, the first major outcome of this dissertation is the development of the *internationalization competency framework*. The internationalization competency framework describes a set of relevant soft competences in global work environments and consists of communication competency, collaboration competency, project management/coordination competency, ICT competency, and intercultural competency (Articles II and III). The development of the framework was an answer to findings of Deans and Loch (1998), who at the end of the 90s had already identified the need for the internationalization of IS curricula. An analysis of model curricula (Articles II and III) shows that the internationalization of curricula did not take place. This framework is the first step to understanding the relevant competences and thus sets the baseline for future studies on soft competences related to international work. According to Ramasubbu and Krishna Balan (2008), providing guidelines for competences and competence orchestration will be the first step toward governance schemes for distributed software development. By identifying relevant soft competencies, this dissertation presents a significant step toward guidelines for competences and competences orchestration. The development of the internationalization competency framework extends the current knowledge base, as competency frameworks mainly address hard competences.

The second contribution of this dissertation is based on *the identification of the lack of competences as a reason for various barriers to GSD*. While previous research has identified a variety of barriers (c.f. Ågerfalk et al., 2005; Noll et al., 2010; Pallot et al., 2010), this dissertation has provided first insights into how

and why barriers to GSD occur. Accordingly, the identification of reasons behind various barriers extends the knowledge base on GSD barriers. Through the identification of barriers that can be accounted for by a lack of competences (Article V), this dissertation provides the first step toward developing targeted interventions. While previous research (c.f. Richardson et al., 2012; Battin et al., 2001) has taken a managerial position on interventions to overcome barriers to GSD, the results of this dissertation can be used as the basis to create competence-based interventions. An analysis of possible interventions has shown that mentoring and team-building activities are seen as more suitable than training in providing required soft competences. This is in line with Casado-Lumbreras et al. (2011), who found that mentoring is a suitable approach to overcoming cultural differences. This dissertation provides first insights into which competences are relevant in overcoming and preventing barriers by providing the internationalization competency framework. The results of this dissertation provide researchers with the first step for a deeper analysis of the barriers to GSD and their relation to competences. This will allow for the refinement of soft competency requirements and the development of targeted competence-based interventions.

In terms of *software development competency*, the initial literature review showed that the corresponding competences were mainly collected and included in various competency frameworks developed and applied by software development companies and other praxis organizations. However, no distinct software development competency construct that was suitable for the planned research could be identified from previous research. For this purpose, a software development competency construct was developed, following the approach of Davis (1989), consisting of ten distinct sub-constructs covering the entire software development life cycle (for more detail, see Article VII). The aim of the software development competency framework was to provide a wide view on potentially relevant competences in different tasks and phases of the software development process. This was necessary, as the competences required to fulfill tasks can differ in various projects (Bassellier & Benbasat, 2004).

Both the internationalization competency framework and the software development competency construct can be seen as an operationalization of important competency areas for GSD that allows for the quantification and measurement of competencies. Through the *development of quantifiable competency constructs*, this dissertation enables the operationalization of the CPT (Korossy, 1999), as it provides measurements for different competencies. The quantifiable competency constructs additionally enable the development of further competence-based theories in GSD, focusing on the relationships between competencies and collective-level constructs such as job performance, organizational performance, and competitive survival. These competence scales therefore provide an important contribution to theory and future research. Both artifacts are highly complex, taking all major aspects into account. However, through their development as higher-order constructs, researchers will be able to adjust the constructs to their specific needs.

Summarized, this dissertation provides the first insights into the competency requirements for GSD in terms of hard and soft competences. Additionally, this dissertation identifies the lack of competences as a reason for a variety of commonly discussed barriers to GSD. Both allow for the development of targeted competence-based interventions in order to enable software developers to overcome certain barriers to GSD and increase the chances of software development companies to leverage the benefits of GSD. Furthermore, through the development of the software development competency construct and the internationalization competency framework, this dissertation extends the knowledge base on competency requirements substantially and enables the conceptualization and operationalization of new theories in the field.

5.1.2 Contextualization of Competency Requirements in GSD

While competences are usually seen as a distinct artifact on a high abstraction level and detached from the work environment, the work context likely has a major influence on the competency requirements (Article IV). Despite this, both research and practice are still using static competency models, without taking the work context into account. The systematic literature review has shown that the contextual influence factors and their impact on the competency requirements have not been addressed sufficiently by researchers (Articles IV and V).

This dissertation shows that competency requirements cannot be seen as static. Instead, dynamic concepts have to be developed in order to adjust the required competences to the current context. The *identification of contextual influence factors on the competency requirements* is a major step in this direction. This dissertation identified the technicality of tasks, the expected levels of innovation and collaboration, and the application domain as potential main contextual influence factors on competency requirements (Article V). This explains and extends the findings of Romero et al. (2008), who identified that, in the subdomain of requirements elicitation, the globalization of processes had a strong influence on competency requirements. According to their findings, some competences had to be adapted based on globalization, while others were unaffected. Additionally, new competence requirements arose. According to the findings of this dissertation, these differences could be explained through the contextual influence factors. While previous research has identified changing competency requirements stemming from GSD, this dissertation provides first insights into how competency requirements change. The identification of contextual influences on competency requirements can be understood as the first step toward new theories explaining and predicting the competency requirements and the performance of individuals in different settings. The presented work describes the start of a new research strand identifying further influence factors and their impact on competency requirements. The identification and validation of further influence factors can potential have a major impact on the overall understanding of competences and their enactment in a business context.

Following the identification of the importance of context on the competency requirements, *differences in internationalization competency requirements between*

the various stages of the software development process have been identified. Article VI shows that the required internationalization competences differ for requirements engineering, software design, implementation, and (system) testing. The results of this dissertation show that the importance of soft competencies is higher for requirements engineering and software design than for implementation and testing. This validates the identified influence factors (Article V) empirically. While requirements engineering is the phase with the highest amount of communication and interaction between people (Penzenstadler et al., 2009) and software design requires a high level of creativity and innovation skills, implementation and testing require a focus on details and high technical understanding (Capretz & Ahmed, 2010). These findings can support researchers when attempting to identify explanations for differences in individual, team, and organizational performance. New or adjusted theories can be created to predict these differences.

Additionally, Article VI provides insight into underlying factors differentiating the phases of GSD. "Adaptability" and "cultural sensitivity" were identified as the main differentiation functions between the four phases. "Adaptability" was especially important for implementation and software design, versus "cultural sensitivity" for requirements engineering and software design. This is also a first step toward understanding the differences and similarities of competency requirements among different phases and tasks of GSD.

The identification of contextual influence factors on competency requirements has various implications. One major implication identified in this dissertation is *the need to adapt competences to the current work context* (Article V). Article V presents an initial approach for the adaptation of competences. Technical—meaning software development or management—competences have to be adapted by applying internationalization competences, meaning that individuals have to evaluate and adjust their work styles and behaviors using their internationalization competences. The result is an adaptation of working styles and behaviors to the changed work context, which indicates the importance of applying technical competences and soft competences together to achieve the highest productivity output possible. In the field of organizational psychology, a distinction between task performance, contextual performance (c.f. Schmitt et al., 2003), and adaptive performance (Jundt et al., 2014) is made. While previous research indicates a relationship between task performance and contextual performance, in terms of interpersonal effectiveness having a bigger effect for technically effective people (Kiker & Motowidlo, 1999), this dissertation indicates that a tight relationship between task performance and adaptive performance is plausible in global settings. This dissertation indicates that having higher adaptive performance increases task performance or the effects of abilities on task performance. This highly interesting research inquiry should be addressed by future research. Furthermore, the understanding of the competence adaptation process that individuals have to apply when changing their work context will allow researchers to develop support mechanisms for individuals.

Summarized, the dissertation shows that the work context has a major influence on the competency requirements in software development. An initial set of influence factors has been identified, and differences in soft competency requirements have been highlighted. These findings point out that a vast amount of additional research is required to understand the competency requirements in GSD.

5.1.3 Consequences of Competencies in GSD

A growing body of knowledge can be found in multiple disciplines on the effect of individuals' traits, such as competences, on individuals' job performance. Theories such as the competence-performance theory (CPT) (Korossy 1997; Korossy, 1999) have been developed and show the major impact of different competencies on performance. The results of Articles IV and V indicate a relationship between technical competences and internationalization competences in GSD.

Article VII addresses this by analyzing *the moderation effect of intercultural competency on the effect of software development competency on in-role job performance*. In-role job performance (Podsakoff & MacKenzie, 1989) represents an example of task performance. Intercultural competency is used as an exemplary subset of internationalization competency in this context. The results of this analysis confirmed the existence of a negative moderation effect, which indicates that with increasing intercultural competency, the effect of software development competency on job performance decreases. In the field of operational psychology, abilities— understood in this dissertation as hard competency— have been found to predict task performance (Schmitt et al., 2003). Dispositional variables, such as soft competencies, are seen as candidates for predicting adaptive performance (LePine et al., 2000). In contrast, this dissertation shows that soft competencies have an indirect (moderating) effect on the task performance of individuals in GSD, which supports the previously described relationship between adaptive performance and task performance in GSD. The results indicate that adaptive performance through the application of intercultural competency has a stronger role in GSD. Further research addressing the relationship between adaptive performance and task performance is highly encouraged, based on the findings of this dissertation. Additionally, the findings open highly interesting, new research questions regarding the nature and reasons behind the moderation effect and which other moderation effects between different competencies can be identified.

The influence of competencies on job performance is commonly assumed. Article VII confirmed this assumption for the effects of software development competency on in-role job performance but failed to confirm the effect of intercultural competency. This is in line with the findings from Schmitt et al. (2003), who found that abilities, such as hard competencies, are useful predictors of task performance. Furthermore, Article VII shows that the relationship between software development competency and in-role job performance is best described with a non-linear function. While a linear relationship is commonly as-

sumed, the CPT (Korossy, 1999) already indicates this non-linear relationship. The CPT indicates that a limited amount of competences is required to fulfill job-related tasks, which indicates that a further increase of competences does not lead to a similar increase in performance. Additionally, the possibility that one competence is required for multiple tasks and multiple competences are needed for one task indicates a non-linear relation. The findings of this dissertation indicate that a non-linear relationship might also exist for the effect of other competencies on performances.

Furthermore, this dissertation shows that *competences enable an individual to overcome and prevent common challenges of GSD* (Article V). Individuals with the right set of competences possess the ability to adjust to changes in work and handle the geographical, temporal, and socio-cultural distance stemming from GSD. Accordingly, this dissertation shows that individuals' competences have a direct influence on organizations' ability to leverage the benefits of GSD.

Summarized, this dissertation shows that understanding the competency requirements and the interdependencies of different competencies and the work context is a critical factor for the success of software development companies' globalization strategies.

5.2 Practical Implications

Reaching a high level of practical implications was a major aim during the research, as the dissertation addresses a highly relevant practical problem in GSD. While previous research has commonly addressed competencies at a higher abstraction level, the aim of this dissertation was to analyze manageable aspects, which refer to any phenomenon that can be directly influenced by managers. Competency and competence management are key aspects of personnel development within organizations and some of the main functions of human resource management (Agarwal & Ferratt, 1998). Accordingly, this dissertation has a major impact on the human resource and competence management of software development companies. Over the duration of the research, the empirical research within the dissertation was conducted in close collaboration with different organizations from the software industry. Participating organizations received direct feedback on their organization's results and support in adjusting their organizational processes, structures, and competence development.

To structure the practical implications of the competence management of software development companies, the implications are organized based on the major functions of the competence management processes. Baladi (1999) defines these as the analysis of future requirements, analysis of present situation, and sourcing of competences (Baladi, 1999).

In competence management, the analysis of future requirements describes the identification of short-term and long-term competency requirements. These competency requirements are based on the organizational strategy and upcoming projects (Baladi, 1999). The literature review of competency frameworks has

shown that soft competencies and, in particular, internationalization competency are rarely addressed. Additionally, an analysis of job advertisements—as part of the development of the software development competency construct—showed that organizations rarely provide job requirements representing the international nature of work. In contrast, this dissertation has shown the importance of soft competencies in enabling individuals to overcome and prevent barriers to GSD. Accordingly, addressing the soft competency requirements can enable software development companies to leverage the benefits of GSD. The internationalization competency framework provides the first insights into relevant competences. Based on the overall framework, organizations can select relevant competencies and competences to create or adjust their own competency models. Through the connection of work context to competency requirements, this dissertation enables software development companies to develop dynamic competency models. Based on the identified influence factors, organizations can analyze their strategy and upcoming projects to see which competences might be relevant. This can lead to more accurate competency profiles for the different positions, as the relationships between tasks and required soft competences can be reevaluated. Project staffing decisions can then be based on the updated competency profiles to achieve a better suitability of project staff to the project tasks.

The analysis of the present situation in the competence management process addresses the assessment of competences based on competence profiles and personal development discussions (Baladi, 1999). Through the operationalization of internationalization and software development competency, this dissertation allows software development companies to assess selected competences of their employees. The modular structure of the competency constructs allows for the selection of specific fields of interest as subcategories of the competency constructs. Based on the results of the dissertation, systems can be developed to continuously track and assess the competences of employees.

The need for competence sourcing can arise through comparisons of future competence requirements and analyses of the present situation. Competence sourcing includes various possibilities, ranging from training and competence development to hiring and outsourcing of specific tasks (Baladi, 1999). This dissertation provides further insight into which competences are important for software developers, based on the different tasks and work contexts. Accordingly, software development companies have the opportunity to streamline their competence-sourcing activities. By addressing not only competencies but also underlying competences, this dissertation provides software development companies the opportunity to implement training, mentoring programs, and other interventions when a lack of competences is identified. Applying these interventions can allow software development companies to overcome barriers to GSD. Article V of this dissertation provides further insight into which interventions are seen as most promising for the different challenges of GSD.

For individual software developers, this dissertation provides valuable insight into relevant competences when working in global settings. The results

are particularly relevant for software developers who are about to change work contexts by changing the work location to a foreign country. The dissertation provides valuable insight into the problems these developers may encounter and provides possible solutions.

Besides practical implications for software development companies and software developers, the presented dissertation also provides strong implications for educational systems. This dissertation provides valuable input for the internationalization of technical curricula, which was already seen as important in the 1990s (Deans & Loch 1998) but has not been accomplished. While educational programs have traditionally focused on technical competences and provided additional courses related to soft competencies, such as communication competency or intercultural competency, the results presented in this dissertation indicate that relevant competencies should be addressed in the context of application. Based on the identified influence factors on the importance of soft competences and the notion of differing soft competence requirements for the various tasks within software development, it appears promising to merge courses on technical competences and soft competences. This merge has the potential to increase the learning outcome of the learner. Additionally, this dissertation shows that a stronger focus on soft competences within educational programs might lead to graduates being better suited for the requirements of the global software development market. Graduates with better soft competences may be better equipped to address and overcome barriers to GSD. Through these findings, the results of this dissertation provide important input for the development of new curricula addressing the global nature of work in IT. While the analysis of model curricula (i.e., Article II) has shown that global aspects have not been sufficiently addressed, the insight from the thesis can inform the development of new model curricula. Through the introduction of model curricula, the findings could be integrated into de-facto standards that are applied by the majority of education institutions worldwide.

For more details on the practical implications of the findings of this dissertation, see the included articles.

5.3 Limitations

Several limitations regarding this dissertation can be recognized. These limitations are mainly based on the strong contextual influence on competency requirements, the diversity of the addressed competencies, or on applied methods for sampling, data collection, and data analysis.

The first limitation relates to the generalizability of the results. While a variety of different GSD companies were involved in the research and provided data, the data might be biased based on their location and fields of operation. This is particularly relevant, as the dissertation identified the influence of the work context on competency requirements (Article V). Thus, it is a legitimate assumption that the results may differ when changing the application domain

and cultural context. The contextual influence factors have not been taken into account during the identification of important competences or while analyzing the differences between the various phases of software development, in terms of their competency requirements. As an example, this dissertation shows that cultural adaptability differentiates requirements engineering and testing. However, if and how the work context influences this differentiation have not been taken into account. It can be assumed that a task's technicality might have a strong influence.

The second limitation is based on the complexity of the involved competencies and the software development process. During the research process, sacrifices must be made in terms of complexity by limiting the scope of the analyzed competences and phases of software development. While major aspects have been addressed in the research, important factors for a specific application domain might be missing. Additionally, the variety of definitions, processes, and approaches in software development increases complexity of the research. For example, the scope had to be limited when addressing testing as a phase of software development, as testing might include system testing or user experience testing. This limited scope of the research prevents the provision of a holistic view of the competency requirements throughout the GSD process. Additionally, competency requirements might strongly depend on the software development process applied. It can be assumed that agile processes require a different set of competences than the traditional waterfall model.

Another limitation is based on the nature of data collection for the quantitative parts of this dissertation. The data were collected using online questionnaires, which required a high amount of effort from respondents. Therefore, fatigue of the respondents and randomness of the answers could have influenced the results. This issue was addressed by an in-depth data screening (see the included articles for more information on the data screening). Related to this issue is the potential bias of the results through cultural influence factors related to the self-assessment of competences. While self-assessments of competences have been shown to be an adequate tool for measuring competence, a bias of the results is possible. This is particularly relevant for the data collected for Article VII. As the research was conducted in Asia and Europe, it is possible that the respondents' cultural backgrounds of the respondent influenced the results.

The fourth limitation is related to the qualitative content analysis and due to the interpretation of statements. As the interpretation of statements is subjective in nature, misunderstandings and misinterpretations may occur. This was addressed by applying several feedback rounds to the results. By presenting the intermediate and final results to all of the participants, misinterpretations should be minimized.

Fifth, while addressing competency and competences, the research in this dissertation focuses widely on skills, abilities, and knowledge items. Important attitudes, which are an integral part of the competence definition, were not taken into account to the same degree. However, attitudes, such as motivation or self-directed learning, might have a major influence on performance outcomes.

Sixth, the dissertation addresses individual competency and its influence on individual in-role job performance. However, other aspects of job performance, such as adaptive performance and contextual performance, have not been addressed. Additionally, as the supervisor provides the rating for the respondents' job performance, the construct actually addresses the perceived in-role job performance of the supervisor. The personality traits of the supervisor, not measured within the research, might have an effect on the perception of performance.

5.4 Future Research Topics

This dissertation opens up a variety of new and important topics for future research. The main aims of the future research topics should be to address the limitations of this dissertation and advance the findings.

To address the presented limitations, further studies are required to identify the competency requirements for GSD. While the major focus of this dissertation is on internationalization competences, a variety of other competences and, in particular, attitudes may have a major influence on the performance of individuals. Additionally, competence requirements have to be further specified for the different phases and roles in GSD. The aim of these further studies should be to achieve a holistic view on the competency requirements throughout the GSD process. Here, the dynamic nature of competency requirements should be the focus of future research.

Another important topic for further research efforts is the identification of contextual influence factors on the competence requirements of GSD. While this dissertation introduces the subject and provides a first set of influence factors, further factors are expected to be identified. Additionally, the impacts of the contextual influence factors on the competency requirements have to be analyzed and validated. A decision support model for the creation of competency models and competency profiles can be created by identifying influence factors. This would directly support organizations involved in software development in their competence management and allow them to dynamically adjust their competency models to strategic changes. This kind of research seems especially important in an increasingly agile work environment.

Furthermore, the competence adaptation processes is a highly important topic for future research. The development of process theories for the adaptation of competences to the work context is highly encouraged and would allow for the support of individuals when changing work context. Through the development of process theories, targeted training and support mechanisms for individuals changing their work environment can be developed.

Another highly interesting topic for future research is the comparison of competency requirements from different countries or continents. This kind of global comparison of competency requirements could be used to analyze the influence of cultural background on the competency requirements. Are compe-

tency requirements similar in the different regions of the world? Which countries are similar, and which countries are very distant from each other, in terms of competency requirements? The answer to these questions could allow organizations to find better-suited employees or outsourcing partners from these regions.

Another highly relevant strand of research would be an analysis of the different dimensions of job performance. While this dissertation focuses on the effects of software development competency and intercultural competency on in-role job performance as an example of task performance, future research should analyze the influence of competency on different dimensions of performance. This future research would lead to a better understanding of how competencies affect different dimensions of performance. Based on the confirmed moderation effect between the software development competency and intercultural competency, the question arises if interactions between the different dimensions of job performance also exist.

Distinct methods for competence management in GSD can be developed by using the results of this dissertation and future research topics. By understanding the competency requirements, interventions in terms of training methods, particularly for soft competences, can be created and tested. For this purpose, a longitudinal research would be required to compare different interventions within a test group without any intervention, to observe the competence level progression. The results would be highly relevant to understanding the processes of increasing soft competences and structuring the competence sourcing of organizations.

Furthermore, while this thesis addresses internationalization competency for software developers, further research is needed to identify competency requirements for other roles and jobs within the IT industry. Here, the internationalization competency framework provides a generic set of competences that can be contextualized to these other roles, jobs, and work settings. Additionally, it can be assumed that additional soft competencies are required and have a positive impact on performance. Here, in particular, competences related to innovation and organizational and individual agility should be analyzed based on the changing nature of the software industry toward increasingly more agile development methods and shorter idea-to-market cycles.

YHTEENVETO (FINNISH SUMMARY)

Ohjelmistoliiketoiminta kansainvälistyy vauhdilla ja sen myötä hajautetusta ohjelmistokehityksestä on tullut yleinen toimintamalli. Kansainvälistymisen avulla yritykset pyrkivät vastaamaan lisääntyneen kilpailun haasteisiin tavoittamalla yritykselle merkittävät voimavarat ja resurssit sekä hyödyntämällä aikavyöhykkeitä tehokkaan työajan kasvattamiseen. Tästä huolimatta ohjelmistoyritykset usein epäonnistuvat tavoitteissaan. Epäonnistumisten syitä on tutkittu, jonka johdosta on tunnistettu useita ohjelmistotuotantoa heikentäviä tekijöitä. Näiden ongelmien ratkaisuun on hyvin vähän tunnistettuja keinoja. Tunnistetut keinot, jotka usein liittyvät prosessiosaamiseen sekä johtamisen käytänteisiin jättävät yksilön roolin ohjelmistokehityksessä huomiotta. Yksilöt, eli ohjelmistokehittäjät, joutuvat kohtaamaan ja selviämään näistä haasteista joka päivä.

Tämä väitöskirja vastaa edellä kuvattuun näkökulmaan tarkastellen osaamisen puutteesta aiheutuvia ongelmia sekä tunnistaen minkälaiset kompetenssit ovat tärkeitä näiden ongelmien poistamiseen. Kansainvälisesti hajautetussa työssä toimivien ohjelmistokehittäjien osaamisvaatimuksia tarkastellaan tässä väitöskirjassa laadullisin ja määrällisin keinoin. Tämä väitöskirja tarjoaa teoriaan ja käytäntöön hyödyllisiä näkökulmia keskeisiin kompetensseihin nähden, selvittäen millaisilla kompetensseilla on potentiaalia tukea ohjelmistokehittäjien toimintaa niiden haasteiden osalta, jotka ovat kriittisiä kansainvälisesti hajautettuun ohjelmistokehitykseen liittyen. Lisäksi tarkastellaan näiden kompetenssien suhdetta koko ohjelmistokehitysprosessiin.

Väitöskirjan tulokset osoittavat, kuinka yleispätevät osaamismallit eivät ole soveliaita, koska työympäristöllä on merkittävä vaikutus osaamisvaatimuksiin. Näiden osaamismallien on otettava huomioon tarvittavien kompetenssien kontekstisidonnaisuus työskentelytavat ja työkäyttäytyminen mukaan lukien. Toisin sanoen, ohjelmistokehittäjien täytyy muokata työskentelyään työympäristön mukaiseksi.

Tutkimuksessa havaittiin, kuinka pehmeät kompetenssit, kuten kansainvälistymiskompetenssit, ovat sopivia ohjelmistokehittäjien itsearviointiin sekä kompetenssien muovaamiseksi työympäristöön sopivaksi. Väitöskirjan empiirinen puoli osoittaa kuinka ohjelmistokehitysosaaminen selittää merkittävästi työstä suoriutumista. Tuloksien mukaan tämä vaikutus pienenee kansainvälistymiskompetenssien myötä. Tämä tarkoittaa, että ohjelmistokehitysosaamisen rooli työstä suoriutumiseen pienenee työntekijöiden kansainvälistymiskompetenssien kasvaessa. Tulokset valottavat kompetenssien suhdetta työstä suoriutumiseen sekä kompetenssien keskinäisiä välillisiä riippuvaisuuksia osana ohjelmistokehitystä.

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ORIGINAL PAPERS

I

A COMPETENCE-BASED VIEW ON THE GLOBAL SOFTWARE DEVELOPMENT PROCESS

by

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A Competence-based View on the Global Software Development Process

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Abstract: The adoption of Global Software Development (GSD) models by software development companies is growing continuously. A variety of challenges such as temporal, geographical and socio-cultural distance are hindering global organizations to achieve potential benefits. As a result, organizations need support in how to overcome the challenges. The emphasis in the literature to date has typically focused on overcoming the challenges by providing tool support, management guidelines and processes. This follows the assumption that a well-established and validated process results in high quality output, not taking the actors within the process into account. While recognized as an important factor for successful GSD, actors and their competences have been addressed from an organizational perspective focusing on organizational and team capabilities rather than from an individual perspective. In this article, we present the results of a literature review on competence-related challenges and competency related research for GSD. We extend existing GSD process models with functions of competence management. The resulting competence-based view allows the management of individual competences throughout the entire GSD process.

Keywords: Competence Management, Competence Based View, Global Software Development, Human Resource Development
Categories: D.2.0, K.6.1, K.6.3, K.7.2

1 Introduction

In today's global and competitive economy, software development companies are searching for a competitive advantage based on costs, quality, flexibility, and increased productivity and risk reduction [Sengupta et al. 2006]. To achieve competitive advantages, organizations often search for external solutions, which leads to globally distributed settings [Prikladnicki et al. 2006]. In globally distributed settings, organizations and individuals are confronted with temporal distance, geographical distance and socio-cultural distance [Ågerfalk et al. 2005] which lead to a wide variety of challenges including aspects of collaboration, coordination, communication and culture [Noll et al. 2010]. [Richardson et al. 2012] state that these challenges can prevent organizations from achieving a competitive advantage. To overcome these challenges, [Beecham et al. 2005] identified the importance of defined and established software development processes. However, [Ramasubbu et al. 2005] identified that key process areas in terms of managing distributed software

development teams are not addressed in traditional software development processes such as the waterfall model and agile methods. Following this, GSD process models with focus on a managerial perspective [Prikladnicki et al. 2006], global teaming [Richardson et al. 2012] and collaboration models [Rocha et al. 2011] were developed. While the majority of these developed GSD process models recognize the personnel as an important factor, competences are mainly considered from an organizational and managerial perspective rather than from an individual perspective [Richardson et al. 2012]. However, individual competencies are a key aspect for organizational business performance [Harvey et al. 2000].

In the software industry, [Lanubile et al. 2010] found that the personnel is crucial as the collaboration between people leads to the development of better software. Additionally, [Rivera-Ibarra et al. 2010] identified that the quality of software strongly depends on the competences applied by software developers throughout the software development process. This shows that, especially in software development, a more human-centric approach than the resource-based view seems appropriate. While development processes are being extended to fit globalization requirements [Prikladnicki et al. 2006], competence requirements and competence management, in particular for non-technical competences, are not researched to the same extent [Colomo-Palacios et al. 2013].

Therefore, a balanced orchestration of team members' competences is needed for successful GSD processes. Therefore, we have developed a competence-based view on the GSD process based on existing GSD process models and an in-depth literature review on competence-related challenges for GSD and potential solutions.

2 Theoretical Foundation

In this section, we first introduce and define the concepts of competency, competence and competence management.

2.1 Competency and Competency Management

The concept of competency is used ambiguously in the IS and computer science domain. On the one hand, competency describes the main abilities of an organization; on the other hand, it also refers to traits, skills and knowledge of individuals. The usage of the term competency as organizational capabilities has its origin in the resource-based view [Peppard and Ward 2004].

From an **organizational perspective**, it is important to differentiate between competences and the related concept of capabilities. Capabilities describe skills or processes [Wade and Hulland 2004] to transform inputs into outputs of a greater worth [Sanchez et al. 1996]. [Sanchez et al. 1996] differentiate between competences and capabilities by looking at the market position of the company. In contrast, capabilities can also be understood as the strategic application of competencies [Kangas 1999]. This means that competencies can be seen as potential of a company and by using this potential strategically they become capabilities.

In the domain of IS, [Peppard and Ward 2004] have analyzed the relation between IS capabilities and IS competencies [Figure 1].

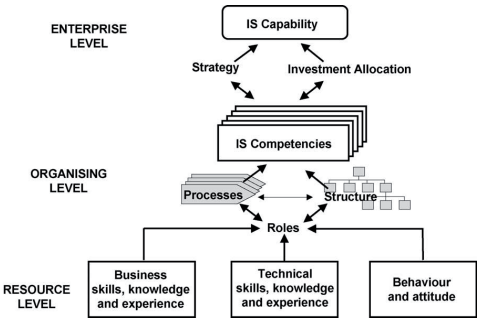

Figure 1: A model of IS capability [Peppard and Ward 2004]

The model shows in accordance with [Kangas 1999] that in the field of IS, capabilities are seen as strategically applied competencies. It also states that competencies are seen on the organizational level connected via processes and roles to resources and individual skills and knowledge. Humans are resources of the company and possess specific skills, knowledge, behaviors and attitudes. The skills, knowledge, behaviors and attitudes represent the **individual or human perspective**. But similar to the organizational level, it remains an unresolved issue what human competencies exactly are [Ley and Albert 2003]. Therefore, many contradicting definitions of individual competency exist [Westera 2001; Winterton 2009]. [Pawlowski and Holtkamp 2012] state that the definition is strongly depending on the research community and a different understanding of concepts, such as competence and learning outcome.

The terms competence and competency lead to some misunderstandings and conceptual problems. From an educational perspective, [Winterton 2009] defines competency as "characteristics of an individual that are associated with superior performance in a job". Competence "describes what a person needs to know and be able to do in order to undertake the tasks associated with a particular occupation". Thus, competency refers to the total set of skills, abilities and attitudes of an individual while competence refers to a specific skill, knowledge item or attitude.

Several authors have criticized current competency definitions. The **contextualization of competencies** is lacking in most of the common research [Sandberg 2000]. Additionally, studies have shown that practitioners are not familiar with concepts such as competency or competence and rather think in problems and possible solutions [Pawlowski et al. 2008].

Within the **human resource management** domain, competence is seen as "an underlying characteristic of a person, which results in effective and/or superior performance in a job" [Boyatzis 1982]. Explaining the relation between organizational and individual competences as well as their management has been one key focus point in HRM [Nordhaug 1998].

[Baladi 1999] identified the most important steps for **competence management** [Figure 2]. Hereby, the competence requirements are based on the strategy and previous experience of the organization. This follows the findings of

[Bergenhenegouwen et al. 1996] who state that an alignment of strategic orientation and HR practices is important. [Green 1999] gives a suggestion how to connect individual competencies with the organizational core objectives and capabilities. With a gap analysis the competence requirements are compared to the results of an analysis of the present situation, which is based on development discussions and competence profiles. Based on the results of the gap analysis several methods for sourcing of competences can be used.

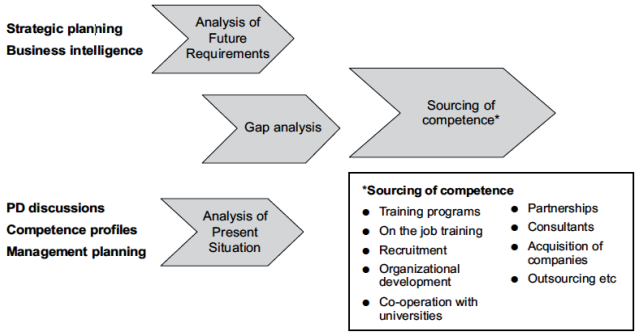

Figure 2: Competence management process according to [Baladi 1999]

Within the GSD domain, the predominant concepts used are skill and knowledge. However, as competence gives a more holistic view we will use competency and competence in this paper. We define competency as a collection of skills, abilities, and attitudes to solve a problem in a given context and competence as an instance of competency.

2.2 Global Software Development Process

The aim of this section is the creation of a structured GSD process to enable the matching of competence-based challenges to the different process phases.

Software development companies are facing a very competitive market. They are searching for a competitive advantage based on costs, quality, flexibility, and increased productivity and risk reduction [Sengupta et al. 2006] leading to distributed settings [Prikladnicki et al. 2006]. [Beecham et al. 2005] identified the importance of GSD processes. [Prikladnicki et al. 2006] argue that the software development process has to be adapted to the global setting. Based on a case study approach, [Prikladnicki et al. 2006] developed a reference model for GSD differentiating three major phases: strategic planning, including project selection and allocation; tactical and operational planning, including the project development; and learning, including evaluation and feedback. A similar structure for GSD projects has been proposed by [Ramasubbu and Krishna Balan 2008] who identified the phases project planning, project execution and project reflection.

Based on the general three-phase structure identified by [Ramasubbu and Krishna Balan 2008], we analyzed processes for GSD identified in our literature review. In the first step, the identified functions were assigned to the three main phases project

planning, project execution and project reflection. Following, the functions from different sources were clustered based on the included tasks and activities. This led to ten distinctive tasks within the project. In the final step, a process flow was identified [Figure 3]. This process should be understood as a sample representation of potential processes as not always all functions are necessary.

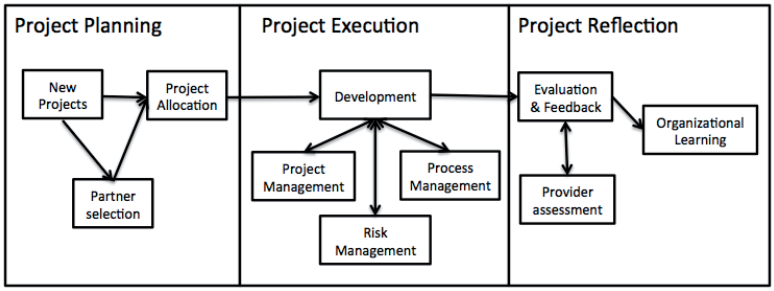

Figure 3: Global Software Development Process

The main goal of the **project planning phase** is the identification of potential new projects both from internal needs and customer requests [Prikladnicki et al. 2006], the evaluation of cost, time and personnel for the project [Ramasubbu and Krishna Balan 2008]) and the selection of potential project partners [Yalaho and Nahar 2009]. The selection of subcontractors is another important step in the planning phase. [Yalaho and Nahar 2009] described a process particular for offshore outsourcing. The team building is another important task within the project planning phase. The **project execution phase** aims at the development of a high quality product. The development is commonly separated into the elicitation of requirements, design of the software, implementation, testing and deployment [Rocha et al. 2011]. The **project reflection phase** deals with the evaluation of all activities [Prikladnicki et al. 2006] and the understanding and recording of potential learning points for the future [Collier et al. 1996]. For this purpose, strategies, the development process, the product [Prikladnicki et al. 2006] and external partners [Yalaho and Nahar 2009] have to be assessed and evaluated. The lessons learned can then be included in the knowledge base of the organization [Prikladnicki et al. 2006] and by that included in the organizational capabilities towards a learning organization [Ramasubbu and Krishna Balan 2008].

Summarized, the main focus of the analyzed literature is on the project execution and in particular the development and the project planning. The functions of the GSD process are used as a classification schema for the literature review.

3 Methodology

This paper follows a design science research approach [Hevner et al. 2004]. Design research usually involves the analysis of current practices and their performance with the aim to understand, explain and improve the analyzed artifact [Hevner et al. 2004].

To analyze the current practices and performance, a systematic literature review [Fink 2005] was conducted.

The main sources for the literature review were IEEE Xplore bibliographic database, ACM Digital Library as well as journals based on the ranking of the Association of Information Systems (AIS). The selected journals were The Management Information System Quarterly, Journal of Management Information Systems, Information Systems Research and European Journal of Information Systems. The journals were scanned in the time period 2000-2011 and all relevant papers were analyzed. To search in the databases Boolean search terms consisting of combinations of the strings such as “competency”, “competence”, “capability”, “skill”, “Information Systems development”, “global software development”, "challenges", “barriers” and “solutions” were used. One example for a search term is “competence” OR “competency” OR “competencies” OR “skill” AND “global software development”. All together a total sum of 378 research papers was taken into account for the analysis. The citations of the articles were scanned based on the before mentioned keywords to identify further important sources for the subject [Webster and Watson 2002]. The analysis of the paper used the following steps:

1. Identification of problems, challenges and barriers for GSD addressed by analyzing the papers for reasons of disturbance.
2. Analysis of the problem, challenge or barrier based on the occurrence as an organizational or individual challenge by mapping the challenges to the GSD process.
3. Analysis of competences, skills or knowledge items connected to the challenges by mapping the challenges to identified competency categories.
4. Identification of proposed solutions or interventions to overcome the challenges by analyzing the papers for identified possibilities to overcome challenges.

In a next step, the results of the literature reviews regarding competence-based challenges and competency related research in GSD were used to combine GSD processes and competence management. Hereby, the occurrence of a competence-based challenge in a specific process function indicates the need for an intervention to overcome the challenge. We address this need by adapting the specific process function with activities of competence management.

4 Results of the Literature Review

In this section we present the results of the literature review focusing on competence-related barriers and interventions for GSD and research addressing competencies and competences for GSD on an individual level.

4.1 Competence-based Challenges of GSD

This section addresses the questions, which challenges for GSD can be accounted for by a lack of competences and in which phases of the GSD process these challenges commonly occur.

Geographical, socio-cultural and temporal distances are usually seen as the **reason for challenges** in GSD [Ågerfalk et al. 2005]. [Ralyté et al. 2008] additionally address organization distance, technological distance and knowledge distance as a

cause for challenges in GSD. The identified distances can lead to weak ties between team members, which again lead to a lack of team awareness [Pallot et al. 2010] and a lack of trust among team members [Battin et al. 2001]. In particular the socio-cultural distance and organizational distance can cause different values, norms and practices [Huang and Trauth 2006]. The different values, norms and practices can lead to incompatible views of problems and misunderstandings [Sclater et al. 2001].

The challenges are rarely addressed from a **competence perspective** but it is evident that in particular aspects regarding intercultural competences, communication competences, collaboration competences and coordination competences are tightly connected to the challenges. [Ralyté et al. 2008] found that most of the challenges identified are related to communication, coordination and control activities. To overcome challenges, often a process and managerial perspective is taken [Richardson et al. 2012]. In spite of this, [Wright et al. 2001] state that it is crucial to examine the "people who engage in the process, the skills they individually and collectively must possess, and the behavior they must engage in (individually and interactively) to implement the process".

[Richardson et al. 2012] have developed a global teaming framework, taking a **managerial perspective** on the GSD process. They suggested process improvements in terms of Global Task Management, Knowledge and Skills management, Global Project Management, Operating procedures and Collaboration between locations. This includes aspects of competence management, in particular competence requirement in terms of business competences, cultural requirements and communication skills and training.

Table 1 shows a selection of example challenges, their mapping to processes and competence categories as well as possible interventions.

The results of the literature review on challenges, which can be accounted by a lack of competences, has shown that the challenges identified can be matched to most functions throughout the entire GSD process. However, the **matching of process and categorization** based on the given descriptions has shown that in particular in the project planning and project execution phase the majority of challenges occurred. Within the project planning phase, challenges could mainly be matched to the partner selection and project allocation. In the project execution phase, the majority of challenges referred to challenges either in the development or project management. In terms of competency categories cultural competences and communication competences seem to be the major underlying cause of the challenges. Hereby it has to be stated that the competency categories are strongly correlated to each other. This means that communication problems could also have a cultural background.

For each of the identified challenges, a suitable **intervention or solution** could be found in the literature. The majority of interventions addresses challenges by suggesting clearly defined and common processes, strategies and plans. However, the interventions also show that these strategies and common processes should not be imposed by one side but rather be collaboratively developed. However, none of the identified interventions directly address the competences of the individual team members.

Challenge	Description	Process function	Competency category	Source	Intervention
Coordination breakdown	Differences in laws, traditions and regulations require extra effort to enforce work standards and processes	Project Management Process Management Development	Project Management Coordination	[Ågerfalk et al. 2005] [Pallot et al. 2010] [Carmel 1999] [Battin et al. 2001]	Collaboratively establish processes; Identify and communicate cultural differences [Richardson et al. 2012] Don't impose a process; Incremental Integration [Battin et al. 2001]
Different conceptual under-standing	Concepts and terms are understood differently based on various cultural backgrounds	Partner selection Project allocation Development	Culture	[Pallot et al. 2010]	Identify cultural requirements [Richardson et al. 2012]
Different tools or tool usage	The selection of tools strongly depends on organizational and cultural influence factors	Development	Tools / ICT	[Pallot et al. 2010]	Common tools [Battin et al. 2001]
Asyn-chronous collaboration	Synchronization of work between different geographical locations within different time zones	Development	Coordination Collabo-ration Communi-cation	[Ågerfalk et al. 2005] [Pallot et al. 2010] [Noll et al. 2010] [Huang and Trauth 2008] [Sarker and Sahay 2004]	Liaison team members [Battin et al. 2001] Clear communication strategy, cooperation and coordination procedures [Richardson et al. 2012]
Missing interpersonal awareness	Weak ties and degree of familiarity among team members can cause several problems such as the lack of team awareness and uncertainty about right contacts	Development	Culture	[Ågerfalk et al. 2005] [Pallot et al. 2010] [Sclater et al. 2001] [Battin et al. 2001]	Liaison team members; Face-to-face meetings [Battin et al. 2001] Meeting strategy [Richardson et al. 2012]
Lack of trust	Uncertainty about working behaviors and competences of team members lead to a lack of trust	Development	Culture	[Pyysiäi-nen 2003] [Pallot et al. 2010] [Noll et al. 2010]	Face-to-face meetings [Battin et al. 2001] Cultural profiles for each team [Richardson et al. 2012]
Communi-cation breakdown	Intercultural and virtual communication requires extra effort to avoid a lack of	Development	Communi-cation	[Ågerfalk et al. 2005] [Herbsleb and Moitra 2003]	Establish communication strategy and interface points; Identify communication skills for GSE

Challenge	Description	Process function	Competency category	Source	Intervention
	informal communication, loss of communication richness and misunderstandings			[Carmel 1999] [Sclater et al. 2001] [Riege 2005]	[Richardson et al. 2012] Continuous communication [Battin et al. 2001]
Language	Language differences can cause misunderstandings, delays and errors	Development	Communi-cation	[Pallot et al. 2010] [Imsland and Sahay 2005]	Clear Communication strategy [Richardson et al. 2012]
Different backgrounds	Different backgrounds of team members lead to incompatible views of problems and misunderstandings	Partner selection Project allocation Development	Culture	[Pallot et al. 2010] [Sclater et al. 2001] [Curtis et al. 1988] [Clausen and Worm 2010]	Identify cultural requirements; Ensure awareness of cultural profiles; Clear conflict management [Richardson et al. 2012]
Differences in negotiations and accepting work	Cultural backgrounds can influence the perceived outcome of negotiations and task distributions	Partner selection Development	Culture	[Ebert and De Neve 2001]	Task allocation strategy [Richardson et al. 2012] Rational task management [Battin et al. 2001]
Values, norms and practices	The cultural background has a strong impact on individual values, norms and practices	Development	Culture	[Huang and Trauth 2006] [Riege 2005] [Pallot et al. 2010]	Identify cultural requirements; Ensure awareness of cultural profiles [Richardson et al. 2012]
Time perception and time-based behavior	Team members from various backgrounds can have a different perception of time and deadlines	Development Project management	Culture	[Huang and Trauth 2006] [Huang and Trauth 2008] [Saunders et al. 2004]	Collaboratively establish work plan [Richardson et al. 2012]

Table 1: Challenges, processes, competencies of GSD

Summarized, the results show that a wide variety of challenges caused by a lack of competences. However, discussed interventions rarely take a human-centric or competence perspective. The focus of the intervention is instead on organizational resources such as processes, strategies and management practices. But as the challenges mainly occur on an individual level, competence-based interventions promise a suitable method to avoid and overcome problems of GSD.

4.2 Competency Research in GSD

The lack of competence-based interventions raised the question regarding the state of the art of research concerning competencies for GSD. Therefore, we analyzed the selected literature additionally for tools that could be used for competence-based interventions. In this case, we understand tools as specific competences, which could be used as learning outcomes for activities connected to interventions. The competences were clustered based on the same categories used for the competency categories in the previous section.

The results of the literature review have shown that competences are researched rather on a category level and that rarely concrete competences were addressed in the studies.

The results also show that the majority of identified studies focus on technical competences. However, in the last decade, a stronger focus on soft skills can be identified. Intercultural competences hereby receive the least attention. The majority of the competency related research addresses problems in a very narrow context. While aspects of competence management are related to GSD tasks, they are not an integral part of the GSD process. [Wright and Haggerty 2005] identified a long temporal lag between the functions situated in the operative side and human resource management. Additionally, [Foss 1993] states that the combination of competences with processes, learning and innovation play a crucial role in the firm's performance. Therefore, an integration of competence-based interventions and the GSD process based on identified challenges can lead to more flexibility and improved productivity. Table 2 presents a summary of the findings

Addressed competencies	**Source**
Technical competences	Development of a body of knowledge for Information Systems with the core areas of IS application knowledge and IS development process knowledge [Iivari et al. 2004] IT curricula of business schools focusing on learning outcomes / course offerings [McAfee 2007] Identification of relevant knowledge areas for the field of information systems [Bacon and Fitzgerald 2001] Influence of webmaster's competences on the job performance including technical, management, communication and collaboration competences [Wade and Parent 2001] Importance of IT managers skills and activities on different managerial levels [Wu et al. 2007] Qualitative analysis of relevant IS competences with a special focus on collaborative software development and modeling [Magenheim et al. 2010]
Application domain (business) competences	Introduction of application domain knowledge as an important factor for the body of knowledge for Information Systems [Iivari et al. 2004] IT curricula of business schools focusing on learning outcomes and course offerings including management courses [McAfee 2007] Development of a model and study on the importance of business competences for IT professionals [Bassellier and Benbasat 2004]
Coordination / project management competences	Identification of management skills for computing professionals [Fernandez-Sanz 2009] Identification of relevant knowledge areas for the field of information systems [Bacon and Fitzgerald 2001] Influence of webmaster's competences on the job performance including technical, management, communication and collaboration competences [Wade and Parent 2001] Team knowledge and coordination in distributed software development teams with a focus on relevant skills [Espinosa et al. 2007]

Addressed competencies	Source
	Importance of IT managers skills and activities on different managerial levels [Wu et al. 2007]
Communi-cation competences	Communication skill teaching in the field of IT management [Sixsmith and Litchfield 2010] Identification of communication skills for computing professionals [Fernandez-Sanz 2009] Influence of webmaster's competences on the job performance including technical, management, communication and collaboration competences [Wade and Parent 2001] Pedagogics for developing cross-cultural communication competencies in virtual collaborations [Paretti et al. 2006] Development of a technical communication competency model [Isohella 2010]
Collaboration competences	Collaboration skill teaching in the field of IT management [Sixsmith and Litchfield 2010] Identification of collaboration skills for computing professionals [Fernandez-Sanz 2009] Collaborative behaviors and activities in multiparty software development [Levina 2005] Influence of webmaster's competences on the job performance including technical, management, communication and collaboration competences [Wade and Parent 2001] Qualitative analysis of relevant IS competences with a special focus on collaborative software development and modeling [Magenheim et al. 2010]
Intercultural competences	Introduction and study on the importance of cultural intelligence as a part of intercultural competency in technology work [Koh et al. 2009] Collaborative behaviors and activities in intercultural software development [Levina 2005] Pedagogics for developing cross-cultural communication competencies in virtual collaborations [Paretti et al. 2006]

Table 2: Competency research in GSD structured by competency categories

5 A Competence-based GSD Process

Based on the results of our literature review, we have identified challenges and interventions related to competences. We merge these towards a guideline for GSD processes outlining the competence-related activities, which must be taken into account.

As the lack of competences can be accounted for a wide variety of challenges, competence management provides suitable interventions to help employees to overcome problems in their work. The inclusion of competence management functions into GSD processes constitutes a competence-based GSD process (Figure 4).

The analysis has also shown that competence-based challenges are present at most stages of the GSD process. Therefore, we propose competence management as an integral part of all GSD processes instead of an additional function. In the following table, we describe the problems and suggested changes for each of the identified GSD process functions.

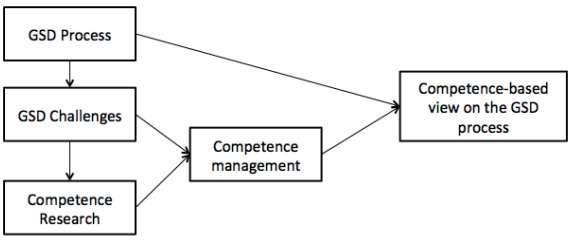

Figure 4: Relation of sub-fields of the Competence-Based View of GSD

Process Function	**Problem**	**Competence-based intervention based on competence management**
New projects	Decision which project to run	In terms of decisions regarding new projects, for each potential project the analysis of the competence management project should be part of the decision process. The knowledge of the competencies of employees allows for a flexible assembling of project teams [Lucas and Weber 2000]. Based on an analysis of required competences and existing competence profiles [Ley and Albert 2003; Reinhardt and North 2003], a gap analysis should be conducted [Baladi 1999]. A plan run of competence sourcing can then establish possibilities to overcome the identified gaps. If external partners should close the gaps, it is necessary to identify if suitable partners are already available or if a new partner has to be found.
Partner selection	Decision which external partners to include in the project	The selection of partners should follow the target of closing competence gaps. This means that the strategic competence analysis [Yalaho and Nazar 2009] should focus rather on individual competences than on organizational capabilities. Ideal would be the provision of competence profiles for each team member of the potential partner. The aim of the partner selection should be to find a best match of complementing competences and price.
Project allocation	Decision which parts of the project to be executed by which partner	The project allocation has the aim to find the best fitting partner. While the partner selection tries to find suitable partners taking all projects into account, the project allocation looks at one particular project. A special focus should be on competences of all potential team members in partner organizations. To analyze the competences of potential team members, different methods are available [Reinhardt and North 2003].
Project planning	Planning of projects risks and personnel	The project planning aims at planning costs, risks and personnel for the particular project. It should take the global teaming framework by [Richardson et al. 2012] into consideration. In particular, Global Task Management, Knowledge and Skills Management, Operating procedures and Collaboration between locations should be planned and established in this phase. For personnel planning, it is important to build a team fitting the established competence requirements.
Project management	Monitoring of project progress and task allocation	The project management function should be extended to global project management [Richardson et al. 2012]. Monitoring and control of the development work should take competencies into account to analyze if the assumptions regarding competency requirements and competence profiles of the team members are adequate. In case new requirements surface, competence sourcing should take place. Additionally, competencies should be taken into account for task allocation to team members [Ley and Albert 2003]

Process Function	Problem	Competence-based intervention based on competence management
Process management	Control of all involved processes	Process management should take processes regarding competence management into account. It is important to monitor the effectiveness of the competence management process to ensure a high performance. The competence requirements of a project can change dramatically both between project planning and project execution and during the project execution [Hiermann and Höfferer 2003].
Evaluation and Feedback	Evaluation of the project	It is important to evaluate strategies and decision regarding competences. Competence requirements should be evaluated to understand if the assumption behind the personnel planning and competence sourcing activities were adequate. Additionally each team member's competences should be evaluated based on the project experiences to update the individual competence profile. The update of the competence profile should also include new experiences and potential training.
Provider assessment	Decision if the partnership should be continued	Teams of external partners should be evaluated. Hereby, both the experienced organizational capabilities and individual competencies should be evaluated. In particular should be evaluated, if the experiences match the provided competence profiles of the team members. The results should be taken into account for upcoming decision regarding project allocation and partner selection.
Organizational learning	Learning from experience	Organizational learning should include a strong focus on individual learning. Based on the experience of the project and the results of the evaluation, individual development plans should be created. The development plans for the team members should therefore be created based on the experiences of previous projects and on requirements for upcoming projects.

Table 3: Integration of competence management and the GSD process

However, to achieve an applicability of the competence-view on the GSD process in practice, substantial further research efforts in terms of competence-related GSD challenges, relevant competences and methods for competence management for GSD have to be undertaken. The following section provides a proposed research agenda on these topics.

6 Discussion

Based on our holistic analysis, we have created a **competence-based view for global software development**, creating a different perspective on causal relations between resources and organizational performance. Therefore, the competence-based view should be understood as an extension or specialization of the resource-based view. Fundamental in the resource-based view is a set of physical, human and organizational resources specific for a firm, which leads to a competitive advantage and a superior long-term performance [Barney 1991; Wernerfelt 1984]. [Dierickx and Cool 1989] state, that highly skilled employees with hard to copy or obtain competences are the best possibility to achieve a competitive advantage. This means that individual competences can explain the gap between resources and the performance [Dierickx and Cool 1989]. Our competence-based view addresses the gap between physical and organizational resources and the performance.

Especially in software development, the quality of products depends strongly on the competences applied by software developers throughout the software development

process [Rivera-Ibarra et al. 2010]. The physical resources such as hardware and the organizational resources such as development processes are tools used by the individual actors to apply their individual competences. The resource-based view hereby neglects the fact that many resources can't be used without the appropriate human resources and competences. This shows that a **human perspective** in GSD might rather lead to a competitive advantage as the product quality is strongly depending on the quality of employees assigned to the project. This is supported by [Foss 1993] who states in his work regarding a competence-based view of the firm that the combination of competences with processes play a crucial role in the firm's performance. If the highly skilled employees are not available for the project, the organization might not be able to achieve a similar product quality even when using the same process.

The competence-based view of the GSD process is also in line with the **competence-based view of the firm** including the continuous change and development of the firm and the included set of competences [Foss 1993]. This seems to be a crucial aspect in the global market with changing project partners and requirements. The competence-based view of the GSD process allows for a dynamic and flexible adaptation based on the changing environment and requirements.

For an operationalization of the competence-based view on the GSD process, a number of questions were either entirely or not sufficiently answered by the literature. In the following, we will shortly present and discuss these questions.

With the help of our literature review, we identified that the challenges discussed in the related literature are not related to the **project reflection phase**. However, it can be expected that both the partner assessment and the organizational learning are more complex in international settings and socio-cultural difference can play an important role. Therefore, it is important to analyze which challenges the globalization of software development raises in this particular phase of software development projects.

Another important aspect is the **relation between competences and challenges**. A wide variety of challenges have been identified [Ågerfalk et al. 2005; Noll et al. 2010; Pallot et al. 2010]. However, the challenges are usually not analyzed taking a competence perspective. It is necessary to emphasize more on the relation between challenges and competences and to validate the findings.

Further more, **team building** and the connected **orchestration of competences** among team members is an important issue. [Ramasubbu and Krishna Balan 2008] state that guidelines regarding the competence orchestration "will be one of the significant first steps towards achieving normative governance schemes for distributed software development projects". Therefore, the orchestration of competences among team members is an important rising topic. It is in particular important to analyze which competences are necessary for all team members and which are necessary for team members fulfilling a specific task. This could lead for example to the creation of new or updated job descriptions and requirements for partner selection and personnel management.

A complex issue is the lack of coherent **standards for competence descriptions** [Reinhardt and North 2003; Ley and Albert 2003]. Different domains and even different organizations might use various ways to represent competences. [Paquette 2007] presents an overview of the definitions and underlying assumptions of the term

competency from different domains and gives a suggestion for a common understanding. However, up to date no standardized form can be found.

Another important issue is the notion of **context** within the competence description. As context is often seen as the crucial driver for competence requirements, we have to understand how this relation works. The understanding how changes of context influence the required competences is crucial for the creation of competence requirements for a specific project.

To enable organizational and individual learning in the competence-based GSD process, it is important to be able to assess individual competences continuously during the project runtime. For this purpose, specific **competence assessment** methods have to be developed as traditional tests or self-ratings might not reach the necessary accuracy. Based on the Competence Performance Theory (CPT), [Ley and Albert 2003] suggest using the repertory grid technique (RGT) for the knowledge elicitation. [Reinhardt and North 2003] state that different methods such as questionnaires and online polls can be used to ascertain the individual competences with a competence catalogue based on the organizational strategy and requirements. However, the suggested methods restrict the competencies to a prior set and do not allow for elicitation of all competencies of the employees. In case of changing requirements based on the nature of new projects, additional competences might emerge as important. Therefore, methods covering the entire competences of individuals seem relevant.

While [Baladi 1999] suggests a wide variety of methods for **competence sourcing**, we have no evidence of the effectiveness of the suggested methods. In particular when discussing intercultural competencies and knowledge sharing, [Casado-Lumbreras et al. 2011] have shown that mentoring might lead to better results than traditional training. [Dodero et al. 2007] suggest the usage of Competence Development Programs (CDPs), which are a collection of learning activities and units aimed at increasing the competences of the employees. However, which method for competence sourcing is best suited for the competences of different competency areas is crucial to plan the competence development.

7 Conclusion

Globally distributed software development is a complex and difficult task [Richardson et al. 2012] based on challenges coming from geographical, temporal and cultural distance [Ågerfalk et al. 2005]. In GSD projects development and management processes are important to handle the complex task. However, the human perspective of team members cannot be underestimated.

In this paper, we have developed a competence-based view on the GSD process. This view enables the direct integration of competence management tasks within the GSD process. The integration of competence management and the GSD process leads to a streamlining of competence activities and a reduction of temporal lag of human resource management. Therefore, the competence-based view has the potential to increase the productivity and guide new ways for achieving a competitive advantage. Additionally, the competence-based view of the GSD process can lead to overcoming or preventing a wide variety of common challenges for GSD by providing individuals with the suitable tools in terms of competences to overcome these challenges.

Competence-based interventions were suggested to close the gap between the required and the actual competence level of employees.

While the theoretical concept of the competence-based view promises a lot of benefits for organizations, the operationalization of the concept requires more research. Based on our literature review we have shown the state of the art of competency research related to GSD and have given suggestions for important research topics.

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II

GLOBALIZATION COMPETENCES IN INFORMATION SYSTEMS AND E-LEARNING

by

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Globalization Competences in Information Systems and E-Learning

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Abstract. Internationalization and globalization competences play a major role for graduates and employees in IS related enterprises. In contrast to other disciplines such as Business or Economics, the IS discipline rarely addresses this competence area. In the paper, we identify generic competence areas: coordination, communication, and cooperation. We derive domain specific competences for the field of E-Learning in Higher Education. The paper concludes with an outlook of promising research areas to foster and intensify research in the domain.

Keywords: Globalization, globalization competence, curriculum development, E-Learning competences

Introduction

Globalization competences contain skills, abilities and attitudes to successfully act in globally distributed settings. This paper describes requirements for graduates in the field of Information Systems (IS) and proposes research trends in the field.

With the globalization of business processes, development, supply and production chains the requirements towards individuals have changed dramatically. Organizations and individuals are exposed to new global challenges, e.g. cultural differences, languages, geographical dispersion, loss of communication richness, coordination breakdown, loss of team awareness etc. Therefore companies and national economies will only be successful on the long term if Higher Education and training organizations prepare current and coming workers as good as possible for these challenges.

In the domain of Information Systems, recent curricula focus mainly on knowledge and methods in the specific subjects [1]. The development of soft skills like presentation and team work is included but the integration of skills for working in globalized environments and international teams stay behind. Therefore, we need new kinds of programs for the specific tasks of internationalization and should integrate the additional objectives in existing courses and skill development.

In previous work [1], we have identified two generic competence fields which can support the preparation of individuals for global distributed working environments:

- Computer /ICT literacy: The importance of computer literacy and e-skills is well documented and also reflected in recent policies within Europe [2].

However, curricula in schools and universities still focus on localized approaches and do rarely take the global dimension into account [3][4].

- Intercultural competences: As a second main area, competences to act in intercultural settings have to be considered. This field focuses on different aspects, such as intercultural management or communication aspects [5].

To acquire necessary competences, the current and coming academic workforce should be prepared in Higher Education for future global work settings. This should be achieved by both, specialized courses as well as in integrated existing courses and exercises. Therefore, existing curricula have to be extended to include these new requirements.

In this paper, we analyze relevant areas and competences by an analysis of current curricula. We identify gaps and requirements for potential globalized curricula. After the identification of required competences, we outline an example how such a generic curriculum framework can be applied to the domain of Technology-Enhanced Learning (TEL). We conclude with an outlook, proposing research directions.

International Aspects of IS Curricula

How are global settings currently addressed in Higher Education in different disciplines? This is the main question we address in this section.
As a first step, curricula can be analyzed regarding global competences, as Higher Education institutions as well as corporate training are affected by the influences of globalization [3]. The need for globalization competences becomes even more important when working in developing countries [6] which is often the case in particular when organizations choose offshore outsourcing models.

Current curricula in IS education programs are in many cases focused on purely domain specific knowledge. For the Anglo-American area, model curricula have been developed outlining key aspects and contents of the domain [7][8]. Those curricula reflecting the current status of learning and teaching rarely take globalization aspects into account. The current ACM model curriculum on Management Information Systems addresses globalization issues in many fields such as policy, market organizational issues [7] but does not address corresponding competences. As a further example, the German model curriculum for Business Information Systems [9] does not even address the topic of globalization or globally distributed work.

To identify generic competences and to analyze global needs, we use the model curriculum structure and guidelines for undergraduate [8] and graduate degree programs [7] of ACM. Information systems graduates need the following high-level IS capabilities which are based on knowledge and skills in the three categories IS-specific knowledge and skills, foundational knowledge and skills, and domain fundamentals [8]:

- Improving Organizational Processes,
- Exploiting Opportunities Created by Technology Innovations,

- Understanding and Addressing Information Requirements,
- Designing and Managing Enterprise Architecture,
- Identifying and Evaluating Solution and Sourcing Alternatives,
- Securing Data and Infrastructure, and
- Understanding, Managing and Controlling IT Risks.

Global aspects are partially labeled in IS-specific knowledge and skills, e.g. in case of customizing processes to address cultural and ethnic needs or for the evaluation of sourcing and offshoring decisions. However, a greater focus can be found in the foundational knowledge and skills that are not unique to Information Systems as a discipline, e.g. leading cross-functional global teams and managing globally distributed projects [8]. Nevertheless, most of the other concepts like Designing and implementing information systems solutions (IS-specific skills) or Communication & Negotiation (foundational skills) will be strongly influenced by global needs.

A master's program in information systems aims on the following competences:

- "A core of IS management and technology knowledge
- Integration of IS and business foundations
- Broad business and real world perspective
- Communication, interpersonal, and team skills
- Analytical and critical thinking skills
- Specific skills leading to a career" [7]

The model curriculum also refines the competences for different career tracks. The topics are summarized as following [7]:

- IT Infrastructure
- Analysis, Modeling, and Design
- Enterprise Models
- Emerging Technologies and Issues
- Project and Change Management
- Strategy and Policy
- Implications of Digitization
- HCI
- Integrated Capstone

Each competence could be measured regarding the level of Knowledge / Competences. These levels are (0) no knowledge, (1) awareness, (2) literacy, (3) concept/Use, (4) detailed Understanding and (5) advanced. For undergraduates only the level 1 to 4 are used [8]. It is clear that all of those topics are affected by global aspects and need to be refined in terms of globalization issues.

As a conclusion, the a globalized IS curriculum needs to be refined for:

- Different career tracks and levels,
- IS subjects and topics,
- General globalization competences.

Competences in global processes

Whereas the last section focused on the analysis of curricula, we have also analyzed current practice in international projects in the domain of global software development and international collaborative work.

Carmel [10] defines five main barriers for distributed teams: geographical dispersion, loss of communication richness, coordination breakdown, loss of team awareness, cultural differences. Evaristo et al. [11] extend Carmel's approach and identify the following influence factors for global teams: trust, level of dispersion, type of stakeholders, type of projects, synchronicity, complexity, systems methodology, perceived distance, policy and standards, culture. This very comprehensive classification gives an orientation which challenges are faced by organizations and individuals in a global work context. In a following publication, Prikladnicki, Audy, & Evaristo [12] provide also recommendations for global organizations. In particular, a well managed (maturing) process, careful preparation, and continuous knowledge exchange can positively influence global projects and work processes. Furthermore, the competences of individuals and stakeholders in the process play a crucial role. This regards mainly the ability to manage and communicate in intercultural teams [13].

One crucial aspect is the exchange and distribution of knowledge [14]. Global knowledge sharing is still a challenging but highly significant task. Global organizations or temporary partnerships work distributed all over the globe – more and more study programs include learners from all over the world in E-Learning study programs like the one addressed in this paper. This means that globally distributed teams need to be supported to work effectively and efficiently.

Based on these approaches, the following influence fields can be derived. For each field, we briefly outline the challenges for individuals in the field of Global Information Systems as well as the key aspects for the corresponding training instruments.

1. **Culture:** Cultural aspects are a crucial success factor for Global Information Systems. Different levels of culture (e.g., national, regional, organizational, [15]) influence work and learning processes. Individuals need to be prepared to analyze, reflect, and react towards their partners' and their own cultural characteristics. In training settings, cultural aspects regarding the contents, communication, or learning styles need to be considered [16].
2. **Coordination and Communication:** In distributed teams, heterogeneous values, norms, and behavior can lead to problem situations, conflicts, and misunderstandings. Common ways of communication need to be agreed and facilitated. Additionally, coordination mechanisms (also addressed in international project management) need to be defined and performed. For training settings, this means that learning scenarios need to be adapted, in particular for collaborative learning settings.
3. **Knowledge Management** plays a crucial role for the success of Information Systems, in particular when work processes are coordinated around the globe. Therefore, supporting instruments and mechanisms need to be defined to

continuously enable and ensure knowledge transfer between the stakeholders involved.

4. **Collaboration** and the application of **inter- and cross-cultural skills** need to be assured in all parts of work settings. Training settings should take those key competences into account when preparing individuals to act in global settings.

Those key aspects should be incorporated in a framework for global IS competences.

Towards an Internationalized IS Curriculum

As identified in the previous sections, the main competences necessary for internationalization can be summarized under computer-related and intercultural competences. To support the work in global distributed work settings we can further summarize the above mentioned competences into the fields of **communication**, **coordination** and **cooperation**.

Coordination could also be seen in a generic way as the project management within a groupwork. The application of the internationalization competences to this three fields lead to the required skills. Meaning, in an international setting the communication, the collaboration and the project management related tasks and functions will change and require different set of competences. So cultural influence factors and also the IT environment for all three will change.

Considering education for individuals confronted with internationalization, besides these three sectors the domain specific knowledge is of crucial importance. In the domain specific knowledge the background and theory part will stay the same but the execution of specific tasks may change, e.g. the monitoring of distributed groups will need a different skill set than the monitoring of a local group. Therefore the methods and contents to teach and to learn the domain specific competences are heavily influenced by the sought internationalization competences. This could be represented depending on the domain e.g. in multi-national case studies, transnational groupwork during the exercises, etc.

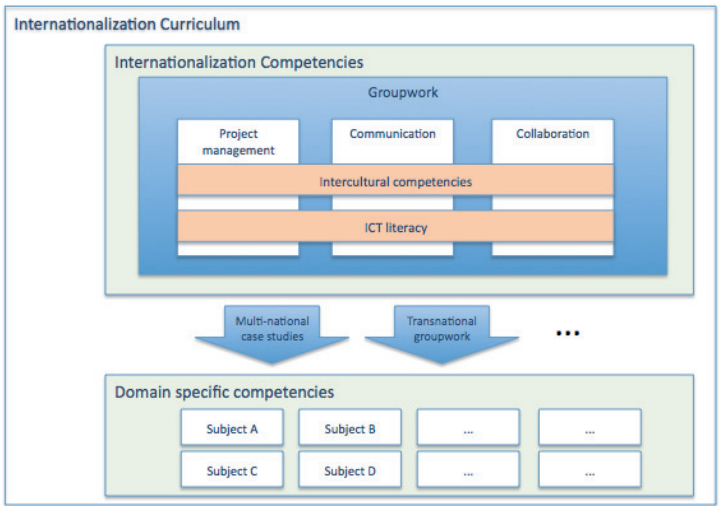

Figure 1: Internationalization Curriculum

This framework, however, only describes the key aspects and main tracks of internationalized IS education. It needs to be adapted to career tracks (e.g. global software project manager, CIO, programmer) and to specialized sub-domains.

Case Study: International E-Learning

To show the use of such a generic model, we will show the application of the framework within the domain of e-Learning and Knowledge Management. In the example we will use the settings of the European project TeaCamp, which deals with virtual mobility within Europe.

Two main competences for internationalization are intercultural and computer-related competences. These will be addressed in our setting within courses regarding culture models and international online groupwork. The target of these courses will be to support the internationalization of project management, communication and collaboration and to give individuals the main necessary understanding of required skills. As domain specific topics we identified the following issues in the project context:

- Learning Strategies
- E-Assessment Strategies
- Advanced Learning Technologies
- Collaborative Online Groupwork
- Information Literacy

In the international context of a virtual mobility activity, these domain specific topics will be influenced by the additional international competences. As an example,

learning or assessment strategies differ significantly [17]. Therefore, it is necessary to develop generic intercultural and international competences and apply those to the domain specific topics as well. A basis can be the use of culture models ([15][16][17]) to acquire internationalization competences and to identify their influences on the technology-related subjects.

Based on this general idea, the curriculum structure is described in the following figure.

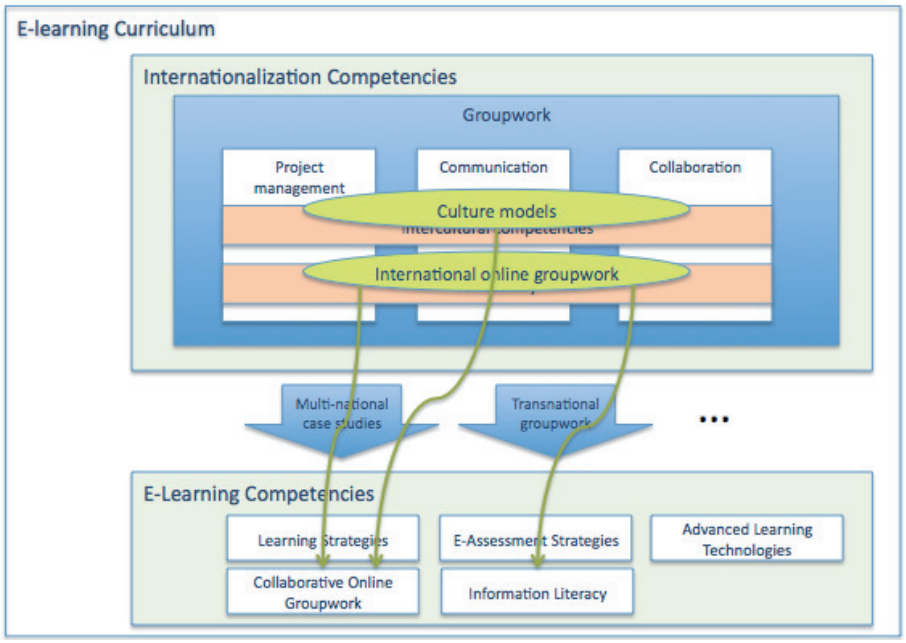

Figure 2: E-learning Curriculum

Due to the fact, that intercultural competences are influencing also the domain specific topics, e.g. international e-assessment might be different from national e-assessment due to different regulations and preferences, we propose, that the topics introduced in the section culture models will be taken into consideration in all other parts as well.

This adaptation of the general curriculum shows one implementation. It has been successfully used to develop a curriculum in a project setting. For a broader curriculum on Technology-Enhanced Learning, a more general approach should be applied, focusing on the full sub-domain [18]. However, the main work is still in progress: Identifying specific curricula for different sub-domains and career tracks.

Conclusion and Future Research

This paper has identified requirements and potentials for internationalizing education in IS education, in particular for knowledge-intensive domains such as E-Learning or Knowledge Management. Based on the theoretical foundations, we have derived a sample curriculum and suggestions for didactic embedding and planning of those learning activities.

Based on the analysis, several research strands can be derived:

- Development of theories and models describing globalized IS competences,
- Identification of general competences in globalized curricula,
- Adaptation of the general framework to sub-domains and career tracks,
- Development of specific country profiles, integration of national curricula,
- Application of culture related theories and models to sub-domains,
- Method development for HR management in global settings for IS professions.

This list should not be seen as complete. It shall service as a basis for the discussion to intensify acresearch in the proposed field and to stimulate discussions on research potentials.

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III

TOWARDS AN INTERNATIONALIZATON OF THE INFORMATION SYSTEMS CURRICULUM

by

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Towards an Internationalization of the Information Systems Curriculum

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Abstract

Globalization has changed the requirements to professionals and students in all branches and sectors significantly in the past decade. However in the domain of Information Systems, these changes have not yet found their way into current study programs and curricula. We identify and validate core internationalization competences and their relation to IS specific competences based on an initial set of competence categories. This is the basis for designing learning services of the future. The presented study aims at validating both and identifying additional categories and competences. In this paper, we present the first results of this study focusing on the internationalization and knowledge management competences. The results can be used for different purposes exploring the human perspective on information systems development.

1 Introduction

The main goal of this paper is to identify both the main competence categories necessary for an internationalized IS curriculum for globally working professionals, in particular in knowledge-intensive settings. By identifying competences to deal with cultural characteristics of globally distributed teams and work environments, we set the basis for designing learning services based on an empirically derived set of competences.

In the IS world, the shift towards international and global work is visible everywhere. This means that graduates of IS are confronted with global work environments and challenging work in international projects, in particular regarding cultural characteristics. This shift was addressed already in the change and introduction of new curricula in other domains, e.g. in business education. New studies such as international business and the European business programs were introduced. However, the IS curriculum in Higher Education institutions was not adapted to these changes.

The importance for an internationalization of the IS curriculum was shown for example by Deans and Loch [3]. Their study indicated that the majority of participants saw the internationalization as very important but did not expect the curriculum to change in the nearer future. An analysis of existing model curricula of IS, mainly focusing on the ACM model curriculum [5] and the German Model Curriculum for business information systems [19], showed that just few aspects of internalization were introduced in the model curricula [13]. This supports the prediction made by Deans and Loch [3] that the adaptation of the curriculum will not be done in the nearer future.

In this paper, we present the results of a study aiming at verifying the identified competence categories and identifying an initial set of generic competences for these competence categories as well as the validation of the complete study. This leads to the following research questions for our study:

- Which categories of competences are important for an internationalized IS curriculum and as how important are they seen?
- Which are the most important generic competences for each category as a basis for learning service design?

2 Background

2.1 Competence

A variety of definitions of competences is currently discussed (cf. [6][11]). There are, depending on the research community, differences in the understanding of competences and related concepts like competency and learning outcome. As a basis, we use the related concept Learning Outcomes (LO), defined in the European Qualification Framework as "[…] statements of what a learner knows, understands and is able to do on completion of a learning process" [4]. When applied to a certain problem in a certain context, Learning Outcomes can be seen as competences. We define thus competences as *a collection of skills, abilities, and attitudes to solve a problem in a given context*.

To identify competences and competence categories relevant for an international IS curriculum, different model curricula, research papers and competence frameworks were analyzed. Table 1 shows an overview of perspectives and focus areas of analyzed sources.

Table 1: Examples of analyzed sources for competences and competence categories

Source Name	Source Type	Reference
ACM model curriculum	Model curriculum	[5][16]
Business Information Systems	German model curriculum	[19]
American Assembly of Collegiate Schools of Business International business curriculum	Model curriculum	[1]
The MBA Core Curricula of Top-Ranked U.S. Business Schools: A Study in Failure?	Research	[12]

The analysis of the literature review revealed that the sources included competences from different categories. From the analysis, we have derived an initial classification of

competences which correspond to main challenges in global settings (see [2][14]) and domain-specific competences (cf. [5]). We can distinguish between inter- or cross-cultural, communication, collaboration, project and knowledge management and domain-specific competences. Examples for these competences are the ability to share knowledge and the ability to use other people's knowledge and expertise. The aspects of knowledge management were included in different categories such as collaboration and project management.

It became also clear that the competences were not always categorizable to just one of the before mentioned categories. Instead they could be seen as cross-category competences combining e.g. cross-cultural and communication competences or communication and management competences. The competences of each category additionally included ICT competences (Information- and Communication technology competences) such as using the right medium for communication. In the categories communication and collaboration, competences within the different sources were coherent and the same competences were included in most of them, just using a slightly different phrasing. As already mentioned, intercultural and ICT competences were strongly connected to competences of different categories and just few competences belong purely to these categories could be identified. The identified competences are additionally not on an atomic detail level, meaning addressing just one specific aspect. Instead they are combinations of atomic competences addressing several aspects such as the ability to adapt and adjust strategies, goals and plans according to the situation.

According to our definition of competences a set of different sources were analyzed. Hereby, we identified competences from different subject areas or categories included in the framework. The following chapter will give a deeper inside into these categories and their origin from the literature.

2.2 Internationalization Curriculum

In this chapter, we present basic findings regarding necessary competences from international IS project work as well as from our literature review regarding challenges to individuals and organization in global IS projects.

As a basis for our work, we have analyzed literature on global (software development) projects regarding main barriers and success factors and existing model IS curricula such as the ACM model curriculum. We also analyzed the literature for intercultural competences necessary in international settings. Outgoing from these findings we will develop a curriculum and set of competences for international IS. As one of the main influence factors for the internationalization curriculum we analyzed literature on barriers and success factors for international work. We assume that success factors related to knowledge and skills can be directly translated into concrete competences. Carmel [2] identified five main barriers for distributed teams: geographical dispersion, loss of communication richness, coordination breakdown, loss of team awareness and cultural differences. To be able to overcome problems caused by these influence factors, team members should have according competences to deal with those problems. According to Holden [8], knowledge management is a crucial aspect for the success of global teamwork. Prikladnicki, Audy and Evaristo [14] point out that especially knowledge sharing is important.

Based on barriers and curricula, we have structured the competences as shown in Figure 1.

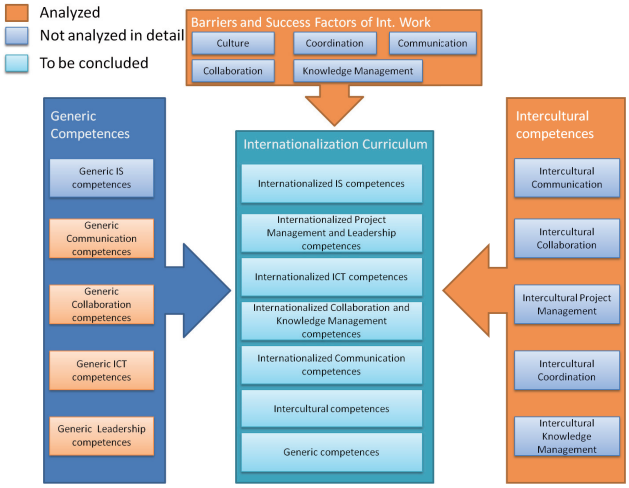

Figure 1: Framework of the international IS curriculum

The categories of this curriculum are named as internationalized competences, in the rest of the paper we will refer to these categories without this specification but assume the usage in an international setting. The figure also shows that generic competences can and will be part of the internationalized curriculum. Seven different categories were identified. These are:

- **Generic competences** which includes unchanged and generic competences from different categories but focusing mainly on domain specific competences.
- **IS competences** focusing on domain specific IS competences adapted for the international context.
- **ICT competences** ranging from basic computer skills and skills to operate different programs to more complex knowledge about IT Architectures, Security and Management.
- **Project Management and Leadership competences**, which could also be referred to as Coordination competences, covering areas such as basic business competences, team management and work distribution.
- **Collaboration and Knowledge Management competences** including knowledge sharing and transfer as well as work attitudes in an international team.
- **Communication competences** which focus strictly on the exchange of messages and information in verbal and written form including choice of communication style and management of communication.
- **Intercultural competences** including cultural awareness and understanding of cultural differences.

The role of intercultural competences has to be further analyzed as it is foreseen that intercultural competences influence competences of the other categories, meaning that for example communication styles and group work behaviors have to be adapted to be

successful in an international context. Especially for the IS competences this relation is unclear at this point and will therefore be not part of this study. We will address this problem in a later qualitative study with several domain experts to analyze which competences have to be adapted. We therefore focus on the last five categories as they are already established in different subject areas such as international business. We proposed a differentiation and will refer to these five categories as internationalization competences while we will refer to the IS competences (generic and internationalized) as domain competences.

The competences related to knowledge management in the combined category with collaboration should be seen as group knowledge management and by that focusing largely on the sharing and transfer of knowledge. Aspects of knowledge management can also be found in other competence categories such as organizational knowledge management in the category of project management and techno-centric knowledge management in the categories of ICT and IS competences.

3 Methodology

The study presented in this paper is part of a research strand targeted at establishing a detailed competence framework and new IS curricula. The main competence categories and competences for this framework and potential curricula are not yet established. Furthermore, we aim at taking the perspective of all involved stakeholder groups into consideration. Therefore, we conduct an explorative study. This is done both by an in depth literature review and qualitative studies with experts of the field. We expect that the analysis of these studies will provide a wide set of competences and competence categories. To filter the results for the most important competences to be included in our framework and in upcoming curricula, we will additionally use quantitative studies covering all stakeholder groups. Therefore, we apply a mixed method approach [7][9].

The main aim of the presented first study is to identify and validate competence categories and an initial set of competences for each category and to control the validity and reliability of our approach. We aim also at providing a sound methodology which can be used to explore competences for specific domains (e.g. E-Business). In the first step, we focus on generic competences and competence categories identified by an in depth literature review to analyze their suitability for an internationalized curriculum. We hereby also focus on the internationalization competences as described in chapter 2.2.

To validate the competence categories and according competences, we ask participants how important they see each of the identified items and whether they suggest additional items to be included. We rank competence categories and competences by importance to analyze which of them should be included in our framework. The results of the qualitative question regarding additional categories and competences were ranked according to the number of mentions. The additional mentioned categories and competences will be analyzed in further studies.

Besides establishing a competence framework, our target is to validate and reliability of our study. We validate our study by analyzing external validity, understandability of specific competences. According to Järvinen [10], the external validity describes to which extend conclusions would be transferable to other people in other locations at other times. The external validity was addressed in our approach by the random selection of participants from

all major stakeholder groups. The study will also be applied in the future in a different setting and context to further analyze the external validity. The understandability of the questions and competences is addressed by using a face validity approach [10]. This means we conduct qualitative interviews with chosen participants of the study of each stakeholder group to gather their feedback regarding the questions and competences. In these interviews we focus especially on the detail level of the competences. This means that we will analyze if the granularity of the competences fits the understanding of participants or if we should change to a different granularity in the competence phrasing.

To check the reliability of the study we focus on the internal consistency reliability [17]. It will be analyzed by calculating the deviation between the ratio of importance of a competence category and the average of the competences in this category.

4 Study

4.1 Study design

In our literature review, an initial set of generic competences was identified. By this analysis, we identified all together 98 different competences: 24 communication competences, 26 collaboration competences, 17 project management competences, 17 intercultural competences and 14 ICT competences. The identified competences are not atomic competences meaning that they can be split into more detailed competences. By this, the competences are better understandable. After an in depth analysis the competences could be clustered into 59 unique competences. Most of these competences are generic competences meaning that they were not internationalized at the point of the study. At the first step the target is to identify a set of possible competences for the internationalization competence categories and in the next step these competences will be enriched by international and cultural aspects. However, few competences had already the international aspect. Outgoing from these findings a first quantitative questionnaire focusing on the relevance of both the competence categories and the specific competences was designed. The categories and according competences were presented to the participants and participants to rate their importance on a five point Likert scale (1 *unimportant*, 5 *very important*). The participants also had the options to suggest additional categories and competences for each category.

To get a good overview of requirements for the internationalization of the IS curriculum a wide range of different stakeholder groups were addressed. All together 76 people were asked to participate in the study. Of these, 33 people (about 42%) answered the questionnaire completely and were used for the analysis. These 33 were in particular:

- Higher Education Teachers / Researchers in IS (20 participation requests / 16 Responses)
- Students (40 participation requests / 12 Responses)
- Professionals (Graduates/HR Managers, 16 Participation requests / 5 Responses)

The participants were chosen randomly to incorporate the different stakeholder groups. They were addressed by several stakeholder specific mailing lists such as student and faculty mailing lists, business sector mailing lists and several more. As one of the main aims of this

study was the validation of the approach a small number of participants were sufficient. The results will be used to engage in a large scale quantitative and an additional qualitative study. However, the aim of this paper is not to compare the needs and requirements of the different stakeholder groups. For exploring the views of the target groups in-depth, we chose the small sample size in this study.

4.2 Findings

In this chapter, we present the first results of the study. We focus on the importance of the different categories and competences for each category.

4.2.1 Importance of competences

The analysis of the results showed that the competence categories communication and collaboration were seen as the most important categories. The importance of these two categories was even seen higher than the importance of the domain specific IS competences. Unlike these categories, ICT competences were seen as the least important for an internationalized IS Curriculum. A full overview of the importance of the categories is shown in Figure 2.

The intercultural competence category was seen almost as important as IS competences. But due to the fact that over 10% of all participants referred to intercultural competences (e.g. knowledge of different religions, cultural knowledge, cultural empathy etc) when asked for additional competence categories, it can be concluded that this category is quite unknown to the participants and needs more elaboration and investigation. This can be explained by the fact, that intercultural competences are not included in the analyzed model curricula.

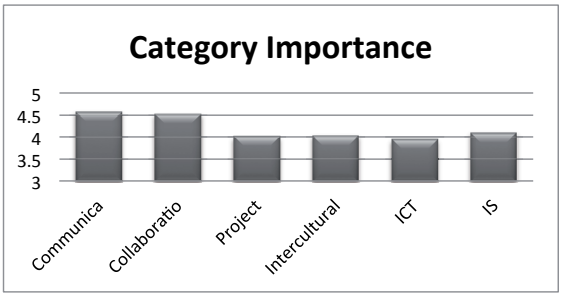

Figure 2: Category importance

Additionally, economics and business competences were mentioned by the participants. These competences are integrated in the German [19] but not in the ACM model [5] curriculum.

Summarized the findings show that the identified competence categories are all seen as important but that additional categories like basic business competences should be considered for future studies. For each of the identified categories, the participants were asked to rate the importance of specific competences from our literature review. The average importance of all competences is between 3,3 (a bit above neutral) and 4,75 (a bit under very important). This shows that our literature review captured a set of important competences for

each category. The most important competences for each category are shown in Table 2. The competences presented in the table are generic competences (see chapter 2.2 and 4.1 and participants were asked how important they would see these in international settings. In the forth column we present the status of the competence meaning if the competence is generic and most likely will stay generic or if it is internationalizable. However, this information was not part of the study and has to be verified with experts.

Table 2: Most important competences per category

Category	Competence Description	Importance	Status
Communication	Ability to communicate sensitively taking into account other personalities and cultures	4,36	Internationalized
	Ability to listen to others and consider their thoughts	4,3	Internationalizable
	Ability to communicate clearly and articulately	4,27	Internationalizable
	Ability to focus on key points during communication	4,27	Generic
Collaboration and Knowledge Management	Ability to build national and international relationships and networks on a professional level	4,4	Internationalized
	Ability to share information and knowledge with the team	4,3	Internationalizable
	Ability to collaborative problem resolution	4,24	Internationalizable
	Ability to understand other peoples perspectives, needs and values	4,24	Internationalizable
Project Management and Leadership	Ability to manage own work	4,46	Generic
	Ability to use other peoples expertise and knowledge	4,46	Generic
	Ability to take responsibility	4,33	Internationalizable
	Ability to make decisions	4,33	Internationalizable
Culture	Foreign language skills (e.g. English)	4,76	Internationalized
	Understanding of the influences and implications culture has in work life	4,33	Internationalized
	Ability to adjust to different cultures	4,12	Internationalized
	Ability to evaluate perspectives, practices and products from multiple cultural perspectives	4,12	Internationalized
ICT	Ability to align ICT with the business requirements	4,27	Generic
	Understanding of importance and limitations of different information sources	4,09	Internationalizable
	Ability to find quality information with the help of ICT	4,06	Generic
	Ability to identify problems with ICT	4,06	Internationalizable

It can be seen that common language skills – in the culture category - are seen as the most important competence for a graduate of international IS studies. This finding is in line with the results of our literature review. In most sources language skills were seen as crucial for the success in an international setting. English skills can be seen as a substitute for finding a common language between all partners involved in the collaboration and team work. This

might be English for most projects but could also be any other language depending on the involved nationalities. Furthermore, the qualitative questions regarding additional competence categories showed, that the participants felled that language competences should be an own category. According to these two results a language category will be considered. The ability to align ICT with the business requirements (as additional competences) is seen as the most important ICT competence but was just mentioned in one of the sources in the literature review. In contrast to that competences like the ability to adapt the communication style to fit the audience and the ability to choose the appropriate medium for the communication, which were included in most competence frameworks, are not seen as most important from our participants.

As a summary, all competences were given an average importance of over three (neutral) and shall be included in the initial set of internationalization competences. Further studies have to be conducted to identify a clear ranking of the importance of the competences.

4.2.2 Framework for the Internationalization of IS Curricula

Based on the presented results, an outline for the internationalization of the IS curriculum was identified. The outline of a first curriculum draft is shown in Figure 3. It is divided into three main fields, namely internationalization competences which may influence related subject competences and IS competences.

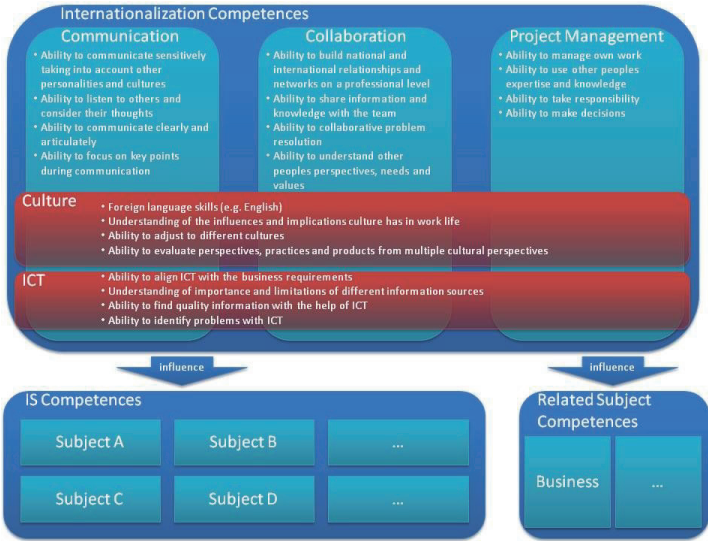

Figure 3: IS internationalization curriculum

The internationalization competences are, according to our classification (see 2.2), divided into communication, collaboration, project management, culture and ICT. Culture and ICT are displayed as horizontal boxes in the figure to visualize the impact they have to the other competence categories. A good example for this is the first competence presented in communication (Ability to communicate sensitively taking into account other personalities

and cultures) which is clearly influenced by the category culture. For each internationalization competence category the four most important competences from Figure 3 are shown.

The related subject competences include at the moment just business competences. These have to be clearly separated from project management competences. We understand business competences on a high level, according to the definition given by the University of Adelaide in their capability definition, as “the understanding of key business drivers for performance and use of sound business practices and the ability to use sound commercial principles in all areas of responsibility” [18]. A further differentiation and specialization will be included in upcoming studies.

Due to the high importance of language competences in the results and the mentioning of these as an additional category it can be discussed if these should be seen as an own related subject. A different option would be to include the language competences into the internationalization competences similar to culture and ICT competences. This can be favoured because the language competences will also influence the other competence categories. It can also be argued, that language competence fall into the communication category and build a foundation for further culture competences. This will be analyzed in a later stage.

The IS competences (and how they are influenced by the internationalization competences) were not included in the presented study and will be analyzed as one of the next steps. The sub domains of IS are not presented in the Framework as they were identified outgoing from existing model curricula but not verified in this study. The verification of these categories and an initial set of competences for each category will be the next step. Especially the influences of cultural differences have to be analyzed. Therefore, a qualitative approach will be taken.

The results show that the literature findings were valid. We extended those based on our study. Nevertheless, because of the limitations of this study further validations have to be carried out.

4.3 Validity, Reliability & Limitations

As described in chapter 3, we use the deviation of the importance for each category to the average importance of the competence of the category to analyze the internal consistency reliability. The results of this analysis can be seen in Table 3.

Table 3: Consistency, reliability & deviations

Category	Category Importance	Average Competence Importance	Deviation
Communication	4,58	4,03	0,55
Collaboration	4,52	4,05	0,47
Project Management	4	4,09	-0.09
Culture	4,03	4,03	0
ICT	3,94	3,95	-0.01

Table 4 shows the average importance of each category, the average importance of the competences of each category and the deviation between those two. The deviation for the categories project management, culture and ICT are zero or close to zero. This means that the importance of the category and the competences are in line. We therefore conclude that

the identified competences are suitable and an initial reliability for these categories is given. Both will be analyzed in upcoming studies.

4.4 Utilization of the Framework

The framework and the identified competence categories and according competences are a first step towards modernization of existing learning services. With the help of these findings we enable university to analyze their offers in terms of IS education and give a first impression how an existing should be adapted to fit the new and changed requirements of the industry. Aspects such as cultural learning, communication and project management are underrepresented in existing IS learning services and curricula but pose a big challenge in today's work life. By integrating these aspects into existing curricula a better fit to industry requirements can be achieved.

From the perspective of industry our research and results give a first impression which individual competences of employees are candidates to lead to an enhanced individual and therefore in the long run organizational performance. Organizations can use the results as a basis for the creation of specific job profiles and can therefore improve their staffing and recruitment practices and processes. They will additionally be able to better analyze the potentials of employees for specific positions within the organization and improve their organization internal employee development and knowledge management as important knowledge, competences and skills besides the domain specific competences were identified.

5 Conclusions & Outlook

In our literature review, we identified a classification and an initial set of internationalization competences and their importance for the IS domain. The study confirmed these findings and some additional categories and competences were proposed and can be analyzed. We also identified an initial set of highly important competences for each category. These competences are valid candidates to modernize existing learning services to achieve a better fit the requirements for companies for graduates ready to work in the international market.

According to these findings, we derived a framework for the internationalization of the IS curriculum. The framework can be utilized both from educational and industrial perspective to design and improve specific learning services as shown in chapter 4.4 This framework will be both used to structure future research and extended and adapted according to new findings.

The results and also the user feedback have shown that more investigation of specific aspects, like the ranking of the importance of the competence categories, is necessary. Therefore, we can see the results of this study as a good starting point for further studies. The positive feedback regarding the relevance of the study from all stakeholder groups shows the needs for the internationalization of the IS curriculum. In the next step, further competences will be derived and validated. Potential future research aspects include the following:

- Analyzing the internationalization of the presented competences including the questions which competences have to be adapted and which stay unchanged

- Analyzing the domain specific IS competences and the influences the internationalization has on them
- Refining competence categories for specific sub-domains / career paths (e.g., E-Business, Software Development)
- Ranking the importance of the competence categories and competences
- Comparative study for different stakeholder groups
- Qualitative analyses to identify changes to the IS competences

Our study serves therefore as a basic framework for internationalizing IS competence frameworks and curricula and as guidance for further research in this field. To address the above mentioned aspects further studies including a Delphi study with an expert group are planned and will lead to an initial proposal for an internationalized IS curriculum.

6 Acknowledgment

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IV

REQUIREMENTS MODELING IN INTERNATIONAL INFORMATION SYSTEMS DESIGN – WHAT COMPETENCIES ARE NEEDED AND HOW TO MANAGE THEM?

by

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Requirements modelling in International Information Systems Design

– what competencies are needed and how to manage them?

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Abstract: Allocating the right competency to the right task is often critical in complex IS development projects, which often take place in a networked world with teams working across cultural barriers, time zones, and knowledge domains. The presented research explores knowledge and competency management issues raised in the early phases of requirement analysis in international IS design projects.

An important management challenge of requirement modelling is to balance user-facing and design-facing activities. Both domain knowledge and IS modelling skills are needed to achieve a correct and complete specification of requirements. Requirement modelling – eliciting, specifying, and evaluating stakeholders' requirements – calls on a variety of competencies. Some of these competencies can be derived from analysis of the information modelling processes, e.g., how communication in natural language with stakeholders informs visual representations of models meant to communicate precise requirements to developers of software or other IS artefacts. However, other competencies will be hard to describe, due to the complex organisation, and coordination and communication issues found in international and intercultural settings. The needed knowledge, skills and attitudes often surface only after some problem or breakdown of processes.

Competency management in ISD, particularly in internationally distributed requirement practices, is not a well researched area. Therefore, this paper focusses on understanding how the competency domain is conceptualised in these settings as a first step towards formal competency descriptions. What processes are involved, and how are competencies derived from analysing these processes? How does an international context impact on the processes and related competencies? For example, will additional competencies in intercultural communication enable a system analyst to be a more efficient modeller? In self-recruited and intercultural teams, how are the critical competences that need management identified?

This research contributes towards answering questions like these, by proposing a two-layer approach to identifying crucial competences in requirement modelling in an international context. A first layer establishes a broad set of competences identified by analysing the processes involved. The second layer of competences is a subset identified through studying breakdowns in enactment of the requirement processes. These competences are the candidates for interventions.

Keywords: Requirement elicitation, international ISD, intercultural competencies, requirement modelling

1. Introduction

In this paper we explores knowledge and competency management issues raised in the early, critical phases (Frederiks and van der Weide 2006) of requirement elicitation and analysis in international IS design projects. The importance of requirements for information systems success or failure has been vividly debated since the Standish Group published their first Chaos report (Standish Group, 1994). Lack of relevant user input, incomplete requirements, and changing specifications are all factors being linked to the management of a project's design requirements (Apshvalka et al. 2009; van Lamsweerde 2000). Project success or failure has also been linked to the quality and usefulness of the models representing the requirements (Rittgen 2010; Moody 2005). However, where research meets practice – when requirements and modelling methods developed through research are presented to practitioners – one may find that adoption of the prescribed methods are lagging behind. As Hansen, Berente and Lyytinen (2009) observe, the gap between research and practice runs both ways: practitioners are slow to adopt the requirements methods developed by researchers, whereas researchers often turn a blind eye to the actual practices and needs of designers.

One contribution to bridge this gap could be to look into how competencies are managed in IS design. The questions we address are related to the challenges globally dispersed design teams have to capture and represent user input throughout the IS design cycle.

- How can the necessary set of competencies for a concrete requirement modelling process be established both from a theoretical and from a practical perspective?
- How are competencies adapted to context and problem to be solved?
- What are the context factors imposed by the international settings, and how do these factors create new layers of competency requirements?

Looking at requirements in the 21st Century, Hansen et al. (2009) described an emerging landscape driven by requirement processes with a Janus face (Figure 1). Building on their model we introduce three aspects of competencies related to the requirement process that will be further discussed in this paper.

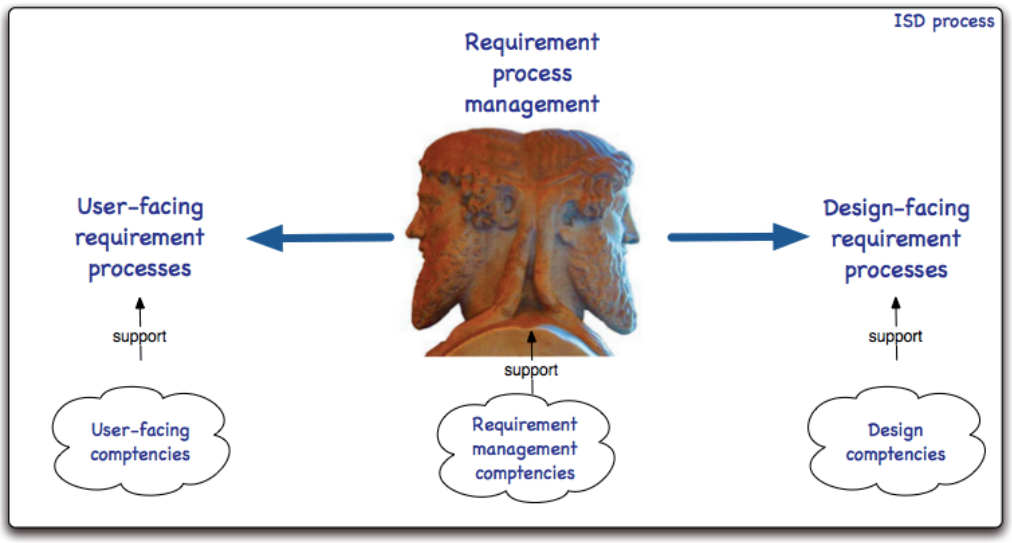

Figure 1: Three aspects of competencies needed in Requirement processes

The first class of User-facing competencies is directed towards working with the stakeholders, managing the user-facing activities. Eliciting diverse requirements call for particular competencies, e.g., in communicating “outside the box” of a specific computer science method or tool.

Facing the other way, the second class of Design context competencies is related to the forward looking design activities. Application domain competencies will be balanced with more generic design competencies related to systems development techniques, methods, approaches and paradigms.

The third class of Requirement management competencies is related to the management of the overall requirement process and its relation to the other ISD processes involved, their enablers and barriers. In particular, challenges related to global and intercultural development teams call for these competencies.

We will position the requirement process within an ISD context and review how literature has described the requirement knowledge creation processes in global information systems development. Based on this initial description of processes and roles in this first phase of international IS design the authors present two perspectives on developing ISD competences resulting in a first model that will be discussed in the context of two small case studies from international IT standardisation and a European software development project. This will contribute to a better understanding of competency requirements in international ISD. We follow a Design Science Approach (Hevner et al. 2004). It is based on a thorough analysis of early requirement and competency engineering, followed by modelling of new constructs to describe the identified problem space. The relevance of the created model is discussed on the background of two cases from current practice, as a first cycle of validation (Hevner 2007). However, this is a new research area and further design cycles are needed to validate the findings in this study

The rest of the paper is organized as follows. Section 2 discusses the related work with a special focus on the state of the art of research related to competency in ISD (section 2.1) and the description of requirement practices in section 2.2. Two approaches to design the competency space in ISD requirement practice are presented in section 3. In the following section 4, we demonstrate the usefulness of the approaches based on two different cases, a European project (section 4.1) and standardization work (section 4.2). The results are shown and discussed based on previous research in section 5, before section 6 presents a conclusion and short outlook on future research.

2. Related work

There has been extensive research on competencies in ISD and on requirement practices. In this section relevant studies are reviewed as a background for construction of a new model.

2.1 Understanding competency in ISD

The competency concept (with competence as a more specific concept) is used in many ways in different areas of research (e.g. Westera 2001; Winterton 2009; Grant and Young 2010). The recent literature on the topic agrees that the competency of a person involves knowledge (ability to think), skills (ability to act and fulfil a task), and attitudes (ability to relate to people and make knowledge and skills useful). In defining competency, it has been noted by some authors that the context of competency enactment is important (Sandberg 2000; Tessmer and Richey 1997). Pawlowski et al. (2010) have suggested that competencies only can be described if the 'competent actions' are oriented towards solving a specific problem. For this paper, competency is defined as a collection of knowledge, skills, and attitudes to solve a problem in a given context. Competence is used to refer to a specific skill or knowledge item.

While in theory, competence, methods, and practice are separate and clearly distinct elements, Omland found that in actual ISD "the three elements form close and integrated relationships" (Omland 2009). So, how do we derive competences related to the international ISD activity we are studying?

Hansen et al. (2009) found that "contemporary designers construct requirements in relation to existing systems and practices, rather than simply eliciting them as much of the literature implies" (existing systems being for example commercial-off-the-shelf applications). This observation is a warning that to construct competency profiles solely based on idealised process or role descriptions may fail. Competences are embedded in tools and practices (Hansen et al. 2009; Downey 2009), and may be hard to disentangle from the "the intrinsically dynamic relationships between actors' competence, methods, and practice in an ISD context" (Omland 2009).

Even if competences are hard to describe, when staffing projects one needs to start from some description of competences. It is been observed that the software industry tended to base their job description on mastery of certain technologies rather than knowledge, skills, and abilities, resulting in a vagueness of the advertisements unlikely to help the companies in recruiting (Downey 2009).

Downey (2009) proposes to move away from focussing on software development roles (Acuña and Juristo 2004; Barreto et al. 2008), which "cannot be defined in a generally applicable manner" as they vary widely between companies and projects and also overlap significantly with other roles. Instead, one should focus on the persons' contributions to the artefacts associated with the development process. These artefacts, often characterised as "boundary objects" (Star and Griesemer 1989), are "used throughout a development project to embody stakeholder knowledge and contribute to the developing process" (Downey 2009).

The artefact-centric skills approach proposed by Downey (2009) resonates with the conclusions of Omland (2009), Hansen et al. (2009), and Pawlowski et al. (2010). Competences need to be understood in the context of the existing systems and work practices. In requirement practice, one observes the "increasingly creative role that designers must play in actively co-producing requirements and artifacts, rather than simply charting out needs that are "out there" a priori" (Hansen et al. 2009).

In summary, this short review of research related to competency in ISD makes it even more pertinent to understand the problem to be solved and the context of the particular ISD activity to be able to reason about competencies in ISD.

2.2 Description of requirement practice
According to Iivari et al. (2001) the user requirements construction together with organisational alignment form the core competence of IS experts. In user requirement construction a repeated cycle of informal and formal specification take place. Frederiks and van der Weide (2006) depicted this process in a model of information modelling, Figure 2.

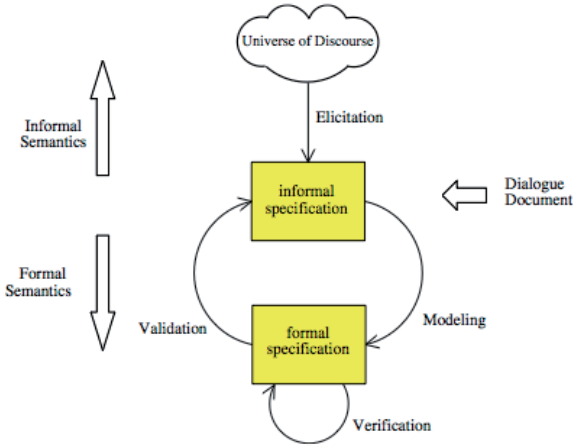

Figure 2: Information modelling process, from (Frederiks and van der Weide 2006)

Information objects from the Universe of Discourse (UoD) are described in a way that produces a document that serves as a common base for understanding and communication while designing the information system. It is clear that two kinds of expertise are involved, embodied in what Frederiks and van der Weide term a domain expert and a system analyst. “Roughly speaking, a domain expert can be characterized as someone with (1) superior detail-knowledge of the UoD but often (2) minor powers of abstraction from that same UoD. The characterisation of a system analyst is the direct opposite” (Frederiks and van der Weide 2006). Where the different areas of expertise meet, natural language is the base mechanism for communication. The domain expert does not need to have any knowledge of formal modelling languages. However, the system analyst should have some abilities to communicate with the “owners” of the problem at hand. Following Frederiks and van der Weide, “the quality of the modeling process is bounded by the quality of concretizing into an informal description augmented with the quality of abstracting from this description” (Frederiks and van der Weide 2006). Of course, the better tool support (language, models, technologies, etc.) these concretisation and abstraction processes have, the better quality of the resulting requirement documents.

In summary, it can be stated that requirement work is a complex process, in which different stakeholders and IS analysts with a diverse set of competencies work collaboratively towards solving a problem. In addition to the described knowledge areas for ISD processes, strong communication competencies are identified as a key resource.

In the next section we analyse which additional issues arise from the internationalisation of work processes and present a model of how competencies could be described in requirement practice in international ISD.

3. Designing the competency space in ISD requirement practice
“The distributed nature of requirements underscores the existence of multiple layers of requirements, based on differences in abstraction, user-orientation, and timing” (Hansen et al. 2009). When elaborating the three aspects of competencies needed in requirement processes, depicted in Figure 1, the distributed requirement premise needs to be understood. Is internationalisation a competency area in its own right, or is internationalisation a modifier of existing processes and related competencies, i.e., a barrier or an enabler?

Nowadays, ISD projects are run by international teams, often distributed over various cultures and time zones. Based on the geographical distance between team members communication and

collaboration are handled virtually using diverse communication and modelling tools. This globalised ISD practice makes it necessary to be able to manage all the different competencies in the requirement processes presented in Figure 1.

To support the management of competencies a two layer model was developed (see Figure 3). The model describes two distinct approaches for the creation of the requirement competency space; the deductive and the inductive approach. Within the deductive approach a generic set of competencies is created. By applying and validating this set of competencies within the context and the problem at hand the competency space is created.. The inductive approach follows a project and knowledge management perspective. The main focus here lies on the orchestration of competencies of all involved stakeholders and development team members. Through this, required competences are identified and a set of required competencies is established. In a next step the necessary distribution of competences among the stakeholders and team members is analysed. The two approaches are described in more detail in the following two subsections.

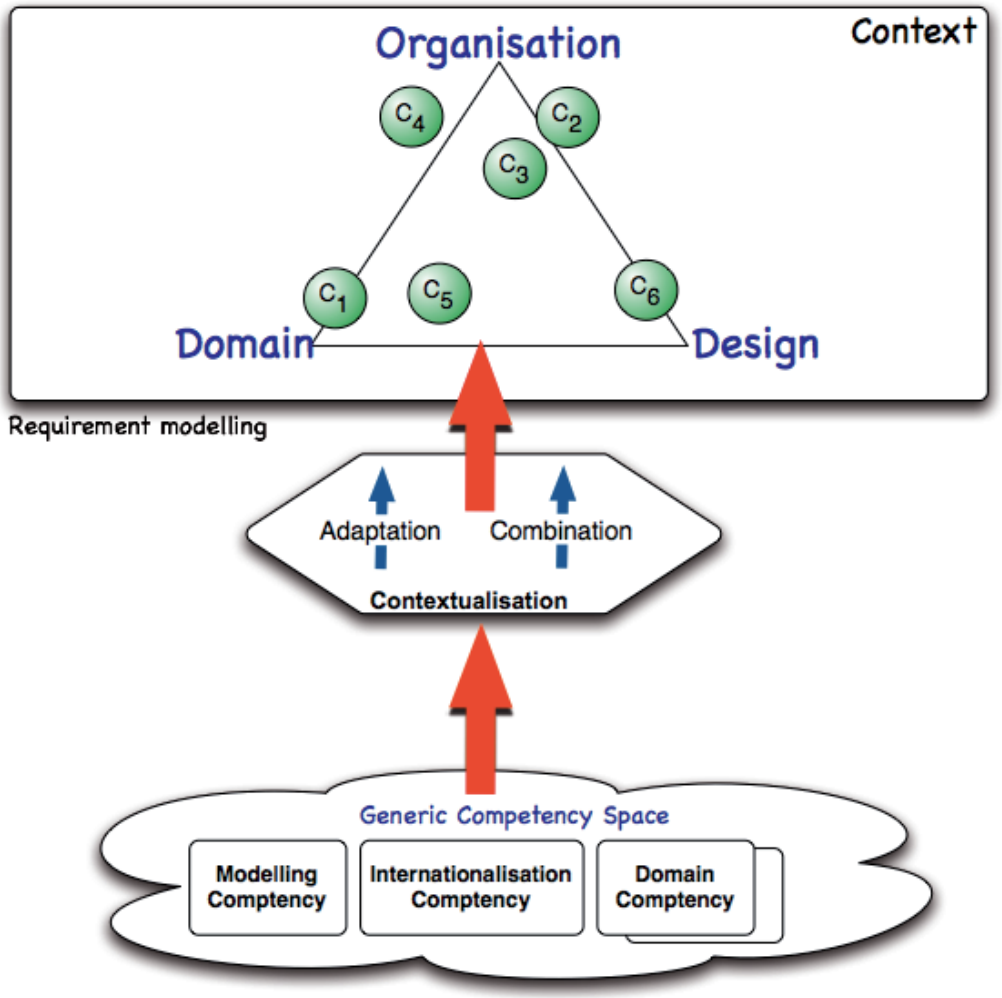

Figure 3: Two layer model of the competency space for the requirement elicitation

3.1 The deductive approach

This approach starts from a generalised “Universe of Competency” (UoC). From this UoC the relevant competencies are selected, and a set of relevant but generic competencies is built.

Requirement modelling, as described in Figure 2, requires a number of generic competences. Frederiks and van der Weide (2006) have identified a number of base skills needed for a domain expert and a system analyst. E.g., a domain expert can provide a *complete* set of information objects, and *provide* any number of significant sample sentences in relation to these objects; and a system analyst can validate a set of example sentences for *consistency* and *grammar,* and match abstract sentence structures with concepts of a *modelling* technique (Frederiks and van der Weide 2006). These problem-specific competences can be seen as context independent.

Another group of generic competences relates to the communication and coordination challenges posed by modelling in an international context. The problem at hand raises social skills challenges when negotiating and communication about objects, sentences, models, etc. The international context raises added challenges related to culture and communication. However, these competences are problem-independent and not specifically designed for the requirement modelling. In this paper these partly overlapping groups of competencies are termed Modelling competencies and Internationalisation competencies; see Figure 3.

Pawlowski and Holtkamp (2012) have identified the following internationalisation competency categories: *culture* (influences almost all aspects of a work environment); *management* (e.g., management of time differences); *communication* (e.g., common working language); *collaboration* (e.g., supported by communication technology); and *ICT* (e.g., usage of tools supporting communication and collaboration).

When an international ISD project is initiated the generic competencies have to be contextualised to fit the specific problem and context of the ISD project. For this purpose we propose the two processes adaptation and combination.

In the *adaptation*, problem and/or context-independent competencies are adapted to fit the specific problem. This could, for example, be built on the understanding how culture influences working behaviours and specific work processes to the understanding how culture influences modelling techniques. In the *combination*, competencies from different areas are combined to construct new competencies, which fit both context and problem. In the international requirement modelling could this for example be the combination of communication and collaboration competencies with the ability to take into account other cultures and their values and perspectives.

3.2 The inductive approach

Figure 1 presented the bidirectional metaphor of the Janus myth as fitting for describing the requirement practice. This requirement process can be depicted (Figure 4) as a triangular space formed by Domain activities facing towards the users, Design activities facing towards a formal requirement specification, and Organisational activities, managing the overall process. The activities are directed towards a problem, and happening within a specific context.

When the requirement process is instantiated one could envision that the management process ensured that the different activities had access to relevant competencies. In real life, this is not the case. The development team has already a history, roles are distributed beforehand, and everyday work takes its own course, as the reviewed literature in this paper has shown. Therefore, the competency space of a particular project has to be constructed in two steps. The first step is to establish what competences are represented in the project related to the task or problem. This is the subset of the relevant competences derived through an analysis of the generic and more specific competences (as described in section 3.1).

As a result of this first step, a list of represented and missing competences may be produced.

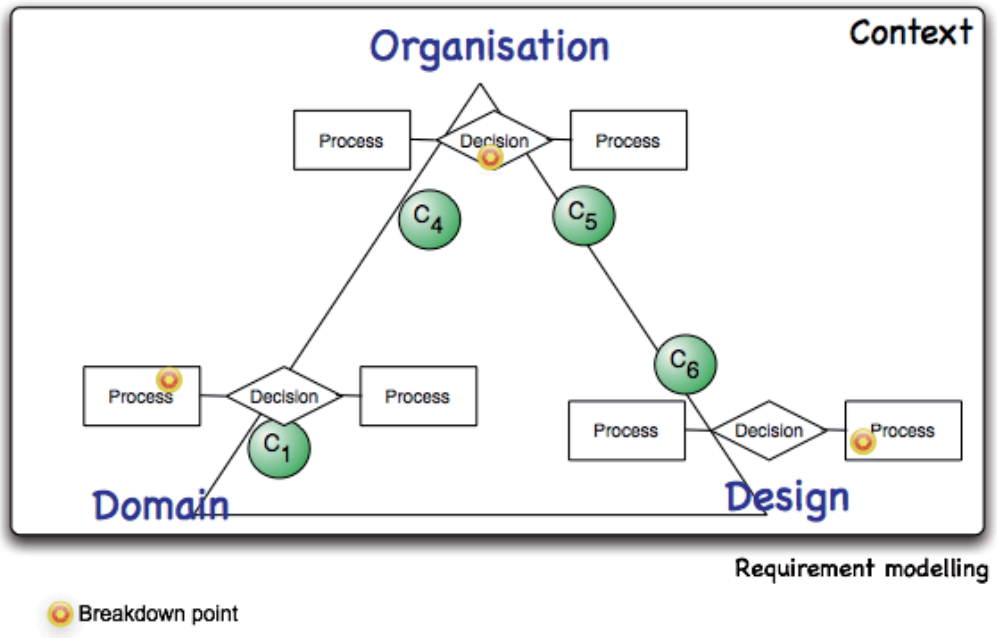

Figure 4: Identification of competences through breakdowns of processes in knowledge areas of requirement modelling

The next step assumes access to dynamic data of the enactment of the requirement process within a particular context. The development of the competency space is driven by both problem and context. E.g., a wicked problem may need particular competences in communication to elicit input from specific user groups. This information is passed on to the system analyst. However, in a culturally diverse setting, competences on how to interpret this information may be lacking, even if this type of competence is represented in the team as a whole.

From a competency management point of view, the focus of interest lies more with what could break down, than what is working fine. Therefore, the challenges of this second step are to identify potential break downs of the process that may be related to competences. The result of this second step is therefore at list of competences that needs to be managed related to certain context-specific processes. These competences may be present in the team, and the challenge is orchestration. Or lacking competences are identified, and recruitment or training actions need to be taken.

In the following we will use this model to analyse two cases within international ISD. The cases will be used to see if the proposed model is helpful in describing ISD in these settings and to suggest further development.

4. Cases

The two cases are described based on participatory observations. They were selected based on their international team structure and audience, and based on the fact, that the team configuration can't be influenced by the management.

4.1 Case 1: OpenScout – a European software development project

The OpenScout project aims at improving access to both professionally produced and user-generated learning resources in the domain of business administration and management. Context is a European project, and problem is software development.

During the requirement analysis and modelling three major breakdowns were identified.

The first breakdown point (lack of understanding) was caused by language problems as English was not the mother tongue of the majority of stakeholders and team members involved. It was also obvious that the two groups (domain experts and stakeholders), even if speaking English, did not

understand each other because of different terminologies and development methodologies. Because of this problem the development team started to look at similar systems to copy the approach they had taken. However, as the similar system was designed for a different domain, the development didn't fit the requirements of the stakeholders. The problem was overcome by introducing a moderator who had basic knowledge in both fields and was able to bridge the communication problem.

The second breakdown (complexity misjudgement) was based on the lack of technical competencies of the stakeholders. They expected proposed functionalities to be implemented on a very short notice and were not able to understand the development work behind a seemingly small functionality. This misunderstanding led to frustration within the development team and a raising conflict between the two sides.

The third breakdown (wrong prioritisation) was based on the lack of understanding which functionalities are most important for the domain, and how the usage would exactly take place. Based on their experience, the development team started with basic functionalities which were rather easy and quick to implement. However, these functionalities were not highly prioritised by the domain experts. The problem was solved by giving a list of upcoming functionalities to the domain expert and allowing them to prioritise what should be implemented first.

4.2 Case 2: Standardisation in a formal and international forum

This case is from international standardisation of learning technologies carried out in a formal standard setting body with a global reach. The problem was requirement elicitation concerning rights management of learning resources. The context is working group activities comprising face-to-face meetings twice a year between experts representing countries of different culture and educational tradition. The meetings are prepared by document exchange between editors before meetings.

The first layer of the competency space is about the alignment of competencies, problem and context. In this case the competencies are less aligned to the problem and context than one might expect. The participating experts are not selected because of the knowledge of rights metadata. They are standards experts nominated by their national body, not necessarily because they have a particular background in education. Even if the experts work in an international setting intercultural communication skills are not a prerequisite; e.g., the discourse during meetings tend to be dominated by experts with an English speaking background.

The second layer of the competency space is enacted when processes break down and critical competences can be identified by the analyst. In this case study we focus on two breakdowns, 1) a conflicting views on scope leading to threats of dissolving the project; 2) wilderness of draft document leading to withdrawal from negotiations.

The first breakdown is caused by differences in opinion on what is in or out of scope for the standard. An encyclopaedic, "be prepared for all cases of rights management" position is opposed by a minimal position arguing learners and teachers only need to know if the learning resources come with rights conditions attached, and what implications for use. Analysing the competency profiles of the proponents of the different positions in this conflict one observes that domain expertise in the field of education is scarcely represented.

The second breakdown is apparently caused by the length and wilderness of the draft document, which quickly grew to nearly 200 pages. In the context of this international working group it is observed that non-English speaking experts lose interest and withdraw from conversation when the documents grow beyond 100 pages. This is not necessarily due to lack of language skills. On the contrary, the reaction may be rational as the experts may not want to waste time on a standard that do not stand the chance to be implemented in their communities. The problem may rest on experts with long-drawn-out style of writing who do not have the cultural competency to design a standard that is easy to implement in an international context.

5. Discussion

Competency management of the initial requirement phase of ISD activities in projects discussed in these cases offer different challenges than competency management for recruitment (Acuña and Juristo 2004; Downey 2009) and learning design (Paquette 2007). At least in theory, when hiring new staff or designing a new course offering one can start by planning what knowledge, skills and attitudes needed or should be developed. In requirement practice in international contexts on the other hand,

one has to manage the competencies that are already there and plan for the unexpected. When particular competences are missing, as discussed in the two cases, the intervention could be to strengthen the processes by allocating new persons with the needed competences. However, in many cases a likely intervention would be to launch an assessment and learning process trying to reconfigure the work processes, mobilising "hidden" competences within the current team, and embark on more development cycles than planned. E.g., when the complexity misjudgement occurred in the OpenScout project an intervention could be to re-design the requirement process so that less technically inclined project members focussed on improving natural language requirement documents. Another example from the standardisation case, when drafts seem to lose contact with practice in the "real world", one could go back to what is called a study period, and new actors or working patterns (e.g., seminars) could be introduced.

The first research question of this paper referred to which competencies are relevant in requirement elicitation in international ISD and how they can be derived. As argued, UoC has a great number of potentially relevant competences driven by the requirement activity, which revolves around informal specification processes involving domain experts, and formal specification processes involving system analysts. In a knowledge management perspective, describing these competences gives just an inventory of the more general competency areas involved. These general competence descriptions can be used to improve understanding of the requirement processes and to prepare further actions, e.g., the learning processes referred to above. However, to be able to act upon competence descriptions they need to be contextualised (in our case to intercultural ISD work), and the descriptions need to be related to particular processes where the competence is needed. This practice-centred approach is demonstrated in the two cases where competency-related issues are surfaced when the progress of the project is in danger, and intervention is called for, not only related to competency matters.

The second research question was related to the different knowledge areas and their relation to specific competences. Based on the previous work of Iivari et al. (2001) and Hansen et al. (2009), we established the three main knowledge areas application domain knowledge, ISD process knowledge and software development knowledge. Particular competences for each of the areas in the given context should be present. However, based on the international context of the requirement elicitation and the presented influence factors, presented in section 3, new requirements for competencies were derived. Pawlowski and Holtkamp (2012) refer to these competencies as internationalisation competencies.

In the ISD practice described in the cases, matching competences to tasks is constrained in many ways. In the beginning of the requirement process nobody knows what competencies are represented in the team, as the participants are more or less self-recruited, and self-promotion does not tell much about real skills. When information about competence gaps starts to emerge, and management learns about competency profiles of individual experts, there is an organisational learning phase taking place before interventions can be designed and implemented. In this learning phase the organisation will be helped by a good understanding of the generic competences involved and how they may be contextualised, combined and adapted to support the ideal requirement processes. E.g., knowing the contextual characteristics of working with an intercultural team, differences in reasoning styles may be considered. Face saving practices may lead to a reasoning that starts with peripheral details and ends with a proposal (Scollon and Scollon, 2001) This may be very different from the reasoning style inherent in the culture that is implied by the working language, e.g., English, with the conclusion first and then what it builds on. However, it is not easy to act upon this competence in intercultural communication unless there is some sort of crisis that could justify intervention.

6. Conclusion and Outlook

This paper has developed a two-layer model of the competency spaces related to ISD requirement practice. The first layer establishes and describes competences related to a problem within a context. The second layer instantiates the requirement activity as a relationship between domain activities, design activities and organisational activities. These activities call for a number of competences, which may or may not be represented in the team. The list of "idealised" competences is vetted against a history of process breakdowns that make it possible to identify critical competences in need of attention from the management function of the project. Thus, the Requirement Competency Space is a dynamic space of competences that need to be managed in order to have a successful project.

The presented model should be understood as a first step towards an understanding of how competency management is part of other management processes in requirement practices. Further

research is needed, both to develop this model and to ground the constructs in practice within international IS development. In particular the authors see a need to focus on aspects as

- Extension and validation of the presented model;
- Breakdown points caused by lack of or suboptimal distribution of competences;
- Competency management interventions to overcome breakdowns; and
- How the inductive and deductive approaches come together.

In further research, the authors will work towards integrating the two approaches in a more coherent model. One outcome of such a work will be framework for development of competency descriptions in the field of international requirement modelling, with a set of competency categories with sample competences.

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V

HOW DO SOFTWARE DEVELOPMENT COMPETENCES CHANGE IN GLOBAL SETTINGS – AN EXPLORATIVE STUDY

by

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How software development competences change in global settings—an explorative study

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ABSTRACT

Global software development (GSD) holds various challenges and problems for team members. When confronted with a contextual change in their working environment, individuals have to adapt to the new situation. This includes the adaptation of working styles, behaviors, and methods. Additionally, new challenges, especially those based on the virtual work and cultural background of team members, have to be addressed. By conducting explorative expert interviews, we identified challenges and potential solutions for individuals when encountering contextual change with a focus on competences. We identified that the lack of competences was seen as a major influence factor for a variety of common challenges to GSD. The identification of underlying factors of challenges could allow for focused development of interventions to overcome these challenges. Furthermore, we identified factors influencing the adaptation of competences to the given context and provided insight into the process of competences adaptation. This is the basis for the future development of a set of internationalized GSD competences. Copyright © 2014 John Wiley & Sons, Ltd.

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KEY WORDS: cultural differences; distributed work; global software development; internationalization; project staffing; skills; competency

1. INTRODUCTION

This paper aims to identify the influence of context on individual competences requirements in global software development (GSD) projects as well as how software development competences have to be adapted when changing context. For this purpose, an analysis of challenges, which can be caused by a lack of competences, corresponding interventions, and contextual influence factors on competences requirements, is presented. The study uses a competences-based approach with a special focus on internationalization and intercultural competences and shows that these competences provide a solid means to enable the actors within GSD to overcome common challenges and barriers in the process.

A study by the Standish Group [1] showed that 24% of new software development projects were canceled during the runtime phase. The study also reported that 44% of the completed projects were challenged (late, over budgeted, and/or with fewer than the required features and functions). This demonstrates the complexity of software development projects and raises the question as to why so many projects fail entirely or fail to meet the plans in terms of budget, pricing, and functional requirements. The study included both local and global projects, and with globalization increasing the complexity of projects, the failure rate of global projects is anticipated to be even higher.

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To understand the reasons behind the failure of globally distributed projects, Noll *et al.* [2] and Ågerfalk *et al.* [3] analyzed challenges and barriers such as geographical distance, sociocultural distance, and temporal distance [3], and success factors such as cost savings and access to large, multiskilled workforces [4]. However, to find the reason for the failure of GSD projects, a step beyond challenges seems necessary. An analysis of the underlying factors of challenges represents the foundations for future research aiming at the development of focused and streamlined interventions to overcome these challenges. Potential underlying factors for challenges range from structural problems within the organization regarding process-based problems to challenges that are based on the lack of organizational capabilities and individual competences.

Curtis, Krasner, and Iscoe [5] stated that a good (competent) team is crucial to GSD project success. As a result of the continuous internationalization of international software development projects, Deans and Loch [6] proposed an internationalization of the information systems (IS) curriculum to achieve more suitable graduates for industry requirements. Although this internationalization would enable graduates to work more successfully in international projects and avoid challenges related to lack of knowledge and skills, the proposal to internationalize the IS curriculum was not implemented [7].

Zaffar and Winter [8] found that the need for workers with better soft skills was globally consistent. They define soft skills as interpersonal skills, presentation skills, and contract negotiation and management skills. Because of the growing globalization of software development projects, the request for better soft skills has been renewed [9, 10]. However, based on the internationalization of software development projects, the requirements for soft skills have changed. The soft skills for international workers can be described as internationalization competences [7]. While development processes are being extended to overcome the challenges of globalization [11], competences requirements and competences management, particularly for nontechnical competences, are not researched to the same extent [12]. The majority of GSD process models recognize the importance of the actors within the process but consider the individual actors from an organizational and managerial perspective rather than from an individual perspective [13]. However, the various development processes implicitly require a specific set of soft competences, which include creativity, interpersonal, and behavioral competences [14], as the process defines the actions of individual actors. The individual actors are facing the challenges of globalization in their daily work and must be equipped to solve upcoming challenges as they arise. In GSD projects, individuals are facing a changing work environment as different projects may include stakeholders, project partners, and customers from various cultural backgrounds. This leads to a situation in which individuals' competences are suitable for one project, but can be insufficient in another environment, as the methods accepted by culturally diverse stakeholders can vary. This implies that individuals have to adapt their competences based on the changes. We describe these changes in the work environment, stakeholders, and cultures as contextual changes. Based on these findings, we focus on individual competencies as an underlying factor of challenges to GSD and, thus, are taking a competences-based perspective.

To identify which competences are required to overcome challenges to GSD and competences adaptation needs, this paper takes a competences-based perspective on the challenges of GSD that aims to identify upon which challenges to GSD the lack of individual competences has a major influence. By combining contextual changes and challenges, we explore how contextual changes influence the required competences. Therefore, we identify challenges that are the result of contextual changes and are strongly influenced by a lack of competences. This allows the analysis of competences requirements and potential interventions to overcome challenges that originate from a contextual change. Interventions should be understood as activities to overcome weaknesses in required competences areas. This allows us to define our problem and solution, which, in turn, gives a clear framework for our research. In the next step, we then focus on the competences requirements to overcome the identified challenges. As our findings demonstrate that the competences requirements are strongly dependent upon the context and that no generalized solution for them can be provided, we analyze how contextual changes influence competences requirements, in particular, in terms of technical competences and internationalization competences as well as the need for adaptation of technical competences based on the contextual changes. This allows us to develop a solution menu of relevant competences and a set of guidelines for identifying the competences

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requirements for a specific challenge in a given context. To summarize, we address the following research questions:

- How does the context influence the selection and the importance of various competences as well as the competences adaptation needs in GSD projects?
- Which contextual changes in GSD projects are accountable for challenges based on a lack of competences?
- Which GSD challenges are based on a lack of competences?
- How can challenges that are based on a lack of competences in GSD be overcome?

To address these research questions, we conducted expert interviews with professionals and researchers of GSD with the aim of analyzing these internationalization competences. Ten professionals with experience in GSD, as well as seven academics with a research background in the domain and practical experience, were interviewed regarding contextual changes, related challenges, and their ideas for possible solutions. Finally, the professionals and researchers were asked to share their opinion on whether technical competences should be adapted to the context by combining them with suitable internationalization competences.

In the next section, we present the theoretical background of our research and describe the methodology of our expert interviews and data analysis. The results of the study are then presented and discussed. The paper concludes with an outlook and proposition for further research.

2. THEORETICAL FOUNDATION

In the following, we discuss the theoretical background by isolating and defining the concepts of competency, competences, and internationalization competency. We also discuss the contextualization of competencies, common challenges for GSD, and interventions and solutions discussed in related research.

2.1. Internationalization competency in a contextual change

The term competency is widely used in research that is related to software development on an organizational or team level [15] and that adheres to a resource-based perspective [16].

From the individual perspective, the combination of skills, knowledge, behaviors, and attitudes is a common denominator of definitions regarding individual competencies in both human resource management (HRM) and education (e.g., [17–19]). Winterton [17] noted that competency and competences are often used synonymously on an individual level and proposed a differentiation. According to Winterton [17], competency relates to the set of skills, abilities, and attitudes while the often synonymously used term, competences, relates to a specific skill, ability, or attitude of an individual.

The context of competency enactment is important for both the competency requirements and the application of competences [20, 21]. Omland [22] identified that competencies, methods, and practices form a close and integrated relationship in software development. Hansen *et al.* [23] added that competencies are embedded in tools and practices. This shows that changing the environment and behaviors might lead to different competency requirements. Hoel and Holtkamp [24] stated that competencies 'should be understood in the context of the existing systems and work practices'. Hereby, context is defined by the organizations and individuals involved in the development process. In the case of an outsourcing and offshoring process, context describes the local work practices and cultures of the team members as well as the work practices and cultures of the offshore location. Lindgren *et al.* [25] stated that the 'use of extant competences is not a mere transfer from stock to a specific situation or action context'. The application of competencies implies a process of transformation [25]. This indicated that competencies have to be applied based on the context. A contextual change, meaning a change of context, therefore leads to a new competences application process.

Based on the differentiation of Winterton [17] and on the importance of context, we define competency as *a collection of skills, abilities, and attitudes to solve a problem in a given context* and competences as *a singular instance of competency*. Competency and competences should be

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understood as dynamic constructs. An individual can possess competences on different proficiency levels that can change over time. This means that both context and time give competency and competences a dynamic dimension.

According to Zaffar and Winter [8], IS and software engineering programs in higher education were created to prepare graduates for their jobs by providing a suitable mix of technical and soft skills. These soft skills refer to interpersonal skills, presentation skills, and contract negotiation and management skills. However, it has been shown that the industry has not been satisfied with the soft skills level of university graduates [26, 27]. Because of the growing global sourcing efforts of software development companies, the plea for better soft skills in graduates has been emphasized with a focus on contract negotiation and management [9, 10]. The appeal for improved soft skills is supported by the findings of the literature review of Zaffar and Winter [8] on the importance of soft skills and technical skills. They concluded that in the majority of cases (86%), soft skills were at least as important as technical skills.

As software development projects have become globalized, competency requirements have changed. Within software development research, requirements elicitation is seen as one of the areas most affected by globalization [28] and most critical to project success [29]. Romero *et al.* [28] identified three categories of competencies: competencies not affected by GSD, competencies affected by GSD, and competences to emerge from GSD. While Romero *et al.* [28] looked at requirement elicitation competences and soft competences, other studies identified that GSD team members additionally required cultural intelligence to be effective in intercultural settings [30, 31]. Pawlowski and Holtkamp [7] described the soft skills required for international settings as internationalization competencies. They identified the following competencies as crucial aspects of internationalization competencies:

- information and communications technology competency, which describes competences from basic computer usage to the application of suitable tools and programs to support the work;
- coordination competency, which covers competences related to the management of team, tasks, and stakeholders;
- collaboration competency, which addresses competences related to behavior and attitude toward working in international teams as well as knowledge sharing;
- communication competency, which describes competences focusing on the exchange of information including the choice of appropriate communication styles; and
- intercultural competency, which includes competences to manage cultural diversity and support decision-making in an international context [7].

Based on the internationalization competencies identified by Pawlowski and Holtkamp [7] and in line with the categories identified by Romero *et al.* [28], Hoel and Holtkamp [24] have described an initial approach for adapting competences to contexts in GSD by adapting the problem or context description of the competences or combining different competences. This adaptation of competences permits flexible adjustment to the given context.

To summarize, we identified that competencies can be addressed from a variety of perspectives as one influence factor for organizational and individual performance. On the individual level, the context of competency enactment has a major influence on competency requirements. In GSD, soft competencies are equally important as software development competencies. However, both education and research are lacking in the understanding of required soft competencies. While a foundation for competency-related research in GSD is laid by the identification of relevant competencies (e.g., internationalization competency), the influence of work context and contextual changes is not taken into account.

2.2. Challenges and interventions for global software development

This section presents a short overview of the ongoing research related to challenges and interventions in GSD from a competences perspective.

Challenges to GSD are rarely addressed from the individual competences perspective. Consequently, we will be looking at generic challenges in which the lack of competences shown by

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an individual is identifiable. Challenges to GSD are seen as a result of geographical distance, sociocultural distance, and temporal distance [3]. Ralyté *et al.* [32] also included organization distance, technological distance, and knowledge distance. These distances cause a work environment in which virtual work among colleagues from various cultural backgrounds is common.

Herbsleb *et al.* [33] identified that both cultural aspects and the virtuality of communication require extra effort. Without extra effort, communication richness is lost and misunderstandings arise. Onyechi and Abeysinghe [34] added that, in virtual settings, tools and tool usage played an important role. Additionally, language differences are also a challenge for GSD [2]. Team members have to speak a common language and use the same terminology. Certain team members may dominate discussions and negotiations because of their language skills alone, as other members may shy away from using a language with which they are not familiar. Even if team members speak the same language, words can have different meanings, depending on the individual's background.

Communication challenges are also reflected in challenges related to the asynchronous collaboration of team members. In particular, the collaboration between different geographical locations within different time zones is mentioned in recent research [2, 3]. Additionally, virtual work leads to weak ties among team members, which can contribute to a lack of team awareness [3, 35]. Together with cultural influence factors, weak ties between team members were identified to also cause uncertainty regarding working behaviors and competences of team members, which again leads to a lack of trust (*cf.* [3]).

Several of the challenges related to virtual and distributed work, such as the lack of trust and communication problems, are strongly related to cultural influence factors. Huang and Trauth [36] identified different values, norms, and practices based on culture as one of the major challenges for GSD. Difficulties encountered may not have occurred if the team members shared the same background. For example, diverse backgrounds of team members can lead to incompatible views of issues and misunderstandings [35]. Team members from varied cultures have a very different perception of time and deadlines [36]. This can lead to team collaboration and communication issues in terms of when results can be expected.

The identified challenges represent problems team members may encounter in international software development projects. To overcome these challenges, team members need appropriate tools.

Noll *et al.* [2] noted that research is focusing on technological solutions to overcome challenges. Presently, challenges are most often addressed from a process and managerial perspective [13]; however, Wright *et al.* [37] stated that it is crucial to examine the 'people who engage in the process, the skills they individually and collectively must possess, and the behavior they must engage in (individually and interactively) to implement the process'. The analysis of skills and attitudes (competences) an individual requires is addressed as competences management in the HRM domain [38].

According to Baladi [38], competences management includes the following steps: specification of competences needs, identification of competences gaps, competences sourcing, and competences development through training, coaching, and staffing the projects. Competences development, as a part of competences management, can be used to train individuals with necessary competences to overcome challenges [39]. According to King and Zeithaml [39], HRM focuses on supporting the acquisition of a competitive advantage by training employees in required skills. One common artifact to support the processes and tasks of HRM is competency frameworks [40]. An example of an information technology (IT) competences framework is the European e-Competences Framework 2.0 [41].

Based on the challenges identified by Noll *et al.* [2] and on the Capability Maturity Model Integration, Richardson *et al.* [13] have developed a global teaming framework that takes a managerial perspective on the GSD process, including some aspects of competences management. They suggested process improvements in terms of global task management, knowledge and skills management, global project management, operating procedures, and collaboration between locations. Within their specific practice of knowledge and skills management, Richardson *et al.* [13] included aspects of competences management, in particular the analysis of competences requirements in terms of business competences, cultural requirements, and communication skills and training. However, it must be stated that, while addressing competences categories, no concrete competences

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to overcome the challenges were analyzed. Concrete competences would be necessary for HRM to develop special training programs to allow team members to obtain the necessary competences.

In summary, we identified that competencies are seen as an important influence factor for project success, but are rarely addressed explicitly. The discussion regarding challenges for GSD has not shown any connection between competencies, challenges, and interventions. Instead, challenges and interventions are addressed from a managerial or process perspective without taking the reasons for the challenges into account. As the importance of competences is accepted in the GSD domain, it can be assumed that individual competencies have a major influence in the occurrence and handling of challenges to GSD projects. Our research addresses the identification of challenges for which competences are seen as a major influence factor. Table II presents the challenges with competences as a major influence factor and a short description regarding which aspects of the challenge are connected to competences. The possession of the right competences at a suitable proficiency level would enable individuals to avoid and overcome challenges to GSD. Therefore, competency-based interventions have the potential to address challenges effectively. For the creation of concrete competency-based interventions, the relationship between competencies and challenges to GSD has to be analyzed in more detail.

3. METHODOLOGY

The presented research was conducted as part of a Delphi study [42] with the aim of identifying how internationalization competencies can help overcome challenges to GSD and how the context influences competency requirements. As the specific area of internationalization competences lacks a theory in the IS field, our research is of explorative nature and is, thus, addressed using a qualitative approach. Based on the explorative nature of the research, a wide variety of different opinions and ideas can be expected among GSD experts. Because a Delphi study aims at finding a consensus between experts with different opinions and backgrounds [43], this approach is feasible for the present research.

We conducted qualitative expert interviews [44]. The study will be used as a basis for a future quantitative study to rank, rate, and validate the results toward a theory of the influence of competences on IS projects/performance.

The participants in the study committed to participate before starting the data collection. The selection of the participants followed a five-step procedure based on Okoli and Pawlowski [42]. The five steps were as follows:

1. Preparation: identification of relevant stakeholders, organizations, and literature
2. Population: identification of relevant experts for each stakeholder group based on the identified organizations and literature
3. Nomination: initial contact with identified experts, including requests for nomination of additional experts
4. Ranking: categorizing identified experts to stakeholder groups and the ranked list for each stakeholder group
5. Invitation: inviting the highest-ranked experts for each stakeholder group until a preset limit is reached

The participants were separated into two groups: practitioners and academics. All participants had substantial experience in GSD projects either in companies or in universities. In total, 10 practitioners and seven academics participated in the study. The practitioners had, on average, more than 5 years of experience in GSD and were distributed among professionals, managers, and top-level executives. Eighty per cent of the practitioners had a university master's degree or higher. All participating academics had a PhD, with five of the participants holding the position of professor. The academics were selected based on their substantial research in GSD or on competency-related or intercultural research. However, all academics, additionally, had substantial working experience in intercultural development projects.

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The integration of the academics allowed us to include not only the perspective of the practitioners and software development companies, but also the perspective of lecturers and researchers responsible for the education of upcoming software developers. The combination of both practitioners and academics allowed us to create a holistic view on the presented problem.

Within the study, participants were asked about their own experiences in GSD projects. Hereby, participants were encouraged to report any specific case in which a contextual change of an employee led to a decrease of productivity and challenges related to this contextual change. In the first step, participants were asked to describe the situation and the concrete contextual change. Afterwards, they provided a description of the concrete challenges that occurred after the contextual change. This allowed us to capture the relationship between the contextual change and the challenges. In the next step, participants were asked to describe which actions were taken to overcome these challenges. If no concrete actions were taken, the participants were asked to elaborate which methods they would propose based on their experience. Based on the answers, we were able to identify potential interventions and connect them to the concrete challenges. In the last question, participants were asked to give their opinion regarding the relationship between technical and internationalization competences and, in particular, if an adaptation of technical competences through the application of internationalization competences was necessary.

Participants either answered an online questionnaire or participated in an interview. We allowed participation via online questionnaire to provide flexibility. Participants were able to write their stories over a longer period in a document then either transfer them to an online system or directly submit them. Based on the research design as a Delphi study and the given commitment for participation, we were also able to include several feedback and further question rounds for the participants who completed the online questionnaire. This means that we were able to ask further questions for specification or elaboration if the original answer was not sufficient or unclear. The online questionnaire can therefore also be described as an asynchronous interview process. The interviews were recorded and transcribed to allow for coherent analysis.

The analysis of data was conducted according to the following steps (based on [45]):

- Extraction of concrete problems/solutions
- Classification of the extracted problems and solutions
- Normalization of extracted problems and solutions ➔ coherent terminology
- Clustering of similar problems and solutions
- Construction of the problem and solution space

In terms of analysis of the relationships between contextual change, challenges, and solutions, we provide a quantitative analysis of the qualitative data. Hereby, we provide the number of times an item or relationship was mentioned by the participants. The number of times an item was mentioned is presented in the frequency column of the result tables. The number of times a relationship was mentioned is given in brackets following the ID of the related item. Additionally, we provide verbatim quotations of important findings for further elaboration.

4. RESULTS

In this section of the paper, we present the results of our study. The results are split into three different parts. In the first part, we describe the relationships between contextual change, challenges, and potential interventions. Hereby, we used a categorization to quantify the results in order to identify the frequency of contextual changes and how often specific challenges occurred. Additionally, we present how often an intervention was named as a suitable solution for the challenges. The quantitative analysis gives an indication of which items and relationships might be the most important. Additionally, we present selected verbatim quotations of the participants to highlight the presented relationships and address the implications of contextual changes and challenges. By this, we are able to show that, according to our participants, the lack of competences is a major influence factor for the occurrence of numerous challenges to GSD.

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The second part of this section addresses the need for adaptation of technical competences following a contextual change. Hereby, we first present aggregated statements of participants and their frequency. Based on concrete verbatim quotations and statements, we then identify contextual influence factors for both the importance of internationalization competences and the need for competences adaptation. We present these findings in a form of a model as the foundation of a future research model to quantify the influences.

4.1. The relationship of contextual change and competences-based challenges

In the first step, we looked at identifying typical contextual changes that lead to a new situation for individuals. This new situation might require different and therefore new competencies. Identifying these contextual changes helps to better analyze problems and challenges to projects. Table I presents the categorized results regarding contextual changes. Hereby, each category is briefly described with a special focus on the geographical distance or virtuality, amount of involved companies, and cultural backgrounds of involved individuals.

Various aspects of internationalization stemming from global development over international clients and customers of international teams were reported to create challenges in which the lack of competences was an important factor. All contextual changes included team members from different cultural backgrounds who potentially spoke different languages. However, just the first two contextual changes and international stakeholders may include virtual work.

These distributed settings represent the majority of situations in which challenges due to a lack of competences occurred. This might be explained by the fact that the distribution of software development tasks increases their complexity by introducing geographical distance and therefore the need for virtual work. But, even in nondistributed settings, varying cultural backgrounds can cause several problems. One participant reported on a case in which

> *an intercultural, newly formed team worked on a new project from Germany. The foreign developers arrived in Germany only the day before the project started and it was their first project in Germany and with German stakeholders. An Indian developer was made project manager as he had the most experience in the technical aspects. But as he had no experience working in Germany, many problems came up based on cultural difference. The problems led to failure of delivery and replacing the team leader with someone familiar with the culture.*

This demonstrates the enormous impact cultural differences and the lack of understanding of these differences can have. The reason for the situation described earlier was that:

> *the Indian team leader always claimed to understand everything that was meant and required but a following discussion gave the impression that he did not understand the key points.*

This proves that contextual changes can cause a variety of challenges that are strongly related to the competences of the individuals.

In the second step, we aim at identifying which challenges occurred as a consequence of the contextual change. Therefore, the participants of the study were asked to provide a description of

Table I. Contextual changes.

ID	Category	Description	Frequency
1	Distributed development	Development among two or more companies from different locations and cultural backgrounds	4
2	Distributed, international team	Development within one company with team members situated in different locations with various cultural backgrounds	2
3	Change of team structure	Changes to the development team by people with different backgrounds leaving or being added to the team	4
4	International stakeholders	Different or changing stakeholders such as customers and clients from various locations	2
5	Change of location	Performing the same job in a different geographical location	2

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the challenges, which occurred following the contextual change. This allowed us to identify the most frequent challenges based on a lack of competences in GSD and their connection to the identified contextual changes. In the following, we will describe some major observations in the relationships between contextual changes and challenges.

In accordance with the example earlier, miscommunication and different working styles and behaviors play an important role. This is supported by the experiences of another participant who stated that they

> *decided to outsource some tasks to another country and a representative of the client company was placed in that team to help with domain and technical issues. However, even in face-to-face meetings the team and the company representative had very different interpretations of what had been agreed on. Experience in local teams didn't help the expert in the new setting.*

This exemplifies another challenge in distributed settings: management style. While face-to-face meetings are an appropriate style in one setting, these may not be acceptable in another setting. Interestingly, working style and behavior, and technical knowledge are seen as challenges to distributed development but not to distributed international teams. This might be explained by the fact that if all team members belong to the same company, they most likely follow the same work processes and are hired and trained under the same standards.

In nondistributed settings, working style and behavior, trust building, and both miscommunication and language present the most frequently recurring challenges. In particular, the change in team structure caused a wide variety of challenges. In opposition to this, international stakeholders and change of location created fewer problems. Here, miscommunication was the most common challenge.

To have a better understanding of the challenges based on the contextual changes, we analyzed how often the challenges occurred and derived an aggregated description of challenges from the participants' reports. The categorized results are presented in Table II. Hereby, the relationship to

Table II. Challenges.

ID	Category	Description	Frequency	Contextual change
1	Miscommunication	Communication gaps and misunderstandings based on differences such as terminology used, cultural backgrounds, communication styles, and preferred communication medium	13	1 (5), 2 (2), 3 (3) 4 (1), 5 (2)
2	Management style	Differences in management styles in terms of motivating team members, perception of hierarchies, and perception of errors	7	1 (3), 2 (3), 5 (1)
3	Working style and behavior	Differences in working style and behavior such as different time perceptions, task allocation, admitting problems, and mind-set based on different cultural backgrounds	6	1 (3), 2 (1), 3 (2)
4	Development methods and approaches	Differences in development methods and approaches used, such as development processes and environments	4	1 (1), 2 (1), 3 (1), 4 (1)
5	Language	Different languages and different levels of proficiency of a common language	4	1 (2), 3 (2)
6	Trust building	Building trust among team members from different geographical locations and cultural backgrounds on both social and professional levels	4	1 (1), 2 (1), 3 (2)
7	Technical knowledge	Different technical education can lead to misunderstandings on a practical level	3	1 (2), 3 (1)
8	Domain knowledge	Differences in domain knowledge based on different education and legislation in various locations	2	1 (2), 3 (1)
9	Network building	Developing new contacts in a different geographical location	1	3 (1)

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the contextual changes is presented by listing the IDs from Table I. The ID is followed by the frequency at which the connection was mentioned.

Miscommunication was the most mentioned challenge in the presented settings. In particular, participants mentioned the differences of communication style and communication medium. This is exemplified by the previously stated example of a team manager moving abroad to handle issues at a client company. Although he is a great communicator in his domestic setting, his communication attempts failed in the new context. Miscommunication was seen as a major challenge for all contextual changes besides the change of team. An explanation could be that in cases of team changes, the situations described by participants usually included the introduction of only a few new team members. This means the communication structure of the team most likely remains intact and new members will have to adapt to the pre-existing communication methods.

The related challenge category of language was mentioned four times. While miscommunication focuses on the communication style and communication medium, the main aspect of language relates to misunderstandings caused by different proficiency levels in a foreign language. While English is a common language in GSD, it was mentioned that local subteams of companies still communicate in their native language, causing challenges when introducing foreign workers to the team. It was also mentioned that project managers speaking the native languages of all subteams members are likely to have a higher success rate. This is supported by the notion of another participant, who addressed two different functions of language:

> *Language is a method to transfer content and information, but underneath is a very important aspect of language to create trust and intangible aspects.*

Both miscommunication and language are also closely related to networking. Networking was seen as a problem with changes in the team structure, such that the relationship between team members has to be rebuilt with new team members influencing the team hierarchy.

Differences in management style were the second most-mentioned challenge by participants. Management style was problematic in distributed settings or when a project manager changes his or her location to another country and culture. The concrete challenges related to the management style were culture related, such as the level of hierarchies, acceptance of errors, and how to address and motivate team members. In terms of acceptance of errors, one of the participants explained that:

> *a quality assurance manager was sent to a company in China to help with their software development. The manager did what had worked in his home country. He organized face-to-face meetings to address identified faults and bugs. To his surprise, he faced reluctance and complaints from the teams. He failed to understand that pointing out someone's errors openly was frowned upon in Asian countries.*

This illustrates that the manager could have adapted his management style to the new culture. Another participant mentioned that even neighboring countries can have big differences in their management style. He stated:

> *the way of managing and motivating people are quite different in different cultures. There is some discrepancy between Finland and Sweden. In Sweden it is assumed that the management is quite soft and motivational and in Finland the Finnish philosophy is management by perkele.*[‡]

Differences in working style and behavior, and problems with trust building were mentioned regarding international, distributed development settings as well as for international teams in the same location. This demonstrated that the distributed setting and virtuality of the work cannot be the reason for these challenges; rather, the root cause is different cultural and educational backgrounds. Participants reinforced these points as they highlighted differing perceptions on time, values, and goals, along with different interpretations of meeting outcomes and not showing weakness as the main challenge of the working style and behavior category. The main challenge regarding trust building was the uncertainty regarding the competences of team members. However, one participant stated that a basic level of trust is needed:

[‡]Management by perkele is a term invented in Sweden to describe the Finnish leadership emphasizing the very hard style of leadership. For more information, see [62].

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'*If you create new project teams, you have to create that level and just then they start to transfer knowledge and start to use their competences in the context'*. Additionally, '*trust leads to openness so that team members tell you what they really think'*.

This implies that trust strongly influences the other presented challenges.

Neither technical knowledge nor domain knowledge was seen as a major challenge. This indicates that technical and subject education are reaching similar standards in the countries involved and that problems and challenges should focus on other aspects, such as cultural differences. Additionally, the lack of problems in terms of technical and domain knowledge can be explained with current educational, hiring, and team-building processes. While educational systems focus mainly on technical knowledge, domain knowledge is usually a part of educational programs or achieved by prior work experience. Therefore, it is comparatively easy to evaluate an employee's knowledge level from his or her curriculum vitae (CV) and educational background. Thus, only people with an adequate technical and domain knowledge are assigned to the projects. However, participants stated that different legislation in various geographical locations could lead to misinterpretations of requirements relating to domain knowledge. In terms of technical knowledge, the application of different development methods and approaches was mentioned more frequently, indicating that technical knowledge may not be an issue, but differences in approach and style of knowledge application can be problematic.

In this section, we identified that participants saw competences as a major influence factor for various challenges discussed in GSD literature. We also briefly described the nature of each challenge and its implications. In particular, challenges related to communication, collaboration, and leadership were affected by the lack of competences.

4.2. Competences-based challenges and interventions

After the identification of challenges, we focused in our interviews on potential or implemented solutions and interventions for overcoming these competences-based challenges. The aim is to analyze which solutions and interventions are seen as the best candidates to overcome or prevent the identified challenges.

Team building was mentioned most often and was, together with team selection, connected to the highest amount of challenges. According to the participants, team building could be used to overcome challenges related to miscommunication, working style and behavior, development methods and approaches, language, trust building, and networking. The highest level of relationship was identified toward trust building and miscommunication. As a method for team building, one participant suggested that companies

should allow 15% of the time that the teams are together to be spent on social communication rather than work related communication because it is social communication that allows you to have a cultural understanding that enables you to have better work related communication.

Related to team building is team selection. Although mentioned by only two participants, team selection was identified as a solution for five different potential competences-based challenges.

While training was mentioned several times, mentoring was frequently perceived to be a better solution. Additionally, mentoring was also connected to the most frequently identified challenges. This reflects the thoughts of one participant who stated that:

the problem with this culture is that you can teach of course about the importance of culture and cultural differences. But it pretty much requires some sort of contact and living in the culture to get a better understanding of the culture.

Mentoring provides 'on-the-job learning by doing'; therefore, it can be seen as a feasible solution to overcome cultural challenges and facilitate communication in diverse groups. One participant suggested:

there might be some kind of cultural mediator. The mediator can then be better able to communicate with both sides and observe the critical points of misunderstanding.

The usage of a common language and terminology was seen to be a suitable solution in overcoming communication and language-related challenges. According to the participants, common processes

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enforced by one of the partners could help with challenges regarding the differences in working styles and behaviors, development methods, and technical knowledge.

Management style adaptation was seen as a solution for overcoming working styles and behavioral challenges. It was suggested by one participant that it would be

> *useful to discuss with a local manager about the methods that were going to be used to see if they are acceptable in the culture.*

Surprisingly, no connection existed between management style adaptation and challenges related to the management style.

The suggested interventions and their relationship to challenges are presented in Table III. Here, we also illustrate how often an intervention was mentioned in total, regardless of specific challenge connection.

To recapitulate, a wide variety of challenges, which are commonly discussed in GSD, has actors' lack of competences as a main factor for its occurrence as well as for overcoming and avoiding it. Different methods were suggested to overcome or prevent the challenges from a competences perspective. The interventions addressed strengthening of competences, selection of teams with complementary competences, and building a level of trust and team awareness. The latter received much attention from our participants, as they felt that having a functional team was crucial for project success.

The combination of contextual changes with challenges, considering the lack of competences as a major factor, has shown that sufficient competences in one context can become insufficient when changing the context. A high level of competences enables the individual to avoid or overcome challenges by flexibly adapting his or her competences and, thus, work methods and working styles to the new context. However, identifying which competences are required for individuals to overcome and prevent GSD challenges is complex, because it is based on the strong context dependence of the competences requirements. Romero *et al.* [28] identified that some competences have to be adapted while others stay the same. This raises the question of which factors influence the adaptation needs for competences and can we identify patterns that allow for the creation of guidelines for the development of GSD competences frameworks. These questions are addressed in the following section by looking at contextual influence factors on the adaptation needs. We also look at the importance of internationalization competences as one candidate for soft competences to enable individuals to overcome and prevent GSD challenges [7].

Table III. Solutions/interventions.

Category	Description	Frequency	Challenges
Team building	Take actions to establish a team feeling among team members and, consequently, build trust among them	8	1 (4), 3 (1), 4 (2), 5 (1), 6 (4), 9 (2)
Mentoring	Establish mentors to support team members in learning cultural differences and facilitating communication	4	1 (2), 2 (2), 3 (2), 4 (1)
Common language	Enforce the usage of a common language for communication, documentation, and process descriptions	3	1 (2), 5 (2)
Training	Provide suitable education, especially in terms of cultural differences and working habits	3	1 (3), 2 (2), 3 (1)
Common processes	Define clear processes and enforce their usage by all involved organizations	2	3 (1), 4 (1), 7 (1)
Knowledge sharing	Establish methods for knowledge sharing both via computer and face-to-face meetings	2	1 (2), 2 (1), 5 (1)
Management style adaptation	Adapt the management style to suit international and intercultural settings	2	3 (1)
Team selection	Select suitable team members and project managers based on their skills, knowledge, and experiences	2	1 (1), 3 (2), 5 (1), 7 (1), 8 (1)
Partner selection	Select suitable partner organizations to minimize risks and differences	1	1 (2), 7 (1), 8 (1)

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4.3. Competences adaptation—contextual influence factors

Based on the findings of the relationship between challenges and interventions, the need arose to identify which competences are needed to overcome challenges to GSD. However, our findings indicate that context might have a strong influence on these competences requirements. This is already reflected in the given definition of competency. As a reminder, competency was defined as *a collection of skills, abilities, and attitudes to solve a problem in a given context* [39]. For this purpose, it is important to identify how the context influences the required competences and which aspects of context are the main influence factors. After gaining an understanding of the contextual influence factors, researchers and practitioners will be able to identify suitable competences for the given context and problem at hand. To address the strong context dependence of competency requirements, Hoel and Holtkamp [24] suggested the adaptation of technical competences to the given context. This raises the question of how technical competences should be adapted to suit a change of context. To answer this important question, we asked the participants for their opinion regarding the relationship between technical competences and internationalization competences with a focus on the need to incorporate or combine aspects of internationalization competences into technical competences. The participants were presented with a contextual change, in particular a manager of a local team for requirements engineering becoming responsible for an internationally distributed team, and were asked how the manager should react.

The clustered results of the statements regarding the relationship between and combination of technical competences and internationalization competences are presented in Table IV.

The relationship between internationalization and technical competences was seen as very context dependent. One participant stated:

> *the context defines the competences requirements. A math professor, while having tremendous competences in mathematics, might not be the best candidate to teach first grade pupils.*

While the majority of participants stated that adapting technical competences is necessary, the level of adaptation needed is strongly dependent on the situation, task, and technical competences itself. One main influence factor suggested by the participants was the level of technicality of a task. The participants suggested that the level of task technicality influences the importance of internationalization competences and the need to adapt technical competences. Hereby, the competences adaptation refers to adapting the competences to the context by changing work methods and working styles. One participant specified:

> *for pure engineering or mathematical problems, the role of internationalization competences is lower and therefore no close connection for the two competences groups can be made.*

Table IV. Relationship between and combination of technical competences and internationalization competences.

Statement	Frequency
Technical competences should be adapted to fit the context, culture, and/or work environment.	10
Different cultures can influence the methods and approaches used in particular tasks.	8
The application domain can influence the methods and approaches used in particular tasks.	3
The level of technicality of tasks influences the need for competences adaptation and the importance of internationalization competences.	3
Technical competences do not have to be adapted.	3
It is sufficient to have both technical and intercultural competences without any adaptation.	2
The level of collaboration influences the need for competences adaptation and the importance of internationalization competences.	2
The ability to adapt one's own level of competences to the context can be seen as important competences itself.	2
It is important that individuals have both technical and internationalization competences.	2
The level of expected creativity influences the importance of internationalization competences.	1
Different approaches regarding technical competences can be as seen positive or negative. Depending on the perception, the technical competences have to be adapted or not.	1

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He gave the following example:

if a bunch of countries want to work together in developing a global game that has cultural references, then intercultural skills must be essential. If there is a mathematical game of some kind or an engineering project then it might not be as relevant or necessary.

Additionally, the expected level of collaboration, creativity, and innovation of a task is seen as an influence factor on the importance of internationalization competences. Here, our participants expect a positive relationship. The collaborative aspect was addressed by one software developer, who remarked:

individual tasks stay the same no matter where you are located. So you should focus on tasks where interaction with other people is needed and try to analyze if you need to change something in your way of working.

When addressing the creativity and innovation of the task, the application domain was identified as a strong influence on how much creativity and innovation are expected. This, again, has an impact on the importance of internationalization competences and the relationship between technical and internationalization competences. One participant addressed this by stating:

in the domain in which I am working, we have some worldwide functioning rules on the technical side where the place for personal creativity is not very big. In that case from the industry where I am working in, I don't think that we have such big differences among the regions of the earth.

This indicates that, in some application domains, the perceived high level of restrictions and legislations lead to low creativity requirements. According to our results, this might reduce the importance of internationalization competences.

The identified influence factors for the competences adaptation needs and the importance of internationalization competences are presented in Figure 1. The presented conceptual framework can be the foundation for a research model to quantify the influences. It has to be stated that the presented framework merely represents the findings of our research. Confirmatory studies with a deeper insight into different influence factors on the competences adaptation needs and the importance of internationalization competences have to take place to transform our framework into a concrete research model. To use the model for quantitative analyses, the validity of constructs has to be analyzed and concrete measurement models have to be established.

The contextual factors identified by our participants influence the necessity for an adaptation of technical competences to the work context. This adaptation could allow professionals to achieve the level of flexibility necessary to overcome or prevent challenges based upon the change in context.

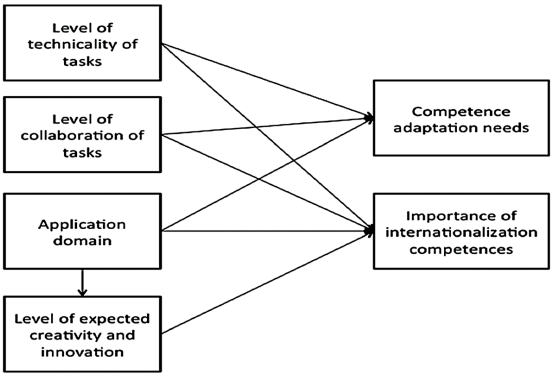

Figure 1. Influence factors of competences adaptation needs and internationalization competences in global software development projects.

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However, this raises the question of how technical competences can be adapted. One participant described the adaptation of competences as

understanding the role of the task in the new environment.

This describes the general approach many participants took when asked how competences can be adapted. It was stated that

the individual should think about each of his steps with regard to the intercultural context. For instance, a requirements engineer should adapt his interview-technique for the requirements elicitation to the intercultural context.

This example suggests that applying internationalization competences for each technical competences to evaluate if the approach is suitable for the context is perceived as a suitable activity to flexibly adapt the own competences to the given context. This means that internationalization competences give individuals the flexibility to adapt their competences to the given cultural work context.

Another participant explained this by providing the example of house building. According to him, the question

how to build a house is something that people in different countries understand completely differently. One can build houses the way one did before, simply adapting the explanations of why it's done the way it is, or one can try to adapt pre-existing competences to build houses the way it's done in the receiving culture.

However, it is important to highlight that when adapting competences to the new context, the core of the technical competences remains the same. As one team leader said,

a requirement is a requirement, but the style, methods of gathering and functions within a project could be very different in a new setting.

These results indicate that context has a strong influence on which competences are needed in the work and how competences should be changed. The results indicate that generalized competences frameworks are not suitable based on the expectedly high influence of context. Instead, competences frameworks should be contextualized, which means created specifically for the given problem and context. For this purpose, no generic list of competences that is required to overcome the presented challenges is presented. Instead, we identified several influence factors based on the suggestions of our participants. The resulting framework can be seen as the foundation of a future research model to quantify the influences. The identification of influence factors will allow the analysis of competences requirements and thus will lead to contextualized competences frameworks. Furthermore, an initial insight into perceptions regarding how competences could be adapted was given. This is the first attempt to identify the cognitive processes applied by individuals following a contextual change. More research in this direction might lead to better support mechanisms.

5. DISCUSSION

5.1. Relationship of results to previous research

In our study, we identified that although GSD involves distributed teams around the world, small contextual changes can cause large challenges and problems. Simple contextual changes, such as the introduction of a new foreign team member, resulted in language problems. The integration of different departments led to a lack of trust and team awareness for international, distributed teams [3, 35].

The existence of challenges due to the change of team structures indicates that the contextual change does not concern only the individual; who is, for example, moving to a new location, but also the existing team. This emphasizes that a lack of internationalization competences on both sides can cause problems and one-sided possession of internationalization competences may not be enough to avoid challenges. The team structure and competences orchestration among team members play an important role in overcoming challenges. This is supported by the findings of Maruping and Ahuja

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[46], who identified the strong influence of team structure upon project risks. We also identified that similar challenges occurred in contextual changes with and without distributed settings. This implies that the distribution of work cannot be the main driver of challenges. Instead, other factors have to be taken into account when looking for a foundation for the challenges. The lack of competences describes one potential alternative foundation for the occurring challenges to GSD.

In terms of challenges, miscommunication and differences in working style and behavior based on cultural backgrounds were the most commonly identified challenges by the participants of our study. This supported the findings of Noll *et al.* [2], who determined that communication and culture-related challenges are the most frequently addressed challenges in their literature review. However, while the reviewed literature addresses communication challenges from a more generic position focusing on virtual work [2], the problems derived from the study are concrete and strongly related to either national or organizational culture. In particular, the study participants mentioned misunderstandings and different views based on diverse backgrounds, which Sclater *et al.* [35] identified (culture) as one of the main challenges to GSD. Based on our results, we identified that a lack of competences of the actors can be seen as one major reason for these challenges. Possessing internationalization competences would allow an individual to understand the views of team members from other cultures. Only select participants mentioned language barriers, which are often seen as a major barrier [47].

Pierce and Hansen [48] stated that 'no facet of virtual team dynamics has received more attention than the question of trust among team members'. Herein, trust is defined as 'the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party' [46]. Trust is commonly seen as a critical success factor for virtual teams [49, 50]. Therefore, it is surprising that only four participants in our study mentioned trust building as a major challenge. However, because a high level of trust has been found to reduce interpersonal transaction costs [51] and conflicts [52] and increase open information exchange [53], it is possible that the lack of trust was not seen as the major challenge but rather represents the cause of the challenge itself. This would be supported by the fact that team building was the most often mentioned solution in overcoming various challenges. The participants particularly mentioned that face-to-face meetings and social activities are key aspects for team building and successful projects. Nohria and Eccles [43] found that face-to-face communication is crucial in developing interpersonal trust. Additionally, Iacono and Weisband [54] identified social activities, especially early in the project, as leading to higher levels of trust.

Few participants mentioned partner selection and connected team selection. This might be based on the fact that teams are often preselected; thus, many individuals do not view team selection as a solution because it is predetermined. Partner selection is a common part of GSD processes [11, 55]. However, Prikladnicki *et al.* [11] specifically refer to organizational capabilities and do not take individual competences into account. Also, team-building efforts usually address the roles of project team members [56] and not the competences of the team members.

While the challenges identified in our study supported the findings of Ågerfalk *et al.* [3] and Noll *et al.* [2], we were able to show that a lack of competences is seen as one of the reasons for challenges to emerge. Currently, most research have taken either a process or managerial perspective on challenges [13], but our results indicate that individual competences, in particular internationalization competences, should be a major focus point when discussing successful GSD. Effective management of internationalization competences could potentially decrease the occurrence of challenges and contribute significantly to GSD project success.

Personnel development is, according to Agarwal and Ferratt [57], one of the main functions of HRM. Personnel development is the main intervention to overcome competences-based challenges. While traditional personnel development is focused on competences development through training [38], our participants identified mentoring as a better solution for overcoming challenges based on cultural differences. In particular, the participants highlighted mentoring and cultural mentoring as facilitation of communication among team members with different cultural and educational backgrounds. Scandura and Williams [58] have identified that mentored employees receive substantial benefits including higher job performance. Within the domain of GSD, Casado-

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Lumbreras *et al.* [59] have demonstrated that mentoring is a suitable tool to help overcome cultural differences and bridge the gap between people. They also identified mentoring as a suitable tool for intercultural knowledge sharing, which has been identified as another potential solution by our participants. In terms of education, Monasor *et al.* [60] reviewed practices on teaching GSD in higher education. They found that, in particular, skills related to communication, management, and empathy were critical. These findings are in line with the internationalization competences introduced by Pawlowski and Holtkamp [7]. To teach the identified skills, Monasor *et al.* [60] found that practical experience is critical. Based on the high complexity of GSD, it is not possible to address 'all stages and problems of GSD' [60]. The notion that practical experience and work in real projects are necessary to achieve competences relevant to GSD represents our findings regarding contextual influence factors.

Common processes and management style adaptation, as suggested by the participants, are partially integrated into the global teaming framework developed by Richardson *et al.* [13]. The framework includes the development of common processes, goals, conflict resolution strategies, and rewards for team members. Through the development of these aspects in cooperation with all involved partner organizations, all cultural backgrounds are taken into account.

In their research to identify how an IT program team's social competences and self-competences affect critical team competences and the performance of the IT program, Parolia *et al.* [61] identified mutual support and interpersonal cooperation as key factors in building team competences. The interpersonal cooperation and mutual support are influenced by individual competences and in particular self-competences and social competences [61]. The findings of Parolia *et al.* [61] regarding the IT program performance are well in line with the findings regarding interventions for competences-based challenges to GSD. Team building, mentoring, and knowledge sharing can be understood as different views on interpersonal cooperation and mutual support. It can be assumed that reducing the amount and impact of challenges will also impact the team, project, or program performance.

Besides notions that competences requirements are context dependent [20], little discussion of the actual influence of context on competences requirements and the competences themselves can be found. However, the participants noted that the competences to adapt to a different context is important in today's global work environment. Our results show that internationalization competences are seen as very important to achieve the flexibility to adapt to different contexts, as they allow individuals to adapt their technical competences. This indicates that soft competences, such as the internationalization competences introduced by Pawlowski and Holtkamp [7], can be seen as the foundation for a more abstract competences of adapting one's own working style to the given context. This raises the question of how the adapting of one's own working style to the given context could be handled based on the possession of appropriate internationalization competences. The participants in our study agreed that the ability to adapt one's own working style to the given context can be understood as a process of adapting technical competences by applying internationalization competences in the evaluation of one's own working styles and methods in the given context. This raises also the question of under which circumstances this adaptation is necessary and which factors influence the importance of this adaptation process. We ascertained that, in particular, the level of task technicality and the collaboration level are believed to have a strong influence on the adaptation need for technical competences. These relationships and methods for competences adaptation and the adaptation of competences descriptions should be taken up in future research activities.

In summary, we identified that contextual changes are responsible for a variety of challenges that were previously discussed in the literature [2, 3]. Competences—particularly internationalization competences—of individual team members are seen as a major factor in overcoming or preventing these challenges. The possession of internationalization competences enables individuals to flexibly adjust their own working styles to the new context. This indicates that competences management and a better insight of competences requirements in terms of soft competences for GSD have the potential to increase the success of GSD projects by providing individuals the tools to prevent and overcome common challenges to GSD. We found that competences requirements change depending on the context and that technical competences have to be adapted for each context. For these adaptation needs, we identified influence factors such as the technicality of tasks, the level of

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collaboration, and the expected level of creativity. Additionally, we provide an initial insight into the process individuals apply to adapt their competences to a context.

5.2. Theoretical contributions

The relationship of our results to related research shows a variety of different contributions to current GSD literature. The main contributions are as follows:

- Identification of competences as a major driver of challenges to GSD
- Relationship among contextual changes, competences-based challenges, and interventions
- Recognition of the strong influence of the work context on competences requirements
- Naming of contextual influence factors on competences requirements
- Classification of the limitations of competences frameworks and guidelines for the creation of context-sensitive approaches
- Identification of the competences adaptation process

While previous research commonly addresses challenges to GSD as a foundation for not achieving targets and competitive advantage, our study went one step further and analyzed the foundations of challenges to GSD. Just by looking at the foundations of challenges, we believe we will be able to create methods and guidelines to prevent challenges and thus remove the challenges. We identified competences as a major driver of commonly discussed challenges to GSD. This indicates that the appropriate educational methods can lead to a significant reduction of challenges to GSD. By identifying the relationship between contextual change, challenges, and interventions, we have laid the foundation for the creation of streamlined intervention methods to improve the relevant competences and thus reduce the appearance and effect of challenges.

However, we also recognized that the required competences are strongly context dependent. So far, competences are commonly seen as a static item that an individual either does or does not possess. Our research shows that competences are a very dynamic concept and that an individual can possess a competences in a given context at a given time; but, after changes in the work environment, the competences level of the individual decreases significantly. This shows the clear limitations of previously developed competences frameworks for GSD. In previous competences frameworks, competences are usually seen as dynamic and do not take contextual influence factors into account. Our results show that this kind of mind-set regarding competences is not applicable to the changing work context. Instead, guidelines on the creation of dynamic competences frameworks based on the work context have to be created.

By identifying a first set of contextual influence factors on competences requirements, we provide initial input for the creation of guidelines for the creation of dynamic competences frameworks. Based on these factors, the importance of soft competences (e.g., internationalization competences) and the importance of adapting technical competences can be analyzed. A new discussion in the research community on the adaptation of competences and the influence of context on those competences requirements should, based on our findings, follow this study. Previous research acknowledged that GSD has an effect on some, but not all, competences, and that additional competences emerge from GSD. However, our results represent the first explication of concrete influence factors and give a first impression of the actual adaptation process individuals take when changing work context. Therefore, our research addresses a new research strain in the field of competences management for GSD.

5.3. Limitations

Based on the research design and research process, a number of limitations to our study can be identified. While striving for a randomized, representative sample of participants, the selection of participants has potentially influenced the results. Especially because the data is based on a relatively low number of participants, it is possible that a different set of experts may lead to varying results. We have tried to avoid any kind of false interpretation of the data by including two feedback rounds. In the first feedback round, participants were presented with a transcript of their interview regarding the combination of answers from the online survey to ensure that no misunderstandings occurred in the process. Additionally, participants were presented with the

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aggregated results. This allowed the participants to see if their own opinion was represented correctly or if misinterpretations took place. However, we cannot guarantee that every participant comment was interpreted correctly. Additionally, the combination of face-to-face interviews and asynchronous interviews via online questionnaire can influence the results. Even if we tried to match the processes as well as possible, the results of the two data collection methods might differ.

5.4. Implications for practice

Our results provide important implications for human resource (HR) managers, as well as for managers in GSD teams and practitioners of GSD. These are, in particular the following:

- Implications for competences requirements gathering and the creation of job profiles and descriptions
- Input for strategic planning of future activities for managers
- Suggestions for practitioners regarding how to adapt working habits to the work context

Our results support HR managers in their daily work of competences management. The results suggest that the work context should be taken into account when gathering competences requirements and creating competences frameworks. To support this process, we identified several influence factors for the importance of internationalization competences. This can strongly support and lead to better-streamlined activities, in particular, in terms of hiring and staff development. Based on the organizational strategy, HR departments can analyze the factors and take them into account when developing competences development strategies. Overall, this might lead to a better fit between task requirements and employees' competences. However, the development of a validated method for the gathering of competences requirements should be an important topic addressed by future research.

Our study also supports managers when developing new strategies for their organization or department. When thinking about future activities, changes in the work environment can be analyzed and potential challenges can be included in the risk analysis. This might lead to better decisions. In the strategy development phase, activities to overcome potential challenges can be analyzed and planned. This allows for a better fit and more accurate risk analysis of future business opportunities. Therefore, the identification of the connection between contextual changes and challenges can also be understood as a decision support for managers when thinking about entering new markets and determining new business opportunities.

The identification of an adaptation process for technical competences, based on the work context, can provide a valuable input for practitioners undergoing contextual change. By applying their internationalization competences to evaluate their work methods for the new context, the efficiency can be increased tremendously.

The presented implications for practice are to be understood as potential implications of the research results. The realization and validation of these implications is the subject of future research, which will be discussed in the next section.

5.5. Directions for future research

Our research has presented a meaningful relationship between context, challenges, and competences. As an initial empirical study that explores competences as an underlying factor of challenges to GSD and competences adaptation needs based on contextual influence factors, our study provides implications not only for the practical application but also for future research.

We identified relationships between contextual changes, challenges, and interventions. However, future research should validate and verify these connections. The main question to be answered by future research is the relationship of the competences to the challenges. We found that a generic solution is not suitable based on the strong influence of the context on the competences requirements and provided the ingredients for the creation of a method to analyze the competences requirements. By using a suitable solution space, such as internationalization competences [39], and applying the provided ingredients, an adaptive competences framework can be created. This research has the potential for a very high practical contribution, as it would allow GSD professionals to dynamically create competences frameworks that are suitable for the work context.

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Second, further exploration of contextual influence factors on the importance of soft competences and on the adaptation needs for technical competences is in order. This study highlights the importance and influence of work context on competences requirements and provides a preliminary indication of influence factors that can allow stakeholders to identify the required competences. However, further research has to go toward identifying and validating the contextual influence factors and toward quantifying their influence.

Finally, we identified an initial approach regarding individuals' adaptation of technical competences to fit the current work context. The understanding of these processes will allow for the development of suitable tools to support individuals in their adaptation of competences. Therefore, further research should go toward identifying and validating the applied processes.

6. CONCLUSION

Numerous challenges are discussed in GSD literature. We identified that the main focus on the solution space was on technologies that could help overcome the identified challenges. Competences of the individual team members were rarely addressed. We identified that a lack of competences was seen as a major influence factor on several challenges commonly discussed in GSD. This extends the discussion of challenges to GSD and provides a different angle to address, overcome, and prevent challenges, thus increasing the productivity of globally distributed teams. In cases reported by our participants, the challenges directly affected the performance of individuals in the projects and its related success. The understanding of relevant competences has therefore the potential to increase GSD project success rates while also decreasing related costs.

While the challenges identified in literature and the results of our study describe similar aspects, we identified a potential cause of the challenges. By identifying one cause of several GSD challenges, the development of focused interventions and solutions in the form of team member training and education can be pursued. Additionally, we illustrated which types of competences sourcing methods can be considered most suitable for different types of competences. While traditional training was deemed adequate for technical competences and domain competences, mentoring and team-building methods were considered superior for intercultural competences. Therefore, the presented research opens an opportunity to reconsider existing findings regarding challenges and interventions for GSD from a competences-based perspective.

Our research indicates that the work context plays an important role when discussing competences and competences requirements. High-performing individuals were not able to sustain their productivity after a contextual change. This indicates that the competences were suitable for the initial context but not for the changed context. The extent to which context influences competences requirements and how this influence can be specified need to be analyzed. We identified that the level of technicality of tasks, level of collaboration, level of expected creativity, and application domain are potential influence factors for the adaptation needs of technical competences. We also created a first draft of a research model, which should be refined, validated, and operationalized in future research and which can be used to analyze the implications the identified influence factors have on the adaptation of technical competences.

Our results indicate that internationalization competences are suitable for enabling individuals to adapt their technical competences, and therefore their working styles and behaviors, to the given context. This indicates that no 'one-fits-all' solution for the required competences in GSD can be given. Instead, our results lay the foundation for future research that enables researchers and practitioners to identify the concrete competences requirements for a given context and problem. However, by providing a framework of internationalization competences and potential influence factors, a first step toward this direction has been taken.

Furthermore, we provide a first indication as to how technical competences can be adapted to the context. This is where a deeper analysis of the cognitive processes applied by individuals when adapting competences should take place. This would allow for the creation of an adaptation process that has the potential to strongly influence both education and practice.

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VI

SOFT COMPETENCY REQUIREMENTS IN REQUIREMENTS ENGINEERING, SOFTWARE DESIGN, IMPLEMENTATION AND TESTING

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Soft competency requirements in requirements engineering, software design, implementation, and testing

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ABSTRACT

Global software development changes the requirements in terms of soft competency and increases the complexity of social interaction by including intercultural aspects. While soft competency is often seen as crucial for the success of global software development projects, the concrete competence requirements remain unknown. Internationalization competency represents one of the first attempts to structure and describe the soft competence requirements for global software developers. Based on the diversity of tasks, competence requirements will differ among the various phases of software development. By conducting a survey on the importance of internationalization competences for the different phases of global software development, we identified differences in terms of competence importance and requirements in the phases. "Adaptability" (of one's working style) and "Cultural Awareness" were the main differences. "Cultural Awareness" distinguishes requirements engineering and software design from testing and implementation while "Adaptability" distinguishes implementation and software design from requirements engineering and testing.

1. Introduction

In the competitive software market, software development companies are continuously increasing their effort in global software development models to achieve a competitive advantage in form or lower prices and increased productivity (Sengupta et al., 2006). However, global software development faces a variety of challenges that hinder companies from reaching their goals (Ågerfalk et al., 2005). Hazzan and Hadar (2008) found that human aspects are the main source of challenges in software development projects. This is supported by the findings of Holtkamp and Pawlowski (2014), who found that several challenges facing global software development (GSD) are due to a lack of competences of the individual software developers. Additionally, the quality of software products strongly depends on the knowledge, abilities, and talent applied by the team members (Rivera-Ibarra et al., 2010)—in particular, specific skills and the ability to apply these skills to solve a problem (Ryan and O'Conner, 2009). The competences of software developers are crucial to overcoming challenges to GSD and producing a high-quality product.

As a result, a variety of research and practical work address technical competency. Conversely, soft competency is not addressed to the same extent (Colomo-Palacios et al., 2013) even though soft competency is particularly crucial in intercultural development teams. Pawlowski and Holtkamp (2012) defined internationalization competency as a set of soft competencies relevant to international development work. The competences included were validated as important for global software and information systems development. However, different phases of the software development process require different competences. Therefore, an analysis of the different tasks and phases of GSD and resulting competence requirements would allow for an in-depth study of the effects of soft competency in GSD.

Even though substantial research on the different tasks and phases of GSD has taken place, analyses from a competency perspective are lacking. Recently, collaboration models of globally distributed organizations and teams in the different phases have raised increased interest of researchers. Accordingly, Smite and Borzovs (2009) analyzed the four phases (systems analysis, design, coding, and testing) to determine the approach of collaboration with an outsourcing company. They identified a total of 19 different collaboration models, which refer to the distribution of jointly or separately handled phases. Based on project reports, Rocha et al. (2011) analyzed whether the work within 11 different phases of software development was handled onsite or distributed. They found that the most reported phases were requirements analysis, software design, coding, and testing. In accordance with Smite and Borzovs (2009), Rocha et al. (2011) found that coding was performed often by an outsourcing partner while no clear

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preference in terms of collaboration models could be identified for requirements analysis, design, and testing. It can be assumed that the model of collaboration has a significant influence on the competence requirements. This means that the importance of internationalization competences may vary depending on the various phases and tasks in the software development process.

To address these issues, this paper presents a study conducted with GSD experts to identify the importance of internationalization competences in the different phases of GSD. We compare the importance of the same set of competences for different phases of software development with the aim to identify differences between the phases in terms of competence requirements. Additionally, we analyze if, based on the competence requirement differences, underlying factors differentiating the phases can be found. We focus our analysis on requirements analysis, software design, implementation (coding), and testing as these four phases represent the most often reported and distributed phases (Rocha et al., 2011).

The research questions are:

- Which internationalization competences are relevant to the different phases of GSD?
- Are there differences in terms of internationalization competency importance between the phases?
- Can we identify underlying factors representing the differences between the phases?

In the next section of the paper, we present the theoretical background of our research, followed by a description of our methodology in terms of participant selection, data collection, and data analysis. The results of the study are then presented and discussed. The paper concludes with an outlook and proposition for further research.

2. Theoretical background

In the following section, we derive and define the concepts of competency, competence, and internationalization competency. We also discuss the various phases of software development and potential collaboration models.

2.1. Internationalization competency

Competency is widely used from an organizational perspective following the resource-based view (Wernerfelt, 1984) and from an individual perspective, mainly in the field of education (Grant and Young, 2010; Winterton, 2009) and human resource management (Boyatzis, 1982).

In most definitions of individual competency, skills, abilities, and attitudes are addressed (Pawlowski and Holtkamp, 2012). However, some critics address the importance of context (Sandberg, 2010) and especially in the domain of human resource management, the target orientation (Boyatzis, 1982). To address both common criticisms of definitions of competency, we follow the definition of Pawlowski and Holtkamp (2012), who defined competency as a collection of skills, abilities, and attitudes to solve a problem in a given context. To differentiate the terms competency and competence, Winterton (2009) stated that competency addresses a collection of skills, abilities, and attitudes. Competence as a specific instance of competency refers to a specific skill, ability, or attitude. Examples of competency are software development competency or intercultural competency. The ability to understand the influence of culture on work life is one example of a competence belonging to the intercultural competency.

Furthermore, when discussing competency, there is a common differentiation between hard competency and soft competency. Jacobs (1989) introduced this terminology to differentiate analytical competency from more creative and behavioral competency. Despite criticism (Woodruffe, 1993), the differentiation between hard and soft competencies and in particular hard and soft skills is widely used in practice.

To address changing requirements of globally distributed work, Pawlowski and Holtkamp (2012) developed a set of internationalization competencies. Internationalization competency hereby describes a set of soft competences relevant in an intercultural, international context. In particular, information and communication technology (ICT) competency, coordination competency, collaboration competency, communication competency, and intercultural competency are part of internationalization competency. A specific competence belonging to the internationalization competency is referred to as internalization competence. Based on the results of their study measuring the importance of internationalization competences for global development, an initial list of competences was selected for our study. The list was presented to five experts of GSD to validate the relevance and applicability of the selected competences. As a result, the following competences were selected for our study:

Comp 1. Ability to communicate sensitively, taking into account other personalities and cultures.
Comp 2. Ability to listen to others and consider their thoughts.
Comp 3. Ability to understand other people's perspectives, needs, and values.
Comp 4. Ability to share information and knowledge with the team.
Comp 5. Ability to manage diversity in the team to enable everyone to contribute and participate.
Comp 6. Ability to adapt and adjust strategies, goals, and plans according to the situation.
Comp 7. Ability to use other people's expertise and knowledge.
Comp 8. Understanding of the influences and implications culture has in work life.
Comp 9. Foreign language skills (e.g., knowing English; speaking a "common" language).
Comp 10. Ability to evaluate perspectives, practices, and products from multiple cultural perspectives.
Comp 11. Understanding and knowledge of one's own culture and its implications.
Comp 12. Understanding of importance and limitations of different information sources.

The selected competences cover the different competency categories of internationalization competency.

2.2. Forms of collaboration in the software development process

For the analysis of competence requirements in the different phases of software development, we first have to look at common software development processes. Previous research indicates that various forms of collaboration are applied in the different phases of software development. Based on the analysis of software development processes and on the applied collaboration models, we selected the best suitable phases of software development for our analysis.

Based on the high complexity of GSD, Beecham et al. (2005) identified the importance of software development processes. However, Ramasubbu et al. (2005) found that the existing software development processes are not suitable for a global application. In line with this, Smite et al. (2010) found that practitioners are "still searching for recipes for success in managing globally distributed projects." Therefore, they analyzed which development methodologies were applied in GSD based on a set of project reports. Agile methods, RUP, and iterative methods were represented to the same degree. However, agile methods, including Scrum and Extreme

Programming, had a slight higher amount of application. This shows that no software development methodology seems predominant in GSD to date. We therefore do not focus on a single development methodology.

Galvina and Smite (2011) analyzed the forms of distribution of software development processes to gain a better understanding of the influences of global distributed work on the software development process. They identified three different alternatives: strict phase separation, joint execution, and a hybrid approach. They then analyzed how the four phases (requirement engineering, design, coding and testing) were handled in various projects. Hybrid approaches were identified as the dominant process organization over the four phases. In a similar review of eight project reports, Rocha et al. (2011) analyzed the collaboration or distribution models for eleven different phases and tasks in software development. However, requirements, design, coding, and testing were the most often reported. The results of both studies support each other in terms of how commonly a phase was handled jointly or only by one partner. Coding was the phase most often handled by only one partner and predominantly by an outsourcing partner, while testing was handled in almost all cases as a joint effort. Requirements engineering and design were handled both jointly and separately (Galvina and Smite, 2011; Rocha et al., 2011).

Consequently, we will focus in our analysis on requirements engineering, design, coding, and testing. These four phases represent the most prominent and common phases in software development processes. They also exemplify phases with predominantly jointly, separated, and mixed approaches. Further phases, such as deployment and maintenance, are not taken into account in this study, as less information is available on their collaboration models. The additional phases should be analyzed in future research.

According to Dörr et al. (2008), the practices of requirements engineering can be classified under the categories of management, elicitation, analysis, specification and validation, and verification. During the full process, a high level of communication with the client is necessary. Additionally, it is important to understand the domain and culture of the client. Hoffmann and Lescher (2009) report that the majority of challenges in requirements engineering, especially in a global context, stem from people related (human) factors. Ralph and Wand (2009) defined software design as "a specification of an object, manifested by an agent, intended to accomplish goals, in a particular environment, using a set of primitive components, satisfying a set of requirements, subject to constraints." We hereby separate the software design from architecture design. This means that the software design looks at the realization of requirements, the presentation, and the usability rather than the technical infrastructure and architecture of the software. The implementation addresses the coding of the software or modules based on the requirements and software design. According to the guide of the software engineering body of knowledge (Abran et al., 2004), testing covers unit testing, integration testing, and system testing. We adopted this technical view on testing for our study. This means that testing in this paper refers to technical system testing and not user experience or acceptance evaluation.

In summary, we found that differences in the competence requirements of the various phases of GSD can be expected. These differing expectations are based on different forms of collaboration, different levels of technicality, and the differing proximity to the user. Requirements engineering, software design, coding, and testing represent the major phases with a substantial amount of research in terms of their levels of collaboration. However, how these differences in the phases relate to competence requirements in terms of soft competency has not been researched to our knowledge. Therefore, an analysis of differences in terms of competence importance for the four phases represents a first step toward identifying soft competency requirements for each of the phases.

3. Methodology

3.1. Research design

The presented research was conducted as a Delphi study (see Okoli and Pawlowski, 2004) with the aim of identifying soft competency requirements in GSD. Because such requirements in GSD lack theories, our research is exploratory. A Delphi study was selected to channel the varying opinions of experts in the domain. We use the previous research of Pawlowski and Holtkamp (2012) to analyze the competence requirement differences based on their internationalization competences. We applied a quantitative approach, rating the importance of selected competences for the different software development phases.

3.2. Participants

The participants of the study committed to participate before starting the data collection. The selection of the participants followed a five-step procedure based on Okoli and Pawlowski (2004). The five steps were as follows:

- **Preparation:** Identification of relevant stakeholders, organizations, and literature
- **Population:** Identification of relevant experts for each stakeholder group based on the identified organizations and literature
- **Nomination:** Initial contact to identified experts, including request for nomination of further experts
- **Ranking:** Categorizing identified experts to stakeholder groups and ranking the list for each stakeholder group
- **Invitation:** Inviting the highest-ranked experts for each stakeholder group until a pre-set limit is reached

In addition to the preselected participants of the Delphi study, further participants were solicited by email and postings in relevant discussion groups. By this, we were able to include the practical and scientific perspective into our study as well as different organizational hierarchy levels. This allows us to include the opinion of all involved stakeholders. In total, 32 people participated in our study. This number is relatively small, but despite this, statistically significant results were achieved because the hypothesized effects were large.

An overview of the participants can be found in Table 1. The majority of participants were from Finland, Canada, and Germany. All participants had at least 3 years of work experience in international

Table 1
Participant demographics

Gender	Male	28	87.5%
	Female	4	12.5%
Age	18–24	1	3.1%
	25–34	15	46.9%
	35–54	12	37.5%
	55+	4	12.5%
Education	High school degree	1	3.1%
	Vocational training	1	3.1%
	Bachelor's degree	7	21.9%
	Master's degree	16	50%
	PhD degree	6	18.8%
	Other	1	3.1%
Current position	Top-level executive	1	3.1%
	Director	5	15.6%
	Manager	1	3.1%
	Professional	24	75%
	Support personnel	1	3.1%
Country	Finland	12	37.5%
	Canada	6	18.8%
	Germany	5	15.6%
	Australia	2	6.3%
	Others (Brazil, Greece, India, Norway, Portugal, Slovenia, USA)	1 Each	Total 21.7%

software development projects. A maximum of two participants were selected from each organization to ensure that organization-specific aspects did not bias the results. Based on the selection of participants following our five-step approach, we were able to select participants based on the proximal similarity model. The level of similarity of people, places, and times to the overall population allows for a generalization of the results. According to Trochim and Donnelly (2008), the level of similarity depends on the relative similarity of people, places, and times. In our sample, we addressed this by selecting a wide variety of participants from various organizations, countries, and positions within the organization. In total, only two participants worked within the same context, meaning organization, place, and team. This approach widens the context of the participants of the study and thus increases the probability of similarity to the overall population. By combining these different contexts of participants, we ensure that the context has no major influence on the research results.

3.3. Data collection

The analyzed internationalization competences are based on previous work by Pawlowski and Holtkamp (2012). As the internationalization competencies represent a holistic set of competences required in international settings, general competences, important in any work environment, are included. For this purpose, we selected the competences with the highest importance and a clear international and intercultural focus. This ensured the applicability of each competence in the given context. Prior to the study, five GSD experts checked the list of competences to ensure validity and suitability. An online survey was created that presented a short definition of the phase and the list of competences. Participants were then asked to rate the importance of the selected internationalization competences for each of the presented phases of GSD. As the internationalization competences were tested by Pawlowski and Holtkamp (2012) for their importance in software and information systems development, it was expected that all selected competences would receive a positive rating, meaning above 4 (neutral). Therefore, a 7-point rating scale (from 1 = not at all important to 7 = extremely important) with the additional option of "not applicable" was selected for the measurement to ensure clearly visible differences (even if only results above 4 were expected). In addition to the importance rating, participants had the option to add competences they rated as important for the phase that were not listed among the internationalization competences.

3.4. Data analysis

The data was checked for missing values. Two missing values in the dataset regarding the implementation phase were identified. The other three phases did not include any missing values. Little (1988)'s MCAR test suggested that all values were missing completely at random, with no discernible patterns in the missing data. Consequently, missing values were replaced with linear interpolation, using the values of the other competences from the same phase. In the next step, extreme outliers were identified and removed from the data. A value was considered an outlier if it deviated from the 25th or 75th percentiles more than three times the length between the 25th and 75th percentiles. As a total, we identified one outlier in the requirements engineering phase, one outlier in the software design phase, three outliers in the implementation phase and no outliers in the testing phase.

Following the preparation of data, non-parametric Friedman tests (Friedman, 1937) were conducted to test the hypothesis that the competences have different importance ratings between the phases. Non-parametric testing was chosen instead of parametric (repeated measures analysis of variance) because the data were ordinal. While the tests consider mean ranks, we also report the means of the competences as their importance rating is better conveyed this way. Because of the number of competences and multiple repeated tests, the level of statistical significance was corrected from the standard $\alpha = 0.05$ to $\alpha = 0.01$ to reduce the familywise error rate and type I error probability. For all statistically significant results, a pairwise post hoc test, in which all pairs of phases were tested using the Wilcoxon signed rank test, was conducted. Statistically significant results of the Wilcoxon test indicated that the importance of a given competence was different among the compared phases. The effect size of the differences in the phases was calculated as the ratio of the mean change to the standard deviation of the change score (Morris and DeShon, 2002).

In the next phase of the analysis, a discriminant function analysis (DFA) was conducted on competences that had differing importance between the phases. DFA is a multivariate method that reveals latent structures within the independent variables and is useful in analyzing the main differences between the groups of the dependent variable (Bogler, 2002). In our analysis, the competences were independent variables or items, and the grouping variable represented the four phases. The resulting discriminant functions, presented as a set of standardized coefficients for the competences, can be used to classify the four phases and to produce a visualized representation, which shows how the phases are related to each other along the dimensions. Wilks's Lambda was used to assess the discriminating power of the functions, and statistically significant results were expected to confirm that the functions were able to discriminate the phases.

To prepare the data for the DFA, the competence importance levels were pooled across the four phases. This resulted in a dataset in which each respondent had four observations, one for each phase. While DFA is robust to violations based on skewness of the data, outliers in the independent variables may cause problems. To assess the homogeneity of covariance of the competences, Box's M test was conducted, resulting in rejecting the homogeneity of covariance (test score 126.62, $p < 0.001$). However, as outliers were removed in preparing the data, and the competences had an expected negative skew, we proceeded with the DFA. The analysis was conducted iteratively: the first iteration included all competences with statistically significantly different mean ranks between the phases. In subsequent iterations, variables were removed from the model to achieve better statistical fit but without changing the interpretation of the model structure.

The results of the DFA were presented to two focus groups consisting of 12 experts in GSD. The experts were participants of workshops on the topic of competence management in GSD. They were either project managers, team managers or HR managers in internationally operating software development companies from Finland and Germany. During the workshop, the experts were asked to find a consensus for a label of the discriminant function of competences.

4. Results

In this section, we present first the results of the Friedman tests, and then building on this, the results of the DFA. First, the Friedman tests are used to assess the proposition that the competences have different importance in different phases. After identifying statistically significant differences, we use DFA to answer whether individual competences reflect universal competence dimensions, which also have a different importance between the phases. These competence dimensions can be understood as functions or factors differentiating the phases.

4.1. Differing competence importance in the analyzed phases

In the following, we present the means of the competences for each phase and the results of a Friedman test for each competence. With the Friedman tests, we analyzed if the claim that internationalization competences have a different importance for requirements engineering, software design, implementation, and testing can be supported.

Table 2
Means and confidence intervals per competence and phase.

Competence	Mean [CI]			
	Req. engineering	Software design	Implementation	Testing
Ability to communicate sensitively, taking into account other personalities and cultures	5.94 [5.62–6.25]	5.52 [5.08–5.95]	5.00 [4.43–5.57]	5.32 [4.89– 5.76]
Ability to listen to others and consider their thoughts	6.36 [6.10–6.62]	5.97 [5.57–6.36]	5.52 [5.02–6.02]	5.52 [5.00–6.03]
Ability to understand other people's perspectives, needs, and values	6.23 [5.98–6.47]	5.68 [5.32–6.04]	5.00 [4.42–5.58]	5.52 [5.00–6.03]
Ability to share information and knowledge with the team	5.84 [5.32–6.36]	6.19 [5.89–6.50]	6.00 [5.69–6.31]	5.80 [5.34–6.27]
Ability to manage diversity in the team to enable everyone to contribute and participate	5.45 [5.09–5.82]	5.77 [5.48–6.07]	5.55 [5.22–5.87]	4.45 [3.93–4.98]
Ability to adapt and adjust strategies, goals and plans according to the situation	5.48 [4.98–5.99]	5.80 [5.41–6.20]	5.39 [4.92–5.86]	4.48 [3.99–4.98]
Ability to use other people's expertise and knowledge	5.81 [5.38–6.23]	5.81 [5.42–6.19]	5.87 [5.52–6.22]	5.61 [5.24–5.99]
Understanding of the influences and implications culture has in work life	5.26 [4.84–5.68]	5.13 [4.75–5.51]	4.29 [3.72–4.86]	4.52 [3.97–5.07]
Foreign language skills (e.g., English, speaking a "common" language)	6.10 [5.75–6.44]	6.00 [5.61–6.39]	5.42 [4.98–5.86]	5.45 [4.90–6.00]
Ability to evaluate perspectives, practices, and products from multiple cultural perspectives	5.68 [5.22–6.14]	5.16 [4.75–5.58]	4.42 [3.89–4.95]	5.29 [4.82–5.77]
Understanding and knowledge of own culture and its implications	5.19 [4.72–5.67]	5.00 [4.58–5.42]	4.16 [3.53–4.69]	4.68 [4.16–5.20]
Understanding of importance and limitations of different information sources	5.36 [4.80–5.91]	5.25 [4.86–5.66]	5.00 [4.48–5.52]	4.84 [4.25–5.43]

Table 3
Friedman test for each competence.

Competence	$\chi^2(3)$
Ability to communicate sensitively, taking into account other personalities and cultures	11.56**
Ability to listen to others and consider their thoughts	14.05**
Ability to understand other people's perspectives, needs, and values	12.60**
Ability to share information and knowledge with the team	3.75
Ability to manage diversity in the team to enable everyone to contribute and participate	24.50***
Ability to adapt and adjust strategies, goals, and plans according to the situation	21.65***
Ability to use other people's expertise and knowledge	2.25
Understanding of the influences and implications culture has in work life	17.03***
Foreign language skills (e.g., English; speaking a "common" language)	13.64**
Ability to evaluate perspectives, practices, and products from multiple cultural perspectives	16.17***
Understanding and knowledge of own culture and its implications	17.76***
Understanding of importance and limitations of different information sources	4.76

χ^2 = Friedman test result with df = 3.
** $p < 0.01$.
*** $p < 0.001$.

This means by analyzing the means and conducting the Friedman tests, we are able to show if statistically significant differences between the phases can be identified.

The means and 95% confidence intervals of the competences (overall and between the phases) are shown in Table 2. The results of the Friedman tests are listed in Table 3. We failed to reject the null hypothesis (no difference in importance between the phases) for three competences: "Ability to share information and knowledge with the team," "ability to use other peoples expertise and knowledge," and "understanding of importance and limitations of different information sources." When looking at the means for these three competences, we see that the maximum mean difference between two phases for the "ability to share information and knowledge with the team" is 0.39; for the "ability to use other people's expertise and knowledge", it is 0.2. This indicates that the competences are seen as rather equally important in the analyzed phases. For the "understanding of the importance and limitations of different information sources", the difference of the mean values is greater, but the difference of mean rank is not statistically significant. The other competences had statistically different importance rankings between the phases. Mean ranks are not reported here as Table 2 provides relevant information for interpreting the differences. For example, the estimated means of "ability to manage diversity in the team to enable everyone to contribute and participate" are compared with the mean ranks: 2.6 for requirements engineering, 2.9 for software design, 2.8 for implementation, and 1.7 for testing (these are significantly different, $\chi^2(3) = 24.495$, $p < 0.001$).

Regarding the three competences without statistically significant mean rank differences, the means of the three competences indicate that the competences were still rated as important for all four phases. This indicates that the competences were seen as equally important for the phases and that they are required on a similar level in all four phases. For all other competences, a statistically significant difference could be found. In particular, the "ability to manage diversity in the team to enable everyone to contribute and participate" and the "ability to adapt and adjust strategies, goals, and plans according to the situation" seem to represent major differences between the analyzed phases.

Based on the means, we can already identify that the importance for internationalization competences seems to be higher in requirements engineering and software design and lower in implementation and testing. In requirements engineering, the "ability to listen to others and consider their thoughts", the "ability to understand other people's perspectives, needs and values", and "foreign language skills" were seen as the most important competences. In the three other phases, the "ability to share information and knowledge with the team" received the highest importance. As previously identified, no statistically significant difference could be identified for this competence as it is seen as equally important for all four phases. For requirements engineering, software design, and implementation, the "understanding and knowledge of own culture and its implications" was seen as the least important competence. In testing, the "ability to manage diversity in the team (. . .)" was seen as least important.

To get a better understanding of the differences between the phases for each competence, a pairwise comparison was conducted. With the help of the pairwise comparison, we can identify **which phases have a statistically significant difference for each competence**.

The results of the pairwise comparison for each competence are presented in Table 4. For easier readability, we present only the statistically significant differences. Hereby, just negative differences are displayed. This means for all cases, Phase 1 has a higher value than Phase 2 for the presented competences. The effect size of the change was between 0.5 and 0.9 in all mean differences, and therefore the effect size of phase on importance of the listed competences can be considered to be from medium to large (Cohen, 1992).

The pairwise comparison showed that for all significant differences including requirements engineering, the importance of the competence was higher in requirements engineering. In contrast to this, for testing, the importance of the competence was always lower than in the phase it was compared to. When looking at the phases, we can identify a clear order in terms of importance of internationalization competences: requirements engineering, software design, implementation, and testing. This can be explained by the proximity to the user. While implementation and testing are more technical tasks, requirements engineering and software design are closer and

Table 4
Post hoc pairwise comparisons of competences between the phases. Only statistically significant comparisons are displayed.

Competence	Phase 1 (i)	Phase 2 (j)	Mean difference ($i - j$)	Z
Ability to communicate sensitively, taking into account other personalities and cultures	Req. engineering	Implementation	0.94	−2.86**
Ability to listen to others and consider their thoughts	Req. engineering	Implementation	0.84	−2.95**
	Req. engineering	Testing	0.84	−3.10**
Ability to understand other people's perspectives, needs, and values	Req. engineering	Software design	0.55	−3.08**
	Req. engineering	Implementation	1.23	−3.36***
Ability to manage diversity in the team to enable everyone to contribute and participate	Req. engineering	Testing	1.00	−3.17**
	Software design	Testing	1.32	−3.79***
	Implementation	Testing	1.10	−3.50***
Ability to adapt and adjust strategies, goals, and plans according to the situation	Req. engineering	Testing	1.00	−2.97**
	Software design	Testing	1.32	−3.88***
	Implementation	Testing	0.90	−3.03**
Understanding of the influences and implications culture has in work life	Req. engineering	Implementation	0.97	−3.22**
	Req. engineering	Testing	0.74	−2.63**
	Software design	Implementation	0.84	−3.00**
Foreign language skills (e.g. English, speaking a "common" language)	Req. engineering	Implementation	0.68	−2.79**
Ability to evaluate perspectives, practices, and products from multiple cultural perspectives	Req. engineering	Implementation	1.26	−3.53***
Understanding and knowledge of own culture and its implications	Req. engineering	Implementation	1.03	−3.49***
	Software design	Implementation	0.84	−3.11**

Z = Wilcoxon test Z-statistic.
** $p < 0.01$.
*** $p < 0.001$.

more related to users and their individual needs. Therefore, the understanding of the user, their perspective, needs, and culture seem more important.

In total, seven statistically significant differences between requirements engineering and implementation were identified. Only the "ability to manage diversity in the team (...)" and the "ability to adapt and adjust strategies, goals and plans (...)" showed no statistically significant differences in terms of competence importance between requirements engineering and implementation. For all other competences, a statistically significant difference could be identified.

Two competences showed statistically significant differences between software design and implementation. Here, the "understanding of the influences and implications culture has in work life" and the "understanding and knowledge of own culture and its implications" represent the differences in terms of competence requirements between the phases.

The comparison of testing and implementation showed also two competences with statistically significant differences in terms of importance of the competence between the two phases. These were the "ability to manage diversity in the team (...)" and the "ability to adjust strategies, goals and plans (...)". This indicates that implementation and testing are seen as similar in terms of intercultural competence requirements. The same applies for the differences between software design and testing.

When looking at the single competences, we identified that the "ability to manage diversity in the team (...)" and the "ability to adapt and adjust strategies (...)" are the competences with the largest differences between the phases. Hereby, we can identify that these competences are less important in testing than in all three other phases. The "understanding of the influences and implications culture has in work life", the "ability to evaluate perspectives, practices, and products from multiple cultural perspectives", and the "understanding and knowledge of own culture and its implications" represent the main differences between requirements engineering and implementation. This indicates that intercultural competences are not seen as being as important in the coding of the software product as in the gathering of requirements.

Summarized, we identified a variety of statistically significant differences in the importance of internationalization competences in the phases of requirements engineering, software design, implementation, and testing. In particular, competences related to the understanding of cultural differences represented a difference between requirements engineering and implementation. Managing diversity in the team and adapting strategies differentiate testing from the three other phases. The understanding of other people's perspectives, values, and needs and a general understanding of culture mainly differentiate software design and implementation.

The existence of significant difference in terms of competence importance between the phases raises the question if we can identify underlying dimensions or factors representing these differences. To better understand the underlying factors representing the differences between the four phases, we conducted a DFA using the results of the Friedman tests. The results of the DFA are presented in the next section.

4.2. Functions differentiating the competence requirements

In order to identify functions that represent the differences between the GSD phases with respect to the required internationalization competences, we conducted a DFA. The three competences with non-significant Friedman tests for differing importance between the competences were excluded from the DFA. The aim of the DFA was the identification of a minimum of two meaningful and statistically significant **discriminant functions**. Therefore, a very explorative approach was taken to analyze the data. Subsequently, three iterations of an exploratory DFA were conducted. As a result of the first iteration, which indicated just one statistically significant discriminant function, "foreign language skills" was removed, as the Wilk's Lambda for this competence was not statistically significant ($\Lambda = 0.936$, $p = 0.046$). In the second iteration, the "ability to communicate sensitively taking into account other personalities and cultures" and the "understanding and knowledge of own culture and its implications" were eliminated from the analysis as only one statistically significant discriminant function could be identified and they represented the variables with the highest lambda scores ($\Lambda = 0.926$, $p = 0.026$ and $\Lambda = 0.919$, $p = 0.017$). Additionally, their removal did not change the interpretation of the function.

Table 5
Test of equality of group means.

Competence	Wilk's Lambda	*F*	Sig.
Ability to listen to others and consider their thoughts	0.915	3.72	0.013
Ability to understand other people's perspectives, needs, and values	0.882	5.33	0.002
Ability to manage diversity in the team to enable everyone to contribute and participate	0.808	9.49	<0.001
Ability to adapt and adjust strategies, goals, and plans according to the situation	0.868	6.11	0.001
Understanding of the influences and implications culture has in work life	0.912	3.86	0.011
Ability to evaluate perspectives, practices, and products from multiple cultural perspectives	0.885	5.18	0.002

Table 6
Structure matrix.

Competence	Function	
	1	2
Ability to manage diversity in the team to enable everyone to contribute and participate	0.71	
Ability to adapt and adjust strategies, goals, and plans according to the situation	0.52	0.56
Ability to understand other people's perspectives, needs, and values		0.81
Understanding of the influences and implications culture has in work life		0.75
Ability to listen to others and consider their thoughts		0.74
Ability to evaluate perspectives, practices, and products from multiple cultural perspectives		0.66

In the third iteration, three discriminant functions were identified. The first two discriminant functions were statistically significant with function 1 $\Lambda = 0.619$, $\chi^2(18) = 56.67$, $p < 0.001$, and function 2 $\Lambda = 0.848$, $\chi^2(10) = 19.41$, $p = 0.035$. The third discriminant function was not statistically significant, $\Lambda = 0.990$, $\chi^2(4) = 1.19$, $p = 0.88$. The percentage of variance in the competences accounted for by function 1 was 67.7% and by function 2 was 30.4%. Functions 1 and 2 together explain 98.2% of the variance between the competences, indicating a good fit for two-dimensional analysis. The Wilk's Lambda of all variables was statistically significant (*F*-tests conducted with df1 = 3 and df2 = 120); see Table 5.

Based on these findings, we examine functions 1 and 2 in more detail. Table 6 presents the structure matrix of the functions 1 and 2. The results show that the "ability to manage diversity in the team to enable everyone to contribute and participate" and the "ability to adapt and adjust strategies, goals and plans according to the situation" represent function 1. The latter of these items has a strong cross-loading on the second function also, which demonstrates that the functions are closely related to each other. However, while the correlation of the item with the second function is understandable, its content is more closely related to the first function. The "ability to understand other peoples' perspectives, needs and values", the "understanding of influences and implications culture has in work life", the "ability to listen to others and consider their thoughts", and the "ability to evaluate perspectives, practices, and products from multiple cultural perspectives" are part of function 2. The structure matrix presented in Table 6 also shows the importance of each competence for the function. Hereby, we removed all values smaller than 0.5 for easier readability and judgment of importance.

The functions were presented to two focus groups consisting of managers of GSD companies. Focus group one consisted of five managers, and the participants were presented with the functions and asked to identify **labels for the function**. After discussing the functions, the focus group came to the consensus to label the functions as "Adaptability" for function 1 and "Cultural Awareness" for function 2. The second focus group consisting of six managers were also presented with the functions. They identified "Cultural Awareness" as a suitable label for function 2. However, they did not find a consensus for function 1. After receiving the results of focus group 1, the participants of the second focus group agreed to the label "Adaptability" for function 1. A group plot was used to present the functions graphically. The group plot is presented in Fig. 1.

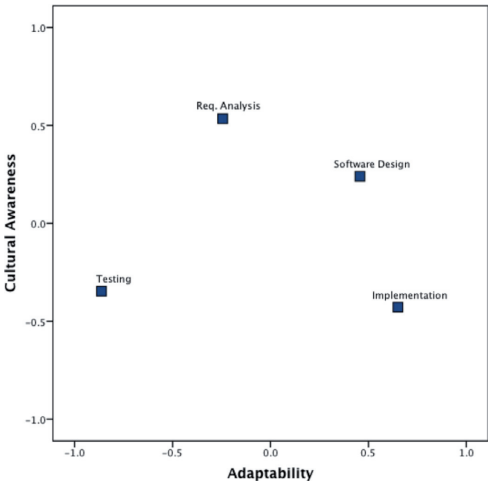

Fig. 1. Differences of the phases according to the DFA.

Fig. 1 shows that software design and implementation are very close in terms of "Adaptability" while requirements engineering and testing have a bigger difference for these. However, when looking at the results of the Friedman tests, we see that for the competences of "Adaptability", no statistically significant differences between requirements engineering and software design and implementation could be found. In terms of "Cultural Awareness", we identified that requirements engineering requires the highest level followed by software design. Testing and implementation have a very similar level in terms of "Cultural Awareness".

In brief, we identified that the "Adaptability" and "Cultural Awareness" represent significant differences between the four analyzed phases. "Adaptability" in particular is important for software design and implementation and less important for testing. "Cultural Awareness" is more important for requirements engineering and software design than for testing and implementation.

4.3. Consolidation of the results

The Friedman tests and the DFA have shown significant differences in the importance of internationalization competences in requirements engineering, software design, implementation, and testing. The results of both analyses indicate that intercultural competences seem to be specifically important in tasks with a high level of communication. We identified that nine of the twelve analyzed competences had differences in their importance for the four phases. Only the competence related to sharing knowledge, using other peoples' expertise, and judging information sources were seen as equally important among the phases. A deeper analysis showed that the majority of competences represented differences between requirements engineering and either testing or implementation. However, we were able to identify differences between all phases. This raised the question if

we can identify functions differentiating the phases. We identified that the two functions "Cultural Awareness" and "Adaptability" were representing the differences between the phases. We also identified that tasks with a closer proximity to the user required a higher level of internationalization competences. This can be identified in the analysis of the differences for each competence but also in the discriminant function "Cultural Awareness".

The further away a task was from the user or client and the more a pure engineering problem was to be solved, the less important competences related to intercultural aspects became. Instead, the level of collaboration within the team became the predominant factor for these phases. Software design and implementation needed a high level of competences related to managing the diversity of the team and adjusting strategies, which the DFA connected as the function "Adaptability". However, the overall high means across phases showed that even for the functions with statistically significant differences, the included competences seem relevant for all phases. The difference rather lies in the level of relevance and importance.

5. Discussion

With the help of Friedman tests and DFA, we identified significant differences between requirements engineering, software design, implementation, and testing in terms of importance of internationalization competences and soft competences. The **importance of competences** for each of the phases is tightly connected to the competence requirements of the phase. If a competence is seen as very important, it should be included in the required competences. However, according to our competence definition, the context in which the competence is used plays a major role. Therefore, the results just represent a guideline and do not have to hold true in every possible situation.

In general, all competences were seen as important for all phases. This was expected as the internationalization competences were already validated by Pawlowski and Holtkamp (2012) based on their importance for global software and information systems development. The importance of most competences was rated between five (important) and six (very important) with only a few exceptions in either direction. However, all competences were rated over four, which represents the neutral rating.

Holtkamp and Pawlowski (2014) identified in their research that the technicality of the task, the expected level of innovation, and the level of collaboration have a significant influence on both the importance of internationalization competences and the need to adapt competences to the context. Based on Holtkamp and Pawlowski (2014), the **technicality of the task** has a negative influence and the **expected level of innovation and collaboration** has a positive influence on the importance of internationalization competences. When looking at the descriptions of the four phases, we can identify that requirements engineering has the highest level of collaboration, software design the highest level of innovation, and implementation and testing the highest level of technicality. This is in accordance with Capretz and Ahmed (2010), who analyzed the soft skill requirements and personality types for the major job descriptions in software development. They identified that a software analyst needs mainly communication and interpersonal skills and a software designer needs stronger analytical and innovation skills. In contrast to this, a software programmer needs the ability to work independently and a software tester needs organizational skills. Both programmer and tester need a focus on details. Our results indicate that internationalization competences are most important in requirements engineering followed by software design. While still important, implementation and testing have lower internationalization competence requirements. This supports the findings of Holtkamp and Pawlowski (2014) empirically. However, the concrete influence of the factors to the importance of internationalization competences still has to be analyzed.

In his research on requirements for job applicants in job advertisements, Fernandez-Sanz (2009) identified that only for 16% of the programmer jobs soft skills were required. For jobs related to the analysis phase of the development project, 25% of job advertisements explicitly mentioned soft skills. This indicates that soft skills are seen as more important in the **analyzing phase** of the project and less in the actual technical realization, in accordance with our results. However, the study by Fernandez-Sanz (2009) also indicates that the awareness of the importance of soft skills and competences is still lacking in practice or organizations are unaware how to address the soft competency requirements. In a similar study, Matturro (2013) analyzed job advertisements in Uruguay for their **soft skill requirements** and their connection to requirements engineering, software design, software construction, and testing. He identified that English skills, teamwork, and proactive behavior were the most often required soft skills over all four phases. English skills were the most mentioned soft skill for each of the phases. While foreign language skills were also seen as important for all phases in our analysis, we were able to identify significant differences among the phases and show that foreign language skills are seen as more important in requirements engineering and software design than in implementation and testing. This again shows that organizations creating the job advertisements might not be aware of the concrete soft competency requirements.

The findings of Rocha et al. (2011) and Galvina and Smite (2011) indicate that implementation is rarely approached in a joint effort with external partners, while testing was often handled collaboratively. This contradicts our definition and findings. However, as neither Rocha et al. (2011) nor Galvina and Smite (2011) defined testing, it is not possible to check for the same understanding. While we addressed testing from a technical perspective, the results for user experience or user interface evaluation might differ drastically.

Requirements engineering is seen as the task of software engineering with the highest amount of communication and interaction between people (Penzenstadler et al., 2009). This is represented in the fact that the "ability to listen to others and consider their thoughts" and the "understanding of other people's perspectives, needs and values" have the highest mean importance for the requirement engineering. Also, "foreign language skills" and the "ability to communicate sensitively, taking into account other personalities and cultures" were among the highest rated internationalization competences for requirements engineering. For **implementation**, the "ability to use other peoples' expertise and knowledge" and the "ability to share information and knowledge with the team" were seen as the most important competences. This reflects the findings of Capretz and Ahmed (2010) who identified that a software programmer has to be able to solve complex problems and be detailed oriented. Therefore, a high level of technical knowledge is necessary, which should be shared with peers.

This might be related to the **differences of implementation and testing**. We could only identify differences in terms of the "ability to manage diversity in the team to enable everyone to contribute and participate" and the "ability to adapt and adjust strategies, goals and plans according to the situation". The importance was rated significantly higher for implementation than for testing. This indicates that implementation might deal with a higher extent of teamwork and more frequent changes in the work environment. This finding might have its foundation in the nature of work of the two phases. According to the Software Engineering Body of Knowledge (Abran et al. 2004), implementation is the process of creating modules of software. This emphasizes that in today's complex software development projects no single developer is able to handle the workload. Instead, the entire team has to work together by deconstructing the entire software solution in smaller modules. This need for collaboration might increase the importance to enable everyone to participate in the work. In the development process, requirements can change based on the input of stakeholders, which requires a higher amount of flexibility in terms of

own work. The high importance of competences in terms of "Adaptability" might be caused by the fact that the changes in the work environment are not self inflicted but come from an external source. In software testing and in particular in technical systems testing, test engineers commonly repeat seemingly independent smaller test runs while test managers oversee the entire test process. Additionally, tests are commonly well designed in the early stages of the development process. Instead of changing tests, changing requirements might lead to additional tests.

5.1. Theoretical contribution

The results of our study describe several important contributions to the current discussion of GSD. These contributions are:

- confirming the assumption of importance of soft competences in GSD;
- identification of difference in terms of soft competence requirements for the different phases of GSD; and
- identification of functions representing differences between the phases.

While the **importance of soft competences in GSD** is commonly assumed in previous research, rarely efforts are taken to gain a deeper understanding of the soft competences relevant in the given context. In fact, in most cases, GSD is seen as a single entity with differences in terms of tasks and phases not taken into account.

While GSD is commonly referred to as a single entity that addresses performance aspects and the competitive advantage of the organization, our study emphasized that a more detailed analysis of the different tasks and phases within the GSD process is required. Just this more fine granular analysis can lead to a holistic understanding of the phenomenon. Our results represent the first step toward an understanding of concrete **soft competence requirements** within the various phases of GSD. While specific phases of software development, such as requirements engineering, were analyzed in more detail, no comparison of the phases and tasks has taken place.

Based on the competence requirement differences, distinct meaningful **functions explaining the differences** between the phases could be identified. Both results indicate that the mindset of treating GSD as a single entity is not suitable when discussing the effects of competences in GSD. It can be assumed that the findings would be similar for other influence factors of the GSD success such as managerial support and processes. Therefore, the research opens an important section toward understanding the microfoundations of competitive advantage and survival of organizations in GSD.

5.2. Limitations

Based on the research design, the small amount of participants represents a major limitation of our research. However, as the nature of our research is explorative, the small sample size allows us to achieve a first understanding that competences are relevant in the different phases of GSD. Additionally, despite the small sample size, statistically significant results with medium to large effect sizes were achieved. This finding provides a starting point for future studies concerning the topic. In our research setting, we used experts of GSD as participants. However, it can be assumed that not every participant is an expert in every phase of the software development process. Limited experiences in a specific phase could bias the results.

Based on the explorative nature of the research, a limited amount of competences were taken into account for the analysis. Additionally, competences were removed in an iterative process to achieve meaningful discriminant functions. Additional studies are required to confirm the findings when taking other competences into account. Further data collections, such as longitudinal data or qualitative data, have the potential to explain and enrich the results. Especially in terms of explaining the identified differences or identifying reasons for the differences.

5.3. Directions for future research

As an explorative study, the results of our research provide implications for future research and practical application. As the analysis has taken place with a very limited set of competences and a small sample size, additional confirmative studies with varying competence sets and a larger sample should take place. Now that plausible discriminative functions have been presented and the average effect size of the difference between the phases established, further research can be founded on a stable set of assumptions and predictions.

As addressed earlier, the results of our study open a variety of different new research fields and implications for future research. Soft competences commonly assumed to be highly important to GSD can and should be further analyzed to gain a holistic understanding of the **importance of competences** within the GSD process. For this purpose, it is not only important to analyze which competences are relevant in the various phases of GSD but also how these competences affect the **job performance** for the different stakeholders. The results of this research can lead to clearly defined competence frameworks for the various tasks in GSD including soft competences and can support organizations in their **competence management** and team building.

An additional highly relevant strain of research would be the analysis of the **relation of competences and the various development processes**. Here in particular the question of how the development process influences the competence requirements in the various phases might be highly interesting. As more and more organizations are striving toward agile development methods, we are still uncertain about the requirements to apply these kinds of methods. Competences might have a strong influence on the success of applying agile methods based on a higher demand in terms of communication and flexibility. Thus, analyzing the relationship between competences and the development process might result in decision support mechanism for the selection of development processes.

Human-centered and user-centered design and development is a more and more relevant topic for many organizations in software development. The aim is to achieve the highest possible fit between user requirements and expectations and the final software solution. It can be assumed that a team of developers with higher soft competences would achieve a higher level of fitness. However, an interesting strain of research would be the analysis of how a human-centric development approach would affect the competence requirements. Are soft competences becoming more important? Or are the differences between the phases shrinking?

5.4. Practical implication

From a practical perspective, focus groups and training sessions with team leaders and human resource management of GSD organizations showed that while importance of soft competences is recognized, the concrete competences relevant in their context are unknown to the companies. In their human resource management processes and in particular in their **competence management,** organizations are not able to focus their activities on the relevant competences. For example, in hiring, instead of hiring employees with targeted soft competences for the organizations and positions requirements, standard competences—such as communication skills, presentation skills, and willingness to learn—are used. The same can be argued about the competence development within organizations. The presented results give an indication for HR managers of which soft competences should be considered in the hiring process for the varying positions in the GSD process. The results indicate that a

different set of soft competences might be relevant for a requirements engineer than for a tester.

Additionally, the results provide valuable input in the process of **team building**. A functional and high-performing team should include the suitable competences to cover the envisioned development process. Here, the common selection of team members based on technical competences is predominant. However, it can be assumed that the full competence orchestration of team members not only influences the success of the development process but might have a strong influence on the best suitable development process itself. The results indicate the importance of soft competences and give a suggestion of which competences the different team members should possess.

Summarized, the results of our research represent a first step toward supporting organizations in their striving for structured competence management, giving them tools to develop or improve their own **competence frameworks and job descriptions**. This will allow organizations to streamline their activities in terms of hiring, team building, and competence development.

Similarly, in **educational programs** soft competences in particular for global working are rarely addressed. The focus is mainly on the technical competences, which leads to graduates not fitting the requirements of the labor market. Our results allow educational institutions to adapt the curricula and syllabi toward including soft competences. Hereby, the differentiation between phases is crucial as the suitable soft competencies should be included in the appropriate courses. When looking at IT-related curricula, we can identify that competences are addressed in additional courses, if at all. However, our results indicate the importance of aligning soft competences with the software development process. It seems important to teach the soft competences within the context of the software development tasks. This means that a course covering requirements engineering should also address the appropriate soft competences.

6. Conclusion

By identifying the differences in competence importance and thus competence requirements between the four main phases of GSD and identifying a set of concrete competences relevant for the phases, we confirmed that soft competencies are highly important for all phases of GSD. However, our findings indicate that the importance of soft competences as well as the selection of competences is strongly dependent on the concrete tasks within the software development life cycle. Our results indicate that a more detailed analysis of soft competences in GSD is required to fully understand the importance of soft competences and their influences on the GSD process.

We identified that “Adaptability” and “Cultural Awareness” differentiate the phases of requirements engineering, software design, implementation, and testing. We showed that the more collaborative and innovative phases need a higher amount of soft competences than the technical phases. However, soft competences are also seen as important for the technical phases. The results should be understood as a first indication of differences.

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VII

MODERATION EFFECT OF INTERCULTURAL COMPETENCY ON THE INFLUENCE OF SOFTWARE DEVELOPMENT COMPETENCY ON THE IN-ROLE JOB PERFORMANCE

by

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Moderation Effect of Intercultural Competency on the influence of Software Development Competency on the in-role Job Performance

Abstract

While it is recognized that competencies have a major effect on the performance of individuals and software quality, the understanding of the relation between competencies and Job performance within global software development (GSD) is lacking. Here, in particular, the importance and effect of soft competencies, competencies without an IT focus, has not been researched sufficiently. As previous research has indicated a relation between software development competency and intercultural competency in terms of adapting working styles and behaviors to the work context, this research aims to identify the effect of these competencies on job performance as well as the moderation effect between the two competencies. The results indicate that software development competency significantly influences lob performance; no support for the influence of intercultural competency was found. However, a negative moderation effect between the competencies was identified. Hereby, a nonlinear function described the significant influences best.

Keywords: Software Development Competency, Intercultural Competency, Job performance, Global Software Development

Introduction

Software development organizations continue to strive for a globalization of their production to gain a competitive advantage through cost reduction, increased productivity [55], and round-the-clock production [9]. However, the increasing literature on challenges of global software development (GSD) [64, 42, 43] indicates that a variety of problems hinder organizations from reaching their goal. Within their literature review, Smite et al. [56] identified that 54% of the analyzed research articles are problem reports. This indicates that software development organizations require support in reaching their goals through globalization.

While a growing amount of literature addresses different aspects of global software development such as processes in global settings [47, 50] and coordination activities for globally distributed teams [38, 15], the knowledge about the requirements for and importance of individuals in these virtual global work environments is lacking [60]. Accordingly, competencies and skills as influence factors on individual job performance and thus on the organizational outcome have been less addressed. Researchers have identified the importance of individual competencies in software development [35, 44], but the competency requirements and their influences in particular for soft competencies – a term used for creative or behavioral competencies not directly addressing tasks associated with the job [24] – are not researched sufficiently [13].

Through the globalization of software development, competency requirements change and previously suitable competences have to be adapted to the new context [52]. Different influence factors such as the technicality of tasks, the expected level of collaboration and innovation, and the application domain influence this adaptation of competences [23]. For the adaptation of competences, hard competences – competences directly associated with the tasks at work as the opposition to soft competences [24] – can be adapted through the evaluation of working styles

and behaviors applying soft competences [22]. In a global setting, in particular, intercultural competences [19] can be applied to adapt technical (software development) competences to the context [22]. While the Intercultural competency construct is established in various different research fields [19], no suitable Software development competency construct could be identified in the literature.

Especially in human resource management and organizational psychology, relations between individual competency and individual and organizational performance have been addressed [21]. The competence-performance theory (CPT) relates a competence space to a task space in the sense that an individual with competences should be able to handle the tasks [30, 31]. This competence space combines hard competences and soft competences.

This paper aims to explain differences in in-role job performance with different competency levels in terms of intercultural competency and software development competency. Based on the notion of competence adaptation and the influence of work context on the competency requirements, this paper also analyzes if intercultural competency moderates the effect of software development competency on in-role job performance. Our analysis shows that software development competency has a signification effect on the job performance of individuals while a significant effect of intercultural competency could not be confirmed. Furthermore, the analysis indicates the existence of a negative moderation effect of intercultural competency on the effect of software development competency on job performance. Hereby, the significant effects were found to be nonlinear.

Theoretical Background

The value of individual competency in GSD

Competency, commonly understood as a collection of skills, knowledge, and attitudes to solve a problem in a given context [45], can be differentiated into hard competency and soft competency [24]. Hereby, hard competency refers to analytical competencies, while soft competency includes aspects of creative and behavioral competencies. Within software development, hard competency accordingly describes the technical competences required to fulfill the job. In contrast to competency, competence should be understood as a single skill, knowledge item, or attitude [45]. Although researchers have identified the importance of individual competencies in software development [35, 44], only few studies have conceptualized and empirically measured relevant individual competencies as well as their influence on individual performance. Rivera-Ibarra et al. [51] identified that competences applied by software developers strongly influence software quality. Ryan and O'Connor [53] add that, in particular, the application of competences to solve a specific problem has a strong effect on software quality. Holtkamp et al. [22] identified that individual competences are essential to prevent and overcome various challenges of GSD. This is supported by Espinosa et al. [16], who found that temporal distance, a commonly addressed origin of challenges of GSD, doesn't directly affect team performance but indirectly through disruptions of team interaction. While the importance of competencies is recognized, the effect of competencies on the performance of team members is rarely addressed. To assess the value of individual competency in GSD, a wide competency construct is required, as the tasks might differ between the various GDS settings and projects [4].

The globalization of software development has had strong implications on the required competencies of individuals. Romero et al. [52] identified three different categories of competences in GSD: competences not affected by GSD, competences affected by GSD, and competences emerging from GSD. This is in line with the findings of Holtkamp et al. [22], who identified that the technicality of the task and the expected level of collaboration have an influence on the importance of internationalization competency. This indicates a first step toward differentiating competences affected by GSD and competences not affected by GSD.

While Ramasubbu and Krishna Balan [49] state that the identification of competency requirements will be a significant step toward governance schemes for distributed software development projects, Colomo-Palacios et al. [13] identified that soft competency requirements have not been researched sufficiently. As an answer to this, Holtkamp et al. [22] identified that the internationalization competency, a set of soft competences relevant in international and intercultural work environments, is more important in tasks closer to the end users, such as requirements engineering and software design, than in more technical tasks, such as coding and system testing.

Summarized, through our literature review we identified that individual competencies are understood to have a high value in GSD and that the human actors are a driving factor for software quality and project success. Additionally, GSD changes the competence requirements and some competences might change in the context of GSD.

The value of individual Job performance in GSD

Individual performance, or individual job performance, commonly refers to how well an individual handles tasks at work. In organizational psychology, job performance is defined as

"the total expected value to the organization of the discrete behavioral episodes that an individual carries out over a standard period of time" [40]. Thus, job performance of an individual is directly linked to the organizational success and performance. Campbell [8] described the most influential model of job performance by defining eight distinct behavioral dimensions. These are job-specific task proficiency, non-job-specific task proficiency, written and oral communications, demonstrating effort, maintaining personal discipline, facilitating team and peer performance, supervision, and management and administration.

Based on the work of Campbell [8], Schmitt et al. [54] differentiated between task performance, contextual performance, and adaptive performance. *Task performance* refers to "role-prescribed behaviors" [27], which directly contribute to the technical core (transformation of materials in organizational products) of an organization [7]. *Contextual performance* refers to behaviors that support the environment in which the task is performed [7]. Herby, contextual performance can be split into job dedication, such as motivation, and interpersonal facilitation, such collaborative and supportive activities [59]. *Adaptive performance* describes the required "versatility and tolerance for ambiguity" in tasks [54]. It thus addresses aspects such as crisis management, stress handling, creative problem solving, interpersonal adaptability, and cultural adaptability [48].

While task-related performance and job dedication has been shown to be predictable by abilities [54], dispositional variables might lead to better results to predict adaptive performance [36] and interpersonal facilitation [54]. Here, the abilities can be understood as hard competencies and dispositional variables as soft competencies.

Relating the research from the field of psychology to GSD, we can conclude that task-related performance of an individual has a direct influence on the value-added processes of an organization while contextual performance and adaptive performance relate more to how well an

individual handles the global distribution of the work, and thus have an indirect influence on the organizational outcome. As task-related performance is a key driver for organization success, we thus focus on it in our research.

Theoretical Model and Hypotheses

Conceptualizing the Competency constructs

Software development competency describes the hard competency required to fulfill technical tasks in development projects. Hereby, software development competency covers the entire software development process. It is important to develop a wide Software development competency constructs, as the tasks may vary in different projects [4]. From a wide perspective, software development competency should be understood as a collection of competencies required to fulfill technical tasks within a software development project. Thus, for a definition of software development competency, an analysis of tasks and related competences is required. As no suitable Software development competency construct was found, a new construct was operationalized. The process of the conceptualization and operationalization of this software development competency construct is described in the methodology section of this paper. Through this process, ten sub-constructs – "Architecture Design," "Database Management," "Implementation," "Integration, Deployment and Maintenance," "Management," "Network," "Requirement Analysis and Specification," "Security," "Software Design," and "Testing" – were identified. Software development competency can be defined as the collection of these sub-constructs.

Intercultural competency is widely applied in various research domains. Through an interdisciplinary literature review, Graf and Mertesacker [19] showed that intercultural

competency can be differentiated into the three constituent parts: cognitive, affective, and behavioral aspects. The affective parts of intercultural competency are usually split into two different aspects, intercultural sensitivity and open-mindedness [19]. Bhawuk and Brislin [6] state that intercultural sensitivity is usually defined "as a sensitivity to the importance of cultural differences and to the points of view of people in other cultures." open-mindedness is the impartial attitude toward different cultures, the interest for different cultures, and positive attitude toward other opinions and ideas [1].

Behavioral aspects of intercultural competency cover the dimensions of flexibility, nonverbal communication and foreign language skills [19]. Zee and Oudenhoven [63] define *flexibility* as the ability "to regard new and unknown situations as a challenge and to adjust one's behavior to the demands of new and unknown situations." Bhawuk and Brislin [6] state that flexibility is "the willingness to engage in different behaviors." Different aspects of flexibility are, for example, the adjustment of behaviors, learning from mistakes, and the adjustment to a new cultural environment [19]. *Nonverbal communication* includes gestures, facial expressions and other Nonverbal signals, and the ability to understand and use these in an intercultural context [39]. It has to be noted that nonverbal communication also includes affective aspects, but the behavioral aspects are dominant [19]. *Foreign language skills* are necessary to communicate in an international environment, to find a common language, and to build trust among team members [32]. The cognitive aspects of Intercultural competency are expressed using *intercultural self-awareness* [19]. Kupka et al. [34] differentiate hereby between situational self-awareness, the awareness of one's own culture, and reputation awareness. Situational self-awareness and awareness of one's own culture describe hereby awareness of own habits. Reputation awareness describes the reputation of one's own culture in other cultures [34].

Based on the conceptualization of software development competency and intercultural competency, both constructs represent complex, multidimensional competency fields. Hereby, the underlying competency areas form and define the constructs.

Linking the Competency constructs with in-role Job performance

Explaining and predicting the performance of individuals based on their skills and/or competencies is a critical aspect of human resource management. The competence-performance theory (CPT) [30, 31] aims at predicting performance based on competence levels and at explaining differences in performance outcomes. CPT is based on criticism toward knowledge space theory, which is the foundation of CPT [30, 31]. CPT extends knowledge space theory by addressing a set of tasks or performance outcomes and a set of competences that are seen necessary to complete the tasks. CPT thus indicates that competences have a direct influence on task-related performance. Additionally, as CPT addresses a set of competences that are required to fulfill a set of tasks, individuals with the required set of competences should fulfill all tasks and thus reach a very high performance. A further increase of competences has, accordingly, very little to low effect on performance. Additionally, based on the possibility that multiple competences are needed for the completion of one task and that one competence might be required for multiple tasks, one might expect situations in which an increase of a specific competence might not lead to an increase in the ability to perform additional tasks, or in which advancement in a single competence might lead to ability to perform multiple new tasks. This means that even though the competences increase, no impact on the performance can be seen in one case and a slight increase of competences might lead to a high increase in performance in

another case. We can therefore assume a nonlinear relation between competencies and performance.

Similarly in the field of organizational psychology, we identified that individual competences not only have a high impact on individual performance but also on organizational productivity [54]. In particular, abilities can be used to predict task-related job performance [54]. Within global software development, technical competency is the main focus of companies in their human resource management, staff development, and hiring. Based on the findings from organizational psychology and the CPT, we can assume that technical competency or software development competency have a positive influence on job performance. Based on the CPT and the findings from organizational psychology, we hypothesize:

H1: Software development competency will positively influence in-role Job performance

Within the frame of the presented research, abilities can be understood as competences. However, no differentiation is made between hard competency and soft competency besides the notion that dispositional variables, which could be interpreted as soft competences, have potential to predict contextual and adaptive performance [36]. Within software development, various studies show the importance of soft competency, and, in particular, intercultural competency is seen as highly important for task-related performance [23]. Software developers are addressed with challenges stemming from the intercultural work environment regularly. We therefore hypothesize:

H2: Intercultural competency will positively influence in-role Job performance

As noted above, there are strong indications for a nonlinear effect for both influences (H1 and H2) due to possible saturation of competences and the multiple relations between competences and tasks or performance.

Moderating Role of Competencies on in-role Job performance

While the influence of competency on in-role job performance is widely discussed in research [54, 37], Holtkamp et al. [22] identified a relation between hard competency and soft competency. In the domain of GSD, they showed that hard competences have to be contextualized using soft competences to achieve a sufficient performance. According to Holtkamp et al. [22], internationalization competency, a set of competences required in international and intercultural work environments, was found suitable to adapt software development competences to the work context. This is in line with the findings from organizational psychology, in which dispositional variables, such as soft competencies, are believed to affect the adaptive performance of an individual [36]. As the adaptive performance includes the adaptation to different work environments and cultures, we can follow that dispositional variables and, accordingly, soft competencies, can have an effect on this adaptation process. In an intercultural context, such as GSD, the effect of this adaptation process on the in-role job performance has not been analyzed. It can be assumed that an individual with lower job-related abilities but better adaptation to the work context reaches a higher performance than an individual with higher job-related abilities but lower adaptation competency. Similar to the direct effect of competency on job performance, a nonlinear effect can be expected as a threshold of intercultural competency required for the adaptation process can be expected. In the case of GSD, a software developer with very high software development competency might

underperform when confronted with colleagues and clients from an unknown culture as he is struggling to adjust his working style and behavior to the new work environment. This is supported by the findings of Holtkamp et al. [22], who identified that common challenges of GSD follow a change of working context. This might indicate that a software developer with lower Software development competency but very high intercultural competency might find it easier to adjust. This might lead to a higher in-role Job performance of the latter developer even though his software development competences are lower. We therefore hypothesize:

H3: Intercultural competency negatively moderates the influence of Software development competency on in-role Job performance

Methodology

Research Context

In total, 86 companies and 886 individuals from Europe, Australia, and the US were contacted based on their appearance and classification in business directories and Open Source projects. Additionally, workshops in Finland through PROFIT[1] and in Germany through BITKOM[2] were organized. The two host organizations spread the information about the workshops and questionnaire in their network. The workshops addressed competence management in GSD, and were directed at team leaders and HR managers of software development companies with an international focus. The participating companies were offered free consulting service, including

[1] PROFIT is a program organized by the Faculty of Information Technology at the University of Jyväskylä providing trainings to support the growth and development of companies in the ICT sector in Central Finland. For more information see https://profit.cc.jyu.fi (in Finnish).

[2] BITKOM is the Digital Association of Germany representing more than 2300 companies in the digital economy including over 1000 SMEs, 300 start-ups and the majority of global players. More information under https://www.bitkom.org

individual data analysis and benchmarking. Furthermore, 9 Chinese companies from the Xi'an region were contacted. No consulting was offered to the Chinese companies. Regardless, 4 Chinese companies joined the study. In total, 144 responses with 49 individual supervisors from 22 different companies were received. This gives an average of 6.18 employees and 2.23 supervisors per company, with 2.78 employees per supervisor. Demographic statistics of the respondents are displayed in Table 1.

Table 1: Participant Demographics

Participant demographics		**Employee**		**Supervisor**	
Gender	Male	112	82.35%	42	85.71%
	Female	24	17.65%	7	14.29%
Age	Under 18	0	0%	0	0%
	18-24	18	13.24%	2	4.08%
	25-34	93	68.38%	27	55.10%
	35-54	25	18.38%	19	38.78%
	55+	0	0%	1	2.04%
Educational Level	No High School Degree	0	0%	0	0%
	High School Degree or equivalent	4	2.94%	2	4.08%
	Bachelor's degree	35	25.74%	9	18.37%
	Master's degree	87	63.97%	30	61.22%
	PhD degree	9	6.62%	8	16.33%
	Other	1	0.74%	0	0%
Current Position	Top-Level Executive	1	0.74%	3	6.12%
	Senior VP	0	0%	1	2.04%
	VP	0	0%	0	0%
	Director	1	0.74%	4	8.16%
	Manager	7	5.15%	27	55.10%
	Professional	127	93.38%	14	28.57%
	Administrative/Support	0	0%	0	0%
Region	Finland	39	28.68%	20	40.82%
	Germany	4	2.94%	6	12.24%
	China	66	48.53%	12	24.49%
	Others (e.g., Greece, Ukraine, Ecuador, Portugal, Brazil, France)	27	19.85%	11	22.45%

Measures

As no broad **Software development competency** construct exists, a step-by-step process to create the construct was taken following the approach by Davis [14]. As a starting point, job requirements of over 100 job advertisements for software developers were analyzed. The results were compared and enriched by the analysis of existing competency frameworks such as the Software Engineering Book of Knowledge [5] and the eCompetence Framework [10]. This led to a total of 72 competences. Through combination and elimination of duplicates, the amount was reduced to 26 competences. These 26 competences were presented to five software development experts. The aim of this pre-test was to evaluate the completeness and correctness of the competences. After reformulating, splitting, and eliminating the items, a total of 31 unique competences were defined. The competence definition requires the application of knowledge and skills. Thus, the 31 items reflecting the qualification of a developer were each paired with an item addressing how this qualification is applied.

Following the definition of the unique competences, the experts were asked to cluster them and label the clusters. The result was ten sub-constructs of Software development competency, reflecting software development lifecycle: “Architecture Design,” “Database Management,” “Implementation,” “Integration, Deployment and Maintenance,” “Management,” “Network,” “Requirement Analysis and Specification,” “Security,” “Software Design,” and “Testing.” These sub-constructs make up the higher-order construct for Software development competency. Thus, in order to measure it, the ten sub-constructs were operationalized as 7-point Likert scales with at least four items each. The respondents are asked to indicate their agreement to statements regarding their qualification and the application of their knowledge.

Intercultural competency was also operationalized as a higher-order construct consisting of sub-constructs. For each of the sub-constructs, a previously applied and tested measurement model was selected. “Intercultural sensitivity” (16 items), “Open-mindedness” (7 items), and “Flexibility” (5 items) were measured through the Intercultural Sensitivity Inventory [6]. The 16 items of “Intercultural sensitivity” were duplicated to represent two different contexts: an individualistic culture, such as Europe, and a collectivistic culture, such as China or Japan. Participants were asked to judge the item for both contexts. Hereby, the items can also be classified as collectivistic and individualistic. Collectivistic items expect a high value in a collectivistic context and a low value in an individualistic context; individualistic items, accordingly, the opposite. The next sub-construct, “Foreign language competency” (5 items) applied the Foreign Language Competence Scale [32]. “Nonverbal communication” (7 items) was operationalized with the Nonverbal Communication Competence Scale [33]. “Intercultural self-awareness” (17 items) was applied from the Intercultural Self-Awareness scale [34]. It comprised two scales, one related to “Public and private self-awareness” and one to “Home culture awareness.” In the questionnaire, 7-point Likert scales were used for all sub-constructs.

Job performance was measured using a five-item scale for in-role Job performance developed by Podsakoff and MacKenzie [46]. The items addressed the fulfillment of duties, formal performance requirements, and responsibilities. Using the scale, the supervisor of the respondent indicated to what extent they agreed or disagreed with the statements concerning the quality and quantity of activities related to the role of the respondent.

As the data was collected both in Europe and China, two native speakers translated the English questionnaires into Mandarin Chinese. To ensure that the Mandarin and English versions were identical, the first native speaker translated the questionnaires to Mandarin, after which the second translated them back to English. This version was then compared to the original, and the second native speaker made suggestions for changes. The first native speaker then addressed these suggestions. The process was repeated until both translators were satisfied with the work.

The data were collected with two online questionnaires. The first questionnaire addressed the self-assessment of competences of the employees, while the second questionnaire concentrated on a Job performance rating by the direct supervisor of the employee. Unique identifiers were used to ensure that the developer responses could be coupled with appropriate supervisor evaluations.

Data Analysis

The data were screened for unreliable responses and missing values. Eight observations with visible patterns in the answers, such as all items having the same value and thus leading to uncertainty about their reliability, were removed. Thus, the number of observations in the analyses was $N = 136$. The data contained seven missing values, which were imputed with the grand mean of the variable.

The hypotheses of the study were tested using a partial least squares (PLS) structural equation model. PLS was selected for the following reasons, based on Hair et al. [20] and Gefen et al. [18].

- The presented research is exploratory and extends existing structural theory.
- The presented model is highly complex with many constructs and indicators.
- We cannot assume normal distribution of the results as we expect high skewness and kurtosis of the data.
- The model includes formative constructs as part of the structural model.
- The amount of observations (*N*) is small based on the complexity of the structural model.

The model consisted of two high-order independent constructs and the dependent construct Job performance. Job performance was modeled as a reflective construct containing the five items filled by the supervisor. Software development competency was modeled as a formative construct comprising the ten sub-constructs, which were modeled as reflective latent variables. For calculating the higher-order construct for Intercultural competency, the following sub-constructs were first combined into intermediate constructs. “Intercultural self-awareness” was modeled as a formative construct from its two scales, “Self-awareness” and “Cultural awareness.” “Intercultural sensitivity” was modeled as a reflective construct from the scales of the two cultural contexts. These constructs as well as the other sub-constructs of Intercultural competency were modeled as a formative latent variable. All sub-constructs were modeled as reflective latent variables.

The inner PLS model, consisting of three latent variables (Intercultural competency, Software development competency, and Job performance; Figure 1), was used to test the three hypotheses of the study. H1 and H2 were tested as direct effects of the two competencies on Job performance, while H3 was tested as a moderation effect of Intercultural competency on the

effect of Software development competency on Job performance. Due to the expected nonlinear nature of the hypothesized effects, WarpPLS software was used for modeling. WarpPLS provides two alternatives for nonlinearity in PLS: a *warp2* algorithm, which analyzes relationships based on a U-curve function, and a *warp3* algorithm, which analyzes relationships as an S-curve function, such as sigmoid, hyperbolic sine, and hyperbolic tangent. As diminishing effects in the relations were expected, the warp3 algorithm was selected for the analysis of the inner model. The warp3 algorithm yields the advantage that also linear and U-curve functions are potential results of the analysis. For the analysis of the outer model, Wold's original PLS algorithm was used [28].

Assessment of Measurement

Even though the constructs and sub-constructs of the study are theoretically distinct, high correlations were observed between the constructs. Further, high indicator cross-loadings, especially for Software development competency, were observed. Based on these high cross-loadings and high correlations with items of other constructs, it seemed that the sub-constructs of intercultural competence did not function as anticipated. In particular, the Intercultural Sensitivity Inventory [6] presented various issues. In terms of "Intercultural sensitivity," only 5 of the original 16 items were included. For "Open-mindedness," four items were removed, and for "Flexibility," two items were discarded. Regarding the Intercultural Self-Awareness Scale [34], one item related to "Self-awareness" and three items of "Cultural awareness" were discarded. For the sub-constructs of Software development competency, two items associated

with “Implementation,” seven with “Architecture,” one with “Management,” and one item with “IDM” were discarded.

Square root of the average variance extracted (AVE) was used for analyzing discriminant validity [17]. This indicator was greater than the off-diagonal construct correlations for all sub-constructs, meaning that each construct shared more variance with its own indicators than with other constructs. This result signifies sufficient discriminant validity of the constructs of the study [18]. Further inspection of AVEs revealed that for three constructs, the threshold of 0.5 was not reached. However, as these values (0.476 for “Management,” 0.488 for “Collectivism Europe,” and 0.495 for “Flexibility”) were fairly close to the threshold and based on satisfactory discriminant validity, the constructs were deemed acceptable for modeling.

Due to some high correlations and cross-loadings of individual items, collinearity of the sub-constructs was diagnosed using Variance Inflation Factor (VIF) scores. These were all well below the threshold value of 10 [41], ranging from 1.17 to 4.58 and thus indicating that collinearity was not a problem for the model. The somewhat larger values (some over 4) for the sub-constructs of Software development competency were expected, because the factors are closely related to each other. The reliability of the sub-constructs was assessed with a construct reliability indicator [17]. All sub-constructs fulfilled the criterion of 0.7 for construct reliability, and a majority of the constructs reached high reliability (greater than 0.85). For the results of the test for discriminant validity, VIF scores, and composite reliability, see Appendix A. Finally, Tenenhaus’ goodness-of-fit (GoF) [57] was used to assess the explanatory power of the inner

model. With GoF = 0.352, the inner model can be stated to have a medium-to-large explanatory power [61].

Results

The PLS model for testing the hypotheses of the study is displayed in Figure 1. The results indicated that while Software development competency had a statistically significant influence on Job performance, β = 0.21, $p < .01$, the influence of Intercultural competency on Job performance was not statistically significant. Further, there was a significant negative effect on the relation of Software development competency and Job performance, β = –0.20, $p < .01$. The model thus supports H1 and H3, while H2 is not supported. In total, the model explained 12% of the variance of the in-role Job performance of software developers in international settings (R^2 = 0.12, adj. R^2 = 0.10).

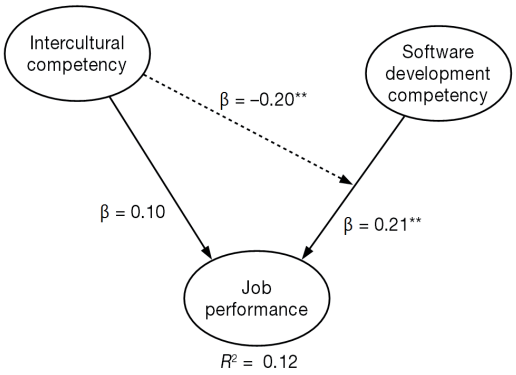

Figure 1: Results of the inner model. ** p < .01

The significant effects were further analyzed by visual inspection. The relationship between Software development competency and Job performance (H1) is displayed in Figure 2. For the

purpose of analyzing and interpreting the effect, it is presented in three different segments. Segment A of the graph represents a group of average software developers, with Software development competency within one sample standard deviation from the sample mean. Segment B represents less-than-average software developers, with Software development competency less than one sample standard deviation from the sample mean. Segment C represents better-than-average software developers, with Software development competency more than one sample standard deviation above the sample mean.

For an average software developer (segment A), the results showed a nonlinear growth of Job performance with increasing Software development competency. For software developers with below-average Software development competency (segment B), the results showed a negative nonlinear relationship. In contrast, for software developers with above-average Software development competency (segment C), an almost linear association of performance with competency was observed.

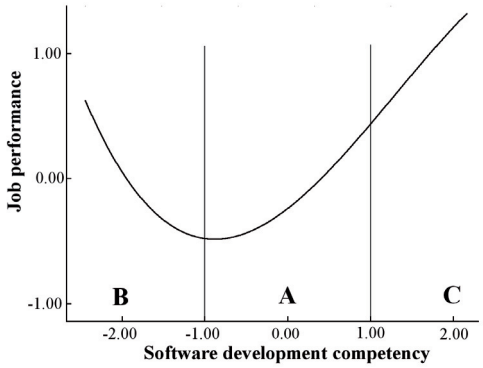

Figure 2: Plotted influence of Software Development Competency on Job performance

The moderation effect of Intercultural competency on the influence of Software development competency on Job performance (H3) is displayed in Figure 3. Similar to the previous effect, the graph was split into three different parts based on the level of Software development competency.

The first observation was that high Intercultural competency lowers the association between Software development competency and Job performance. For average software developers (segment A) with low Intercultural competency, a nonlinear positive association between Software development competency and Job performance was observed. In contrast, for average developers with high Intercultural competency, the effect of Software development competency on Job performance was diminished.

For segment A, an intersection of the associations between Software development competency and Job performance for low and high Intercultural competency was observed at approximately one-third of sample standard deviation from the sample mean. For developers with Software development competency below the intersection, the effect of Software development competency on Job performance was higher with high Intercultural competency. With Software development competency higher than the point of the intersection, the effect of Software development competency on Job performance was higher for developers with low Intercultural competency.

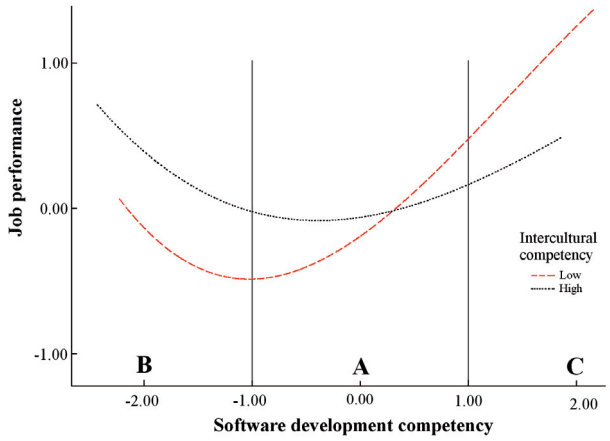

Figure 3: Plotted Moderation Effect of Intercultural Competency on the Influence of Software Development Competency on Job Performance

For software developers with below-average Software development competency (segment B), there was a negative nonlinear effect of Software development competency on Job performance. Therefore, within developers with below-average Software development competency, an increase of Software development competency leads to a decrease of Job performance. However, Figure 3 also indicates a main effect for Intercultural competency: developers with higher Intercultural competency have higher Job performance. Finally, in the group of software developers with above-average Software development competency (segment C), the effect of Software development competency on Job performance is higher with below-average Intercultural competency.

Discussion

Through the application of nonlinear PLS, we identified significant nonlinear influences of software development competency on the in-role job performance and a moderation effect of intercultural competency on the effect of software development competency on in-role job performance. However, no significant influence of intercultural competency on in-role job performance could be found.

The **identification of the moderation effect** confirms the findings of Holtkamp et al. [22] that a relation between intercultural competency and software development competency exists. In their research, Holtkamp et al. [22] identified that intercultural competences can be used to adapt software development competences to the work context. This would ensure a high level of performance given changing work environments. Our results show that with an increasing level of Intercultural competency the influence of software development competency on in-role job performance decreases. Figure 3 allows the **interpretation of the moderation effect**. As described in the results section, for **average software developers (segment A**) with low intercultural competency, a nonlinear increase of the effect of software development competency on job performance was identified. In contrast to this, the figure shows that for average software developers with high intercultural competency, only small changes on the effect of software development competency on job performance could be identified. This might indicate that, in intercultural work environments, reaching a threshold of software development competency in other aspects, such as intercultural competency, has a bigger impact on performance than further increase of software development competency. While a software developer with high intercultural competency is able to adjust to the cultural differences, a software developer with low intercultural competency is solely relying on software development competency. Thus, an

increase of software development competency has a bigger impact on job performance for a developer with low intercultural competency. Based on recent results in the field of organizational psychology, we can differentiate between task performance – in our research represented by in-role job performance – adaptive performance, and contextual performance [54]. These three dimensions build the overall performance of an individual. Our results might indicate that, in international settings, the adaptive performance and contextual performance might have a stronger impact on the overall performance than the task performance or present a moderating factor for the influence of task performance on the overall performance.

For **software developers with below-average software development competency** (segment B of Figure 3), the analysis showed surprising results. According to the analysis, for these developers an increase of software development competency decreases the effect on job performance. This holds true for high and low intercultural competency, with the effect being bigger for software developers with high intercultural competency. To analyze these findings, we have pointed out that the amount of observations for software developers with below-average software development competency was significantly lower than for developers with average or above-average competency, which might lead to skewed results based on single outliers. The results might look differently when addressing hard-performance aspects such as lines of code. We additionally have to point out that while discussing job performance, we actually deal with a construct representing how the supervisor perceives the job performance. The results might indicate that the supervisor uses different approaches to judge the performance for software developers with below-average software development competency. In terms of the CPT [30, 31], this might indicate a different performance space for these software developers.

An almost linear moderation effect was identified for **software developers with above-average software development competency** (segment C of Figure 3). Here, the results show that the effect of software development competency is higher and increasing with a steeper slope than for software developers with low intercultural competency, compared to the developers with high Intercultural competency. This again indicates the importance of software development competency is decreasing with the level of intercultural competency. Thus, other factors become more important for the explanation and prediction of job performance. This is supported by the findings of Kollmann et al. [29], who identified that, with raising technical competency and experience, a higher level of interpersonal competency is appreciated. This indicates that experienced professionals see the importance and value of soft competencies.

Within the discussion on individual performance, various researchers [54] have shown that abilities are able to predict task performance. The abilities hereby stand in contrast to dispositional variables, which have the potential to predict predictive performance and parts of the contextual performance [36]. In our research, software development competency can be understood as abilities and intercultural competency as dispositional variables. Our research has confirmed the findings of previous research as a **significant influence of software development competency but no significant influence of intercultural competency** on in-role job performance was identified. In addition, our results show that the influence of software development competency on in-role job performance is **nonlinear**. Until researching the turning point, an increase of Software development competency leads to a nonlinear increase of in-role Job performance. After the turning point, the influencing effect is diminished. This indicates that the relation between software development competency and in-role job performance has a saturation point. After reaching the required competences to perform the tasks as expected, an

increase of competences has little effect on the performance. When looking at the competence-performance theory [30, 31], the competences are described as a competence space and the performance as a task space. Hereby, the assumption is that the set of competences will enable the individual to perform the tasks. Therefore, in our case we can assume that achieving the expected level of competences will allow a software developer to fulfill the tasks related to the job. So, if the expected level of competences is reached, all tasks essential for the job can be performed.

The presented model explains **12% of the variance** of in-role job performance. While the variance explained is comparably low, it can easily be explained by the amount of different influence factors on job performance. Multiple different aspects, such as personality and personal traits [58, 2, 25], motivation [11], organizational support [12], work stress [62], and many others, are shown to have an influence on the performance of individuals. In the presented research, we abstracted from these various influence factors to decrease the complexity of the research and focus on the influence of competencies. Based on the amount of potential influence factors, 12% of variance of in-role job performance explained must be considered as a realistic amount. As Bassellier et al. [3] accordingly describe competences as the potential to lead to effective behavior, the additional influence factors can be seen as factors promoting or decreasing the effect of competences on the performance. Accordingly, it would be highly interesting and relevant to identify underlying mediation and moderation effects.

Theoretical Contributions

The results of our study provide several highly valuable contributions to the current discussion of GSD. These contributions are:

- Development of a wide Software development competency construct
- Confirmation of the existence of an moderation effect of intercultural competency and software development competency
- Identification of nonlinear influences of competencies on in-role job performance
- Rejection of the hypothesis of a direct influence of intercultural competency on in-role job performance

While more and more research addresses competencies and their importance, the level of detail commonly does not exceed competence categories, which cannot explain particular requirements for individuals. Through the provision of a wide **Software development competency construct** with high validity and reliability, the presented research enables future research to analyze (global) software development competences and their influence on a more detailed level. Through the creation of the construct as a higher order construct, researchers are also able to select sub-constructs relevant for their research. Through this, our research provides suitable constructs not only for software development competency but also for all underlying competency constructs.

Previous research [22] indicates a relation between soft competency and hard competency in the context of GSD. Our research gave **support for the moderation** for the cases of intercultural competency and software development competency. While the influences of different competencies on aspects such as individual or organizational performance were addressed previously, no analysis of the interactions between the influencing competencies has taken place. The identification and confirmation of the interaction effect between intercultural competency and software development competency could indicate a general interaction between soft

competency and hard competency. This opens a new strain in competency and performance research.

The influence of competencies on job performance is commonly assumed. However, rarely is the nature of the influence analyzed in more detail. Our results have shown that a **nonlinear relation between software development competency and in-role job performance** exists. This indicates that a nonlinear influence is plausible for other competencies also. Our research indicates a clear saturation point for influence of the competency on performance. Achieving a higher level of competency wouldn't lead to any more increase of job performance.

The results of this research provide valuable extensions to the CPT [30, 31] through the operationalization of the theory and the identification of the nature of relation between competence space and performance space. Additionally, our results have shown that it might be necessary to extend the CPT to address multiple competence and performances spaces. Hereby, one competence space can address the hard competences and the other the soft competences of an individual, and three different performance spaces for task performance, adaptive performance, and contextual performance might be required. This extension might provide a more complete view of the theory and allow the analysis of relations between the different spaces.

The results also provide valuable insight for researchers addressing organizational capabilities and organizational performance. As organizational capabilities and organizational performance might be based on individual competencies and performance, the presented operationalization of competencies allows for an analysis of these relations.

Practical Implications

From a practical perspective, our analysis of job advertisements in global software development, as part of the conceptualization and development of the Software development competency construct, has shown that soft competences and, in particular, intercultural competences, are not commonly addressed. Instead, a focus on technical competences is clearly visible. This indicates that companies focus on the task performance rather than on aspects of adaptive performance or contextual performance. However, even for the task performance, our research has shown that intercultural competency has an important impact on the performance of software developers. While no direct effect could be shown, the moderation effect indicates the importance of intercultural competency. In an intercultural work environment, our results indicate that intercultural competency can substitute software development competency to some extent.
Our results indicate that software development organizations should focus on the intercultural competency of their employees, particularly in situations where the adaptation of working styles and behaviors of individuals might be required. In these situations, a lower level of software development competency might be sufficient if the individual has a high level of intercultural competency. Thus, the results provide valuable insight for software development organizations in their staffing of projects, hiring of new employees, and competence development.
Furthermore, the results also provide strong implications for educational systems. While traditionally educational programs focus on technical competences and provide additional courses related to soft competencies, such as communication competency or intercultural competency, the existence of the moderation effect indicates a direct relation between hard and soft competencies. Therefore, it appears promising to merge courses on technical competences

and soft competences to allow learners to gain the competences within the appropriate context. This merge has the potential to increase the learning outcome of the learner.

Limitations

Based on the selected analysis method, the selected tool for analysis represents one of the major limitations of our research. While WarpPLS allows the application of nonlinear PLS algorithms, and research using WarpPLS has been published in major IS journals, the nonlinear PLS algorithms themselves have never been published in peer-reviewed scientific journals. Due to the limitations of the tool, the results should be understood as preliminary indications for the relations. Further analysis of the observed effects using wider samples and different algorithms is thus warranted.

Another major limitation of the study is the selected Intercultural competency construct, which in its original form didn't pass validity and reliability criteria and had to be reduced drastically. This indicates that the applied Intercultural competency construct, which was shown suitable in different contexts, was as such not suitable in the given context. The results might differ using a better suitable Intercultural competency construct. However, as our study represents the first study to analyze the interaction effect of different competency constructs, the results should be understood as a first indication, and further research regarding the existence and nature of the interaction effect should follow.

The third limitation of the presented research is based on the length of the questionnaire. While participants usually stated that it was no problem, the length of about 30-40 minutes might affect the results of individuals. To address this issue, all answers were scanned and answers with

obvious patterns in the replies were deleted. Based on the different roles of the participants in the software development process and their different amount of international and intercultural work, deviations of the results can also be expected.

Another limitation is based on the measure for in-role job performance. As the supervisor provides the rating of the job performance, the construct actually addresses the perceived in-role job performance of the supervisor. The results, in particular for software developers with very low Software development competency, indicate that different standards for the rating of job performance for team members with below-average software development competency are used. This means that an objective measure of in-role job performance might lead to different results. The influence of the supervisor could have been addressed through the inclusion of control variables. However, based on the already high complexity of the model, we decided for the exclusion of control variables.

Due to the relatively small sample size, generalizations of the results should be made with caution. The current study provides evidence of the moderation effect of intercultural competency on the effect of software development competency on job performance, but the details of this effect need further study. For example, at what point does the increase of software development competency increase job performance more for developers with worse-than-average intercultural competency, when compared to developers with higher-than-average intercultural competency?

Directions for Future Research

As the first study analyzing the interaction effect of different competencies, the results of our research provide implications for future research. Firstly, the developed **Software development**

competency construct should be tested and validated in different settings. Based on the holistic software development construct, more detailed analyses of the effect of competencies on different aspects of individual performance, organizational performance, organizational success, and product quality can be founded on a validated construct.

As discussed previously, the selected **measures for intercultural competency** did not meet the expectations and results in terms of validity and reliability. While the measures were applied successfully in other fields such as psychology, in our context, only stripped-down measures could be used. To fully analyze and understand the influence of intercultural competency, it is important to develop a construct suitable for international and intercultural work. Only then can the results of our research be confirmed and validated. For this purpose, it will be critical for future research to understand the underlying dimensions of intercultural competency and their importance in the context of GSD. Here, in particular, the adaptability to different work environments should be in the focus of future research.

Another highly relevant strain of research would be the analysis of the **different dimensions of job performance**. While we addressed the in-role job performance as an example for task performance, organizational psychology addresses additionally the adaptive performance and the contextual performance of individuals. Our results show that Intercultural competency has no significant influence on the task performance, but this doesn't neglect the possibility that an influence on the adaptive performance and contextual performance could be identified. Therefore, future research should analyze the influence of competencies on the different dimensions of performance.

Our research identified that a significant moderation effect of Intercultural competency and Software development competency exists. We interpret this based on the adaptation of software

development competences to the context [22]. This does not just open the question of which other **interactions between different competencies** could be identified, but also if we could **identify an effect of the adaptive performance on the task performance**. Future research should address these two aspects.

The identification of a **nonlinear influence of competency on the in-role job performance** raises the question of how the relation of other influence factors on job performance can be described. Future research should analyze the relations in more detail to understand the types of effects and relations.

Conclusions

The globalization of work life in the software industry leads to internationally distributed and culturally diverse teams. Intercultural competency is discussed to be a major factor for job performance of software developer in such a global work environment. While our research has provided no evidence of a direct impact of intercultural competency on job performance, we did observe a moderation effect of intercultural competency on the effect of software development competency on job performance. Furthermore, we have identified that the relation of software development competency on in-role job performance is nonlinear. This indicates that, after reaching a threshold level of competency, the positive effect of software development competency on performance is shrinking.

Our work provides valuable new contributions to the body of knowledge on competencies and skills of IT professionals and, in particular, software developers. We have developed a wide Software development competency construct including the different phases of software development. This study also adds to the body of knowledge on individual job performance by

confirming assumptions of predictors of in-role job performance and showing a nonlinear relation between hard competency and task performance.

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Appendix A: Intercorrelation among Reflective Constructs

	VIF	Composite Reliability	Individualism Europe	Collectivism Europe	Individualism Asia	Collectivism Asia	Open-Mindedness	Flexibility	Non-verbal Communication	Language	Collaboration	Self-Awareness	Cultural Awareness	Implementation	Management	Software Design	Architecture	Testing	Databank Management	Network	Requirements Engineering	Security	Integration, Deployment, Maintenance	Performance
Individualism Europe	0.521	0.848	**0.858**																					
Collectivism Europe	2.902	0.741	0.475***	**0.699**																				
Individualism Asia	2.901	0.809	0.694***	0.321***	**0.824**																			
Collectivism Asia	2.789	0.772	0.299***	0.647***	0.468***	**0.732**																		
Open-Mindedness	1.574	0.786	0.343***	0.277**	0.262**	0.187*	**0.742**																	
Flexibility	1.167	0.746	0.282***	0.148	0.195*	0.023	0.174*	**0.703**																
Nonverbal Communication	1.597	0.91	0.1	0.277**	0.171*	0.318***	0.222**	0.028	**0.82**															
Language	1.675	0.942	0.203*	0.017	0.111	-0.112	0.348***	0.077	0.279**	**0.875**														
Collaboration	1.63	0.92	0.006	0.318***	0.184*	0.378***	0.213*	0.038	0.245**	0.134	**0.923**													
Self-Awareness	2.006	0.852	0.221*	0.4***	0.19*	0.338***	0.337***	0.031	0.422***	0.055	0.286***	**0.733**												
Cultural Awareness	2.048	0.89	0.361***	0.173*	0.307***	0.206*	0.414***	0.118	0.326***	0.301***	0.236**	0.506***	**0.712**											
Implementation	2.97	0.919	0.109	0.143	0.167	0.07	0.065	-0.054	0.04	0.111	0.19*	0.144	0.169*	**0.767**										
Management	3.589	0.816	0.271**	0.149	0.254**	0.095	0.221*	0.053	0.122	0.257**	0.331***	0.178*	0.242**	0.486***	**0.69**									
Software Design	3.366	0.811	0.107	0.172*	0.203**	0.206**	0.116	-0.017	0.115	0.029	0.255**	0.322***	0.315***	0.631***	0.674***	**0.72**								
Architecture	4.418	0.884	0.151	0.127	0.231**	0.062	0.123	0.067	0.11	0.078	0.268**	0.154	0.187**	0.71***	0.675***	0.678***	**0.75**							
Testing	2.792	0.925	0.223**	0.215*	0.21*	0.182*	0.155	0.013	0.181*	0.187*	0.27**	0.173*	0.283***	0.555***	0.647***	0.59***	0.65***	**0.821**						
Databank Management	3.572	0.907	0.237**	0.206*	0.27**	0.102	0.196*	0.095	0.192	0.121	0.185*	0.193*	0.328***	0.674***	0.537***	0.633***	0.723***	0.663***	**0.788**					
Network	3.6	0.928	0.194*	0.082	0.276**	0.109	0.046	0.042	0.002	0.065	0.175*	0.043	0.103	0.398***	0.608***	0.545***	0.672***	0.569***	0.529***	**0.874**				
Requirements Engineering	2.295	0.873	0.232**	0.079	0.273**	0.094	0.278**	0.114	0.14	0.131	0.25**	0.292***	0.384***	0.348***	0.609***	0.539***	0.554***	0.53***	0.523***	0.462***	**0.795**			
Security	4.099	0.887	0.154	0.014	0.233**	0.063	0.007	0.031	0.084	0.13	0.226**	0.126	0.166	0.444***	0.621***	0.556***	0.658***	0.557***	0.487***	0.792***	0.486***	**0.815**		
Integration, Deployment, Maintenance	4.583	0.869	0.157	0.075	0.17*	0.011	0.175*	0.039	0.136	0.264**	0.244**	0.1	0.221*	0.483***	0.672***	0.538***	0.709***	0.698***	0.657***	0.685***	0.614***	0.749***	**0.755**	
Performance	1.276	0.946	0.165	0.113	0.189	0.07	0.074	0.062	0.069	0.198	0.026	-0.047	0.134	0.066	0.26**	0.093	0.164	0.149	0.226**	0.169**	0.099	0.167	0.266**	**0.882**

Note: *Correlation is significant at the 0.05 level
**Correlation is signification at the 0.01 level
***Correlation is signification at the 0.001 level
Diagonal boldface elements are the square root of the average variance extracted

Appendix B: Items for Intercultural Competency

Dimension	Variable Name	Question
Individualism Europe	EMP_EU13	It is important to develop a network of people in my community who can help me out when I have tasks to accomplish (Imagine living in a European country such as Finland or Germany)
	EMP_EU14	I enjoy feeling that I am looked upon as equal in worth to my superiors (Imagine living in a European country such as Finland or Germany)
Collectivism Europe	EMP_EU4	I enjoy developing long-term relationships among people with whom I work (Imagine living in an European country such as Finland or Germany)
	EMP_EU12	I enjoy being emotionally close to the people with whom I work (Imagine living in a European country such as Finland or Germany)
	EMP_EU15	I have respect for the authority figures with whom I interact (Imagine living in an European country such as Finland or Germany)
Individualism Asia	EMP_AS13	It is important to develop a network of people in my community who can help me out when I have tasks to accomplish (Imagine living in a Asian country such as Japan or China)
	EMP_AS14	I enjoy feeling that I am looked upon as equal in worth to my superiors (Imagine living in a Asian country such as Japan or China)
Collectivism Asia	EMP_AS4	I enjoy developing long-term relationships among people with whom I work (Imagine living in a Asian country such as Japan or China)
	EMP_AS12	I enjoy being emotionally close to the people with whom I work (Imagine living in a Asian country such as Japan or China)
	EMP_AS15	I have respect for the authority figures with whom I interact (Imagine living in a Asian country such as Japan or China)
Open-Mindedness	Open1	Given acceptable hygienic conditions, I would not mind if my children ate local food at school, when I am living in another country
	Open2	We all have a right to hold different beliefs about God and religion
	Open3	I like to meet foreigners
Flexibility	Flexi2	I don't get upset if I do not get a letter or call from my close friend(s) for more than a month, when I am living abroad
	Flexi3	I do not mind receiving unannounced visitors at home
	Flexi4	I do not mind customs officers meddling with my baggage at the airport
Non-verbal Communication	Non1	I anticipate non-verbal signals/behaviors in my current business environment mostly accurately Communication

	Non2	I perform non-verbal signals/behaviors in my current business environment mostly accurately
	Non3	I am motivated to interpret and perform non-verbal signals/behavior when I interact in my current business environment
	Non4	I think I use non-verbal signals/behaviors appropriately to express ideas when I interact in my current business environment
	Non5	I think I use non-verbal signals/behaviors effectively to express ideas when I interact in my current business environment
Language	Lang1	I have sufficient knowledge of the language of my current business environment
	Lang2	I have sufficient skills in the language of my current business environment
	Lang3	I am sufficiently motivated to use my knowledge and skills in the language of my current business environment
	Lang4	I think I use my knowledge and skills in the language of my current business environment appropriately
	Lang5	I think I use my knowledge and skills in the language of my current business environment effectively
Collaboration	Col1	To what extent are you willing to commit to the sharing of responsibilities with international IS project partners for the development and implementation of a future IS project?
	Col2	In the future, to what extent do you intent to develop strong partnerships with your IS project partners?
Self-Awareness	Self1	In my current cultural context, I am conscious about my inner feelings
	Self2	In my current cultural context, I am concerned about the way I present myself
	Self3	In my current cultural context, I am self-conscious about the way I look
	Self4	In my current cultural context, I am reflective about my life
	Self6	In my current cultural context, I am aware of my innermost thoughts
Cultural Awareness	Cul1	I am aware that I have a specific reputation
	Cul4	In the culture that I identify as my home culture, I am aware of traditions (e.g. ceremonies, holidays, etc.)
	Cul5	In the culture that I identify as my home culture, I am aware of values (e.g. family, work, entertainment, community, individuality, etc.)
	Cul6	In the culture that I identify as my home culture, I am aware of rules (e.g. who communicates how with whom, who can do what at what point in time, etc.)
	Cul7	In the culture that I identify as my home culture, I am aware of my ethnic background
	Cul8	In the culture that I identify as my home culture, I am aware of my religious background

	Cul9	In the culture that I identify as my home culture, I am aware of food (which foods, how to eat, when to eat, where to eat, etc.)
	Cul10	In the culture that I identify as my home culture, I am aware of time management customs (one thing at a time, several things simultaneously, etc.)

Appendix C: Items for Software Development Competency

Dimension	Variable Name	Question
Implementation	Imp1	I am qualified to implement program code in a relevant programming language (e.g. Java, C/C++, PHP, HTML etc.)
	Imp2	I am qualified to use specific development environments and tools (e.g. Eclipse, Visual Studio) and versioning tools (e.g. CVS, Subversion)
	Imp4	I am qualified to use programming frameworks (e.g. Struts, Hibernate):
	Imp5	I am qualified to use programming techniques (e.g. multi-threaded)
	Imp6	In software development projects I implement program code in a relevant programming language (e.g. Java, C/C++, PHP, HTML etc.)
	Imp7	In software development projects I implement program code using programming frameworks (e.g. Struts, Hibernate)
	Imp8	In software development projects I implement program code using programming techniques (e.g. multi-threaded)
	Imp10	In software development projects I use specific development environments and tools (e.g. Eclipse, Visual Studio) and versioning tools (e.g. CVS, Subversion)
Management	Man1	I am qualified to apply development methodologies and follow software development processes (e.g. Agile methods, Iterative Models etc.)
	Man2	I am qualified to keep up with technology trends and assess their values for upcoming development projects
	Man4	In software development projects I apply my knowledge of the system development life-cycle (entire software development process) and according steps and processes to ensure the success of the entire development project
	Man5	In my work I keep up with technology trends and assess their values for upcoming development projects
	Man6	In software development projects I ensure the usage of appropriate development methodologies and follow software development processes
Software Design	Soft1	I am qualified to design and implement based on software design patterns (e.g. Creational patters, structural patterns and behavioral patterns)
	Soft2	I am qualified to design graphical user interfaces following design principles, standards and frameworks and using appropriate tools (Visual Studio, QT, Dreamweaver etc.)
	Soft3	In software development projects I design graphical user interfaces following design principles,

		standards and frameworks using appropriate tools (Visual Studio, QT, Dreamweaver etc.)
	Soft4	In software development projects I design software based on software design patterns (e.g. Creational patters, structural patterns and behavioral patterns)
Architecture	Archi2	I am qualified to apply my knowledge of APIs of operating systems and their influences on software development
	Archi3	I am qualified to apply my knowledge of Webserver including related infrastructures (e.g. Apache Infrastructure, JBoss, Websphere etc.)
	Archi6	I am qualified to apply my knowledge of Open Source frameworks and communities (e.g. Linux development, SourceForge communities)
	Archi10	In software development projects I use my knowledge of Webserver and related infrastructures (e.g. Apache Infrastrucute, JBoss, Websphere)
	Archi11	In software development projects I apply my deep knowledge of APIs of operating systems and their influences on software development
	Archi12	In software development projects I ensure, that appropriate software architectures (e.g. SOA, n-tier architectures, MVC etc.) are used and their influences on software development are taken into account
Testing	Test1	I am qualified to design test cases based on product specifications
	Test2	I am qualified to write test scripts based on designed test cases and product specifications
	Test3	I am qualified to evaluate the test results based on designed test cases and product specifications
	Test4	In software development projects I write test scripts based on designed test cases and product specifications
	Test5	In software development projects I evaluate the test results based on designed test cases and product specifications
	Test6	In software development projects I design test castes based on product specifications
Database Management	Data1	I am qualified to design and implement database solutions including the design of database schemas
	Data2	I am qualified to check the integrity, safety and availability of data, data structures and information
	Data3	I am qualified to use database solutions including the usage of query languages
	Data4	In software development projects I design or implement database solutions including database schemas
	Data5	In software development projects I use database solutions and according query languages
	Data6	In my work I check the integrity, safety and availability of data, data structures and information

Network	Net1	I am qualified to design and specify networks and networking technologies
	Net2	I am qualified to assess risks and take care of errors and security aspects of networks and networking technologies
	Net3	In software development projects I assess risks and take care of errors and security aspects of networks and networking technologies
	Net4	In software development projects I design and specify networks and networking technologies
Requirements Engineering	Req1	I am qualified to apply my knowledge of modeling languages to represent data structures and requirements (e.g. UML modeling languages)
	Req2	I am qualified to collect, formalize and validate stakeholder and business requirements
	Req3	In software development projects I collect formalize and validate stakeholder and business requirements
	Req4	In software development projects I use my knowledge of modeling languages to represent for example data structures and requirements (e.g. UML modeling languages)
Security	Sec1	I am qualified to identify potential risks and failures (e.g. External attacks, data security aspects etc.) during the runtime of the system (operating system, infrastructure and software) and to take corresponding actions
	Sec2	I am qualified to identify and analyze hazards of software and take corrective and preventive actions using appropriate methods and tools (e.g. TrustZone, DRM):
	Sec3	In my work I identify and analyze hazards of software and take corrective or preventive actions using appropriate methods and tools (e.g. TrustZone, DRM)
	Sec4	In software development projects I am identifying potential risks and failures (e.g. External attacks, data security aspects etc.) during the runtime of the system (operating system, infrastructure and software) and to take corresponding actions
Integration, Deployment, Maintenance	IDM1	I am qualified to operate shells using the appropriate scripting language (e.g. Linux Shell, Korn shell, Powershell)
	IDM2	I am qualified to integrate diverse software modules, to detect problems and to verify and test the integration
	IDM3	I am qualified to deploy software solutions in the clients infrastructure and to correct possible malfunctions
	IDM4	In software development projects I deploy software solutions in the clients infrastructure and correct possible malfunctions
	IDM6	In software development projects I work with shells using appropriate scripting languages (e.g. Linux Shell, Korn shell, Powershell)

Appendix D: Items for In-Role Job Performance

Variable Name	Question
JP1	This worker always completes the duties specified in his/her job description.
JP2	This worker meets all the formal performance requirements of the job.
JP3	This worker fulfills all responsibilities required by his/her job.
JP4	This worker never neglects aspects of the job that he/she is obligated to perform.
JP5	This worker never fails to perform essential duties.