INTERNAL CROWDSOURCING SYSTEM: HOW TO DESIGN AND ADAPT A NEW MODE OF WORK

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ABSTRACT

Digitization gives rise to dynamic forces shaping future working structures. In practice, companies are increasingly interested in using their own employees as an internal crowd. Therefore, the application of internal crowdsourcing in companies as a new form of orchestrating work has increased substantially. Early research has shown that organizations should apply internal crowdsourcing due to its benefits, such as fast access to internal knowledge and increased productivity. Although studies have identified some advantages, internal crowdsourcing is a complex initiative and we do not sufficiently know how to design internal crowdsourcing systems as well as rollout initiatives in a company and to guide them to a state of stable operations in the adaptation stage. Drawing on socio-technical systems (STS) perspective, organizations must understand how they can embed an internal crowdsourcing system effectively in order to exploit its potential. The dissertation follows an action design research approach and develops comprehensive design principles for designing an internal crowdsourcing system. It develops these principles by deriving the requirements from literature, developing them further in a bank project, validating them in additional cases and evaluating them with external experts. Furthermore, the dissertation focuses in a second step on deriving barriers for internal crowdsourcing and solutions on how to overcome them. However, most barriers in current research focus mostly on the operational stage, when the initiative is already stable. Some research addresses adaptation barriers, but the assessment frameworks in current literature used to detect them were incomprehensive resulting in only few adaptation barriers and solutions. Thus, the dissertation identifies adaptation barriers of internal crowdsourcing through the technochange theory in a multiple case study, assesses what solutions the companies applied and describe how the solutions work in order to display how to overcome barriers. In addition, it provides overall recommendations to improve the adapted internal crowdsourcing system through standardizing measures. Finally, the dissertation summarizes the learnings of the design principles and adaptation barriers in a teaching case before pointing out limitations and providing a research outlook.

KURZFASSUNG

Im Rahmen der Digitalisierung entstehen dynamische Kräfte, die zukünftige Arbeitsstrukturen prägen. In der Praxis sind Unternehmen zunehmend daran interessiert, ihre eigenen Mitarbeiter in einer internen Crowd einzusetzen. Daher hat die Anwendung von internem Crowdsourcing in Unternehmen als neue Form der Orchestrierung von Arbeit erheblich zugenommen. Erste Untersuchungen haben gezeigt, dass Unternehmen aufgrund der Vorteile dieser neuen Arbeitsform, wie schneller Zugang zu internem Wissen und erhöhter Produktivität, internes Crowdsourcing einsetzen sollten. Obwohl Studien einige Vorteile identifiziert haben, ist internes Crowdsourcing eine komplexe Initiative und wir wissen nicht ausreichend, wie man interne Crowdsourcing-Systeme in einem Unternehmen gestaltet und sie in der Adaptation-Phase zu einem stabilen Betrieb führt. Ausgehend von der Perspektive der Socio-Technical System Theorie (STS) müssen Unternehmen verstehen, wie sie ein internes Crowdsourcing-System gestalten können, um sein Potenzial zu nutzen. Die Dissertation folgt einem Action Design Research Ansatz und entwickelt umfassende Designprinzipien für die Gestaltung eines internen Crowdsourcing-Systems. Sie entwickelt diese Prinzipien, indem sie die Anforderungen aus der Literatur ableitet, in einem Bankprojekt weiterentwickelt, in zusätzlichen Cases validiert und mit externen Experten bewertet. Darüber hinaus konzentriert sich die Dissertation in einem zweiten Schritt auf die Ableitung von Barriers für das interne Crowdsourcing und Lösungen zu deren Überwindung. Die meisten Barriers in der aktuellen Forschung konzentrieren sich jedoch hauptsächlich auf die operative Phase, wenn die Initiative bereits stabil läuft. Manche Forschungsarbeiten befassen sich mit Adapatation Barriers, aber die Analyserahmen, die zur Aufdeckung verwendet wurden, waren nicht umfassend, was zu nur wenigen Adaptation Barriers und Lösungen führte. Daher identifiziert die Dissertation Adaptation Barriers des internen Crowdsourcings durch die Technochange-Theorie in einer Multiple Case Study, untersucht, welche Lösungen die Unternehmen angewendet haben und beschreibt, wie die Lösungen funktionieren, um zu zeigen, wie man Barriers überwindet. Darüber hinaus werden allgemeine Empfehlungen zur Verbesserung des angepassten internen Crowdsourcing-Systems durch Standardisierungsmaßnahmen gegeben. Schließlich fasst die Dissertation die Erkenntnisse der Designprinzipien und Adaptation Barriers in einem Teaching Case zusammen, bevor sie auf Grenzen hinweist und zukünftige Forschungsperspektiven bietet.

1 INTRODUCTION[1]

1.1 Motivation and Research Gaps

Digitization fundamentally and simultaneously changes the environment and companies. In order to address fast-moving and uncertain developments, companies seek ways to improve the agility, productivity, and effectiveness of their business. One approach to achieve this is the principle of crowdsourcing, which is a new form of orchestrating work. Hence, the importance of crowdsourcing has increased to a large extend recently, which constitutes a promising alternative to the traditional mode of work in today's digital era (Knop et al. 2017; Kuek et al. 2015). Blohm et al. (2013) describe the fundamental principle of crowdsourcing as a crowdsourcer (which could be a company or an institution), who proposes to an undefined group of contributors (individuals or formal or informal teams) the voluntary undertaking of a task presented in an open call.

In organizations, crowdsourcing provides several benefits. For instance, broader access to specialized skills (Prpić et al. 2015), increased flexibility, faster hiring processes (Kuek et al. 2015), shorter product development cycles (Simula 2013) and low costs (Schenk and Guittard 2011). Crowdsourcing can be applied externally and internally of company boundaries. At first, crowdsourcing was used within the external setting, where contributors originate from beyond the company boundaries, which take part in a version of digital freelancing. Recently, companies increasingly use their own employees as a crowd for internal crowdsourcing in order to leverage co-production, collective intelligence and to organize them more efficiently in certain initiatives (Knop et al. 2017; Zuchowski et al. 2016a). The current practical sphere provides examples for the various applications of this principle internal crowdsourcing within business processes, such as the crowd providing innovation foresight in the market (Rohrbeck et

[1] Parts of this dissertation were published as early drafts:
Knop, N., and Blohm, I. 2018. "Adaptation Barriers in Internal Crowdsourcing: A Multiple Case Study," in: *European Conference of Information Systems (ECIS)*. Portsmouth, Great Britain.

Knop, N., and Blohm, I. 2018. "Leveraging the Internal Work Force through Crowdtesting - Crowdsourcing in Banking," in: *International Conference on Information Systems (ICIS)*. San Francisco, USA.

Knop, N., Blohm, I., and Leimeister, J.-M.. 2019. "Internes Crowdsourcing – Herausforderungen und Lösungsstrategien für eine erfolgreiche Transformation der Arbeitsorganisation," *HMD Praxis der Wirtschaftsinformatik* (56:4).

Knop, N., Durward, D., and Blohm, I. 2017. "How to Design an Internal Crowdsourcing System," in: *International Conference on Information Systems (ICIS)*. Seoul, South Korea.

al. 2015). The phenomenon of internal crowdsourcing involves complex interactions between humans and technology and therefore it describes novel socio-technical systems (STS) (Baxter and Sommerville 2011; Geiger et al. 2012). In the context of internal crowdsourcing, social as well as technical factors determine the organizational performance. Against the background of the STS theory (Leavitt 1964; Lyytinen and Newman 2008), the dissertation assesses the internal crowdsourcing phenomenon as systems covering four interrelated components: *task*, *structure*, *actor* and *technology* (Beese et al. 2015; Weilbach and Matthee 2015). Moreover, the research community examined STS issues affecting the specification, design and operation of work to some extent in the external setting (Baxter and Sommerville 2011). Yet, to implement internal crowdsourcing successfully within companies, research on external crowdsourcing cannot be directly applied to the internal crowdsourcing case because of major structural differences. The principal difference between internal and external crowdsourcing is the relationship between crowdsourcer and contributors that are clearly defined by employment contracts (Simula and Vuori 2012). The external context includes individuals in the crowd, not associated with the crowdsourcer's company. The individuals in the external crowd are rather self-employed agents since they are not employed by the crowdsourcer's company through a regular employment relationship and thus can freely define the terms of their employment in terms of time and location (Durward et al. 2016a). These differences lead to lack of design principles, which require new solutions (Knop et al. 2017).

Despite the identification of internal crowdsourcing advantages, organizations still require more knowledge regarding the design principles, how they can design a crowdsourcing system internally (Fitzgerald and Stol 2015) to capture its benefits (Zuchowski et al. 2016a). Only a few studies have been published addressing single components of the STS with respect to internal crowdsourcing filling some gaps. In the context of the STS component *actor*, as actors in internal crowdsourcing systems, early studies examined the benefits from aligning solvers and requestors (e.g., Simula and Ahola 2014), which can have a connection through an appropriate reward structure (e.g., Zogaj and Bretschneider 2014). Furthermore, internal crowdsourcing systems have been analyzed with respect to their incentive mechanisms (Benbya and Van Alstyne 2010; Leung et al. 2014) and evaluation methods (Geiger et al. 2012). Nevertheless, the selection criteria as well as composition have not been assessed comprehensively to date. Additionally, the incentive mechanisms of internal crowdsourcing maintaining a

mid- or long-term commitment of the crowd is missing (Zuchowski et al. 2016a). With respect to the STS *task* component, recent results from the research community focused either on the classification of tasks (Jette et al. 2015; Prpić et al. 2015), or highlighted the decomposition of tasks (e.g., Lopez et al. 2010). However, the design principles regarding connections between the subtasks and the task allocation process requires additional research, because these phenomena significantly influence the overall task design. Furthermore, the STS *technology* component, as in information technologies of internal crowdsourcing systems have been assessed especially with respect to the integration of crowdsourcing platforms in existing IT (e.g., Rohrbeck et al. 2015) and the specifications of those platforms (e.g., Bailey and Horvitz 2010). In contrast, the user interfaces or usability topics have been neglected leading to the lack of design principles. Despite the request of the research community for overarching frameworks as well as requirements for design principles, the STS components for internal crowdsourcing systems remain mostly unexamined. Furthermore, there are no research results from studies systematically analyzing all STS components in one system and their interrelations. Especially, the knowledge regarding the design of an internal crowdsourcing system, which is based on the STS components, is currently a black box in studies. As a result, internal crowdsourcing systems may be poorly designed and less successful in capturing the benefits, not delivering the value expected or required. The incentive mechanisms may not be effective to maintain an internal crowd in the mid- and long-term. Or the tools for the crowd are not designed according to requirements for contributors in the crowd leading to a crowd with lower productivity. Therefore, the dissertation seeks to apply the comprehensive STS theory to provide design principles enabling organizations to capture the benefits of internal crowdsourcing systems filling the outlined research gap (Knop et al. 2017).

In addition to the lack of design principles, internal crowdsourcing systems also provide change management challenges which arise during the process of transforming the traditional work mode in companies towards the new mode of internal crowdsourcing. Simply designing a system, but neglecting an appropriate rollout would prevent or reduce the capture of internal crowdsourcing advantages (Knop and Blohm 2018a). The research community and companies do not sufficiently know how to rollout internal crowdsourcing systems and guide the system to stable operations. Cooper and Zmud (1990) frame the process of guiding IT to stable operations in their IS implementation model as the adaptation stage. The dissertation will apply this framework, due to its

precise cover of the rollout until the stable operation. Internal crowdsourcing constitutes a complex socio-technical system that involves managing the crowd, providing IT solutions and embedding it internally in the company. The rolling out of such a system needs knowledge with respect to what management challenges actually occur during the adaptation stage and how to cope with them in order to benefit from the system by guiding it to stable operations (Zhao and Zhu 2014a; Zuchowski et al. 2016a). In general, employees are not acquainted with the new mode of work organization called crowdsourcing, which has egalitarian communication patterns with rather horizontal hierarchies. It stands in contrasts with the traditional, vertical and hierarchal mode of instructions through direct supervisors. Because of these differences, internal crowdsourcing alters the culture of companies (Zuchowski et al. 2016a). This change will include an introduction of new information systems (IS) or different use of IS currently available, due to the enablement of internal crowdsourcing through IS. Therefore, the adaptation of internal crowdsourcing is a technologically-driven organizational change, as described by the technochange lens (Markus 2004). This technochange lens combines the perspective of IS projects as well as their organizational challenges (Markus 2004). The dissertation analyzes the barriers of the internal crowdsourcing adaptation stage with the technochange perspective to examine the phenomenon comprehensively as well as to find solutions to adequately cope with them. The research community views adaptation barriers as critical incidents, challenges and risk factors that prevent or complicate the adaptation of IS, as seen in, for instance, internal crowdsourcing. The adaptation barriers come from organizational, communicational or legal incidents or risk factors (Bannerman 2008; Lüttgens et al. 2014; Malhotra et al. 2017). The process of overcoming the barriers is required to understand as well as adapt internal crowdsourcing, leading to new knowledge, which finally achieves the intended change. Thus, organizations have to engage with the barriers and learn from the process of removing them. Nevertheless, the process leading to the new mode of work is not completely assessed. The results of Malhotra et al. (2017) show seven barriers for internal crowdsourcing as well as solutions on how to overcome them. Nevertheless, these barriers remain mainly in the operational phase, as seen with, for instance, employees that do not possess enough time to participate or hesitate to do so, due to their boss being part of the crowd. Only a few studies examine adaptation barriers, where the assessment frameworks in recent literature detecting them were not based on comprehensive theoretical lenses (Erickson et al. 2012), but rather extracted

their results from literature reviews with respect to crowdsourcing only. Thus, Erickson et al. (2012) have found only a small number of adaptation barriers for internal crowdsourcing but also derived few solutions to overcome them. Because of the limited range of research results addressing adaptation barriers, unknown adaptation barriers exist, and organizations are troubled by encountering them as well as deriving solutions to overcome them in order to capture the benefit of internal crowdsourcing systems.

To know how to design an internal crowdsourcing system and to possess solutions to remove adaptation barriers supports an informed decision process of companies regarding the choice of selecting internal crowdsourcing as a system for solving a problem or not (Leicht et al. 2016b; Zogaj 2016). Finally, it enables organizations to capture the benefits of internal crowdsourcing through appropriate design and solutions guiding the system to stable operations (Knop and Blohm 2018a; Malhotra et al. 2017). Therefore, the dissertation follows the research request of Zuchowski et al. (2016a), Leicht et al. (2016b), Zogaj (2016) as well as Zhao and Zhu (2014a) to conduct comprehensive studies with respect to the design of internal crowdsourcing and related barriers in its adaptation phase.

1.2 Research Questions and Goals

In the beginning, the research community had shown why companies use internal crowdsourcing in their organizational context (e.g., Ågerfalk and Fitzgerald 2008). First study results shed light on the benefits of applying internal crowdsourcing, for instance, the fast access to increased productivity (Jette et al. 2015) and internal knowledge (Gaspoz 2011). But regardless of increasing scholarly interest, some important research gaps remain in the field of internal crowdsourcing. In order to address the design principles of internal crowdsourcing systems and management challenges of adaptation barriers, illustrated in chapter 1.1, the dissertation follows two research questions (1) *How to design an internal crowdsourcing system?* and (2) *How to overcome adaptation barriers for internal crowdsourcing in organizations?*

RQ1: How to design an internal crowdsourcing system?

The dissertation answers the first research question by developing design principles, which were missing according to the research gap described in 1.1, through the Action Design Research (ADR) method. Design principles are an appropriate means to fill the research gap, because they are a form of design knowledge providing more than

instantiations and are applicable in a broader context (Chandra et al. 2015; Gregor and Hevner 2013; Gregor and Jones 2007). Therefore, design principles reflect a rule, guidelines, general design considerations or standard of conduct (Hevner and Chatterjee 2010; Lidwell et al. 2003; Sein et al. 2011), which would improve the current status of internal crowdsourcing system design. The ADR research method is appropriate to develop these design principles, because on one hand it combines theory with practice through a comprehensive cycle of design and evaluation deriving systematic specification of design knowledge. On the other hand, ADR develops prescriptive design understanding by building as well as evaluating IT artefacts (Gregor and Jones 2007; Sein et al. 2011; Von Alan et al. 2004).

In order to achieve this research goal, the dissertation describes design goals as challenges in "Problem Formulation" 4.2.1 in detail and subsequently follows a systematic literature review (Vom Brocke et al. 2009; Webster and Watson 2002) assessing the current research outcome regarding requirements for internal crowdsourcing systems. Thus, the dissertation is to identify requirements to increase the understanding of design principles as described in 1.1. In addition, workshops with testing and crowdsourcing experts are conducted deriving missing requirements and to fill the gaps. The sum of requirements were structured according to the socio-technical system theory and its four components (Mumford 2006) enabling an overview of components, which were necessary to be addressed with the goal of achieving a comprehensive set of requirements. Relating to the comprehensive requirements, building blocks of an internal crowdsourcing system are conceptualized in order to operationalize and evaluate it. Based on the evaluation, the dissertation can reflect the results and derived design principles, which were consolidated according to the STS components. Through the procedure described above the dissertation seeks to derive robust design principles for internal crowdsourcing systems and to address the research gap regarding missing design knowledge.

RQ2: How to overcome adaptation barriers for internal crowdsourcing in organizations?

After designing a system, it needs to be rolled out in the organization successfully in order to capture the benefits of internal crowdsourcing. Yet, results from the research community addressing adaptation barriers of internal crowdsourcing are rare and the research gap remains. As described in 1.1, the current state of research regarding internal crowdsourcing barriers focuses mainly on few results or falls outside the adaptation

phase. The lack of knowledge regarding adaptation barriers and solutions to overcome them, prevents companies to capture the benefits of internal crowdsourcing (Zhao and Zhu 2014a; Zuchowski et al. 2016a). Therefore, the dissertations goal is to widen the knowledge base through a multiple case study (Siggelkow 2007; Yin 2013), while focusing on the adaptation phase (Cooper and Zmud 1990). The dissertation fills the research gap by examining the adaptation barriers of internal crowdsourcing comprehensively with the technochange theory (Markus 2004), assessing the solutions companies used and depicting how the solutions are applied to overcome barriers in internal crowdsourcing (Knop and Blohm 2018a). The technochange theory is an appropriate means to support the goal of the dissertation in the multiple case study because it represents a perspective that summarizes the great complexity of change management in IT projects and acts as a lens identifying challenges related to the changes, such as barriers in internal crowdsourcing initiatives (Fearon et al. 2013; Harison and Boonstra 2009; Knop and Blohm 2018a). Furthermore, the multiple case study is suitable for the research question because of the contemporary phenomenon of internal crowdsourcing, which is analyzed in a real-life context with a complex social setting, whose boundaries between the phenomenon and its context are not entirely evident. (Eisenhardt 1989; Maxwell 2008; Yin 1994).

The multiple case study is applied in three cases of different companies overcoming adaptation barriers of internal crowdsourcing, which were accompanied up to 18 month in order to collect from several arrays of multiple data sources (Creswell 1998). In this period, the dissertation focused on a main case and analyzed the occurring barriers in depth. In addition, the results were compared with the barriers and solutions that occurred in the other cases. In order to ensure comparability, the dissertation focused on crowdsourced software testing, providing a context of complex and reoccurring crowdsourcing initiatives presenting a large number of opportunities for observing and assessing the adaptation barriers in 18 testing iterations. Based on the described procedure, the dissertation aimed to identify adaptation barriers and their solutions to overcome them in order to fill the research gap. Finally, recommendations are presented to further standardize the adapted system and increase the capture of internal crowdsourcing benefits.

1.3 Structure of the Dissertation

In order to answer the research questions stated in chapter 1.2. the dissertation is structured as follows (see figure 1.).

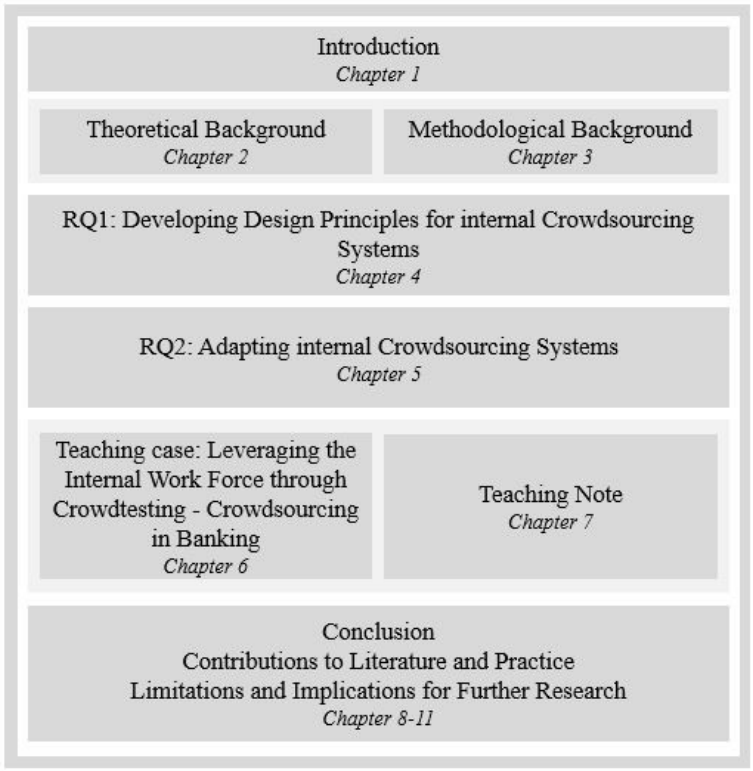

Figure 1. Structure of the Dissertation

The dissertation introduced the research scope in chapter one and will continue to describe the means to address the scope in chapter two and three. In chapter two the theoretical background is reflected, providing the theoretical frameworks and theories, which were used to answer the research questions. The theoretical background provides the reader an understanding of the concepts addressed in the dissertation and explains the purpose of the theories regarding the research questions. In addition, the methodological background in chapter three gives the reader the overview for the chosen research methods and describes the procedures as well as how they will support the dissertation in answering the research questions. In chapter four the dissertation answered the first research question by developing design principles for internal crowdsourcing systems. Following in chapter five, the second research question is answered by assessing adaptation barriers of internal crowdsourcing systems in organizations and their solutions to overcome them. The chapters six and seven summarize the findings of research questions one and two in a teaching case and

teaching note by restructuring them for teaching purposes. They reduce complexity and focus on the essential aspects by prioritization of the dissertation's outcome. This transparency will support practitioners to focus on important first steps and guide scholars to important future fields of research. The chapter eight concludes the findings of the dissertation, leaving chapter nine and ten to describe the contributions to literature and practice. Finally, the dissertation provides in chapter eleven the limitations and implications for further research.

2 THEORETICAL BACKGROUND

The theoretical background introduces the theoretical frameworks and theories, which were used to answer the research questions regarding the design of internal crowdsourcing systems and their adaptation towards a stable operation. The chapter provides the reader first the understanding of the basic principle of the dissertation "crowdsourcing" and continues with the differences between internal and external crowdsourcing, clarifying the dissertation scope of internal crowdsourcing.

2.1 Crowdsourcing

The principle of crowdsourcing originates from the two words "Crowd" and "Outsourcing", which were first combined by Howe (2006). As crowdsourcing taps into the potential pool of a large undefined crowd, there are various ways of conducting a crowdsourcing initiative leading to different outcomes. Geiger et al. (2012) classify the various crowdsourcing ways in archetypes according to two dimensions. Firstly, they differentiate between homogenous as well as heterogeneous outcomes and secondly, between emergent and non-emergent outcomes.

Firstly, crowdsourcing can value contributions homogeneously. As soon as a contribution complies with a predefined specification, the outcomes are accepted and equally valued. The contrary is the case with a heterogeneous appreciation of outcomes, based on their individual values. Each contribution is seen individually and may constitute an alternative to other outcomes or be complementary. Secondly, in a non-emergent crowdsourcing initiative, the value from the outcome derives from all or some of the individual crowd submissions. The value comes from the entity of the submissions or the links between them. A single submission adds only a part of the value and is dependent on the value of the other contributions. Isolated submissions are not accepted or valued.

The combinations of the two dimensions lead to the four archetypes of Geiger et al. (2012). The four archetypes are illustrated in figure 2. These give an overview on different options of how a crowdsourcing challenge might be set up. The first archetype is called "Crowd Processing" and describes an initiative that seeks homogeneous submissions and non-emergent values from the single contributions. The submissions are equal in quality and gain value on their own, while not being dependent upon other

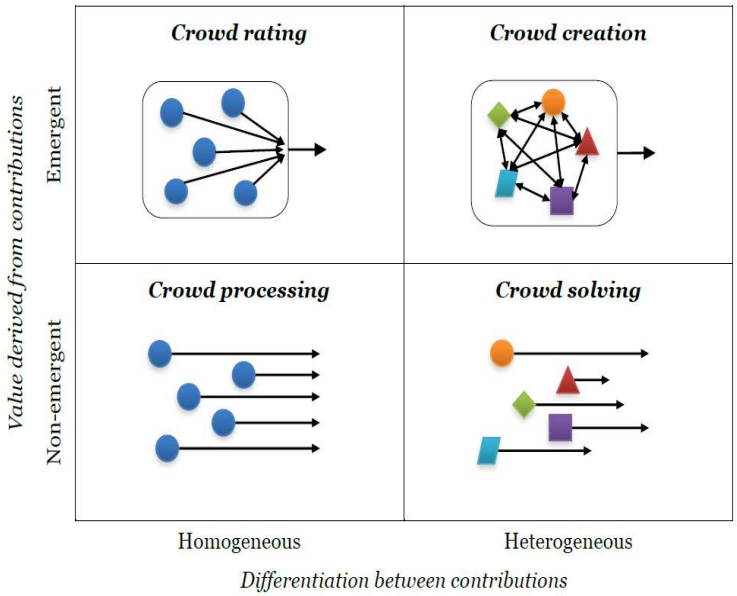

Figure 2. Crowdsourcing Archetypes (Geiger et al. 2012)

submissions. An example of such an archetype could be initiatives with a crowd conducting tasks in large quantities, which were splitted up before, such as micro-tasks of Amazon Mechanical Turk (Blohm et al. 2014; Doan et al. 2011). The second archetype is called "Crowd Rating". It derives the value from large quantities of homogeneous submissions and the emergent relationships between them. Homogeneous submissions are referred to be equal and, in this context, gain value in the emergent collection of the other contributions. In this regard, "Crowd Rating" enables rating systems to be more precise using the wisdom of the crowd (Blohm et al. 2013; Surowiecki 2005). The third archetype is "Crowd Solving". It derives non-emergent value from individual heterogeneous submissions. Each submission is assessed according to predefined specifications and can vary in quality, being alternative or complementary to a given task. This archetype could be used to address a specific problem or task, such as the Netflix Prize. Netflix conducted a competition to optimize algorithms with a crowd whereby the best submission would win a prize (Bennett and Lanning 2007). The last archetype is "Crowd Creation", which seeks heterogeneous

submissions and derives its value in the emergent collection of them. It focuses on the individual quality of each submission adding to the total emergent outcome of the crowd. Such an example would be YouTube or Wikipedia, which will be elaborated upon below (Geiger et al. 2011). The crowdsourcing archetypes can operate in different settings, depending on two dimensions: i) who designs as well as operates the crowdsourcing platform and ii) who represents the crowd. Regarding the first dimension, an intermediary can provide the platform as a service and operate it as a mediated platform. Conversely, the crowdsourcer itself can design and operate a crowdsourcing platform. In this setting, the crowdsourcer is responsible for designing and operating it independently. This would include additional tasks and responsibilities for the crowdsourcer, which it would not face if it chose the service of an intermediary (Knop et al. 2017; Leicht et al. 2017). Regarding the second dimension, the crowd can be an external or internal one. The external crowd constitutes individuals from outside the organization's boarder. Therefore, a crowdsourcer can tap into the talent pool of a crowd without having to respect important changes internally. The internal crowd constitutes individuals from inside the organizational boarder, such as employees. Since crowdsourcing constitutes a new means of work distribution, using an internal crowd would mean adapting and managing a cultural change within the organization (Zuchowski et al. 2016a).

These two dimensions lead to four different settings for crowdsourcing. Firstly, "Internal Crowdsourcing" operates its own crowdsourcing platform and uses an internal crowd. In this setting, the crowdsourcer requires the design and operation of the internal crowdsourcing platform with respect to all tasks and responsibilities. As the crowdsourcer uses an internal crowd, it has to adapt crowdsourcing internally, but also manage the cultural change. Secondly, "Internal Mediated Crowdsourcing" operates with the assistance of an intermediary's platform but uses an internal crowd. On the one hand, the crowdsourcer does not need to design an internal crowdsourcing platform and is thus able to transfer tasks, as well as responsibilities, to the intermediary. On the other hand, the crowdsourcer has to adapt and manage the cultural change internally, due to the internal crowd. Thirdly, "External Crowdsourcing" operates an internal crowdsourcing platform with an external crowd. The design, tasks and responsibilities of an internal platform remains with the crowdsourcer, but it does not require a cultural change in management, due to the external crowd. The design, tasks and responsibilities of an internal platform remains with the crowdsourcer, but it does not require a cultural

change in management, due to the external crowd. Finally, "External Mediated Crowdsourcing" uses an intermediary providing the mediated crowdsourcing platform with an external crowd. In this setting, the crowdsourcer transfers tasks, as well as responsibilities, to the intermediary and does not design a crowdsourcing platform. In addition, the crowdsourcer does not manage an internal cultural change, due to the external crowd (Blohm et al. 2014; Knop et al. 2017; Leicht et al. 2017; Zuchowski et al. 2016a). The crowdsourcing settings are depicted in figure 3.

2.1.1 Differences of Internal and External Crowdsourcing

Internal crowdsourcing and external crowdsourcing are related to some extent but also

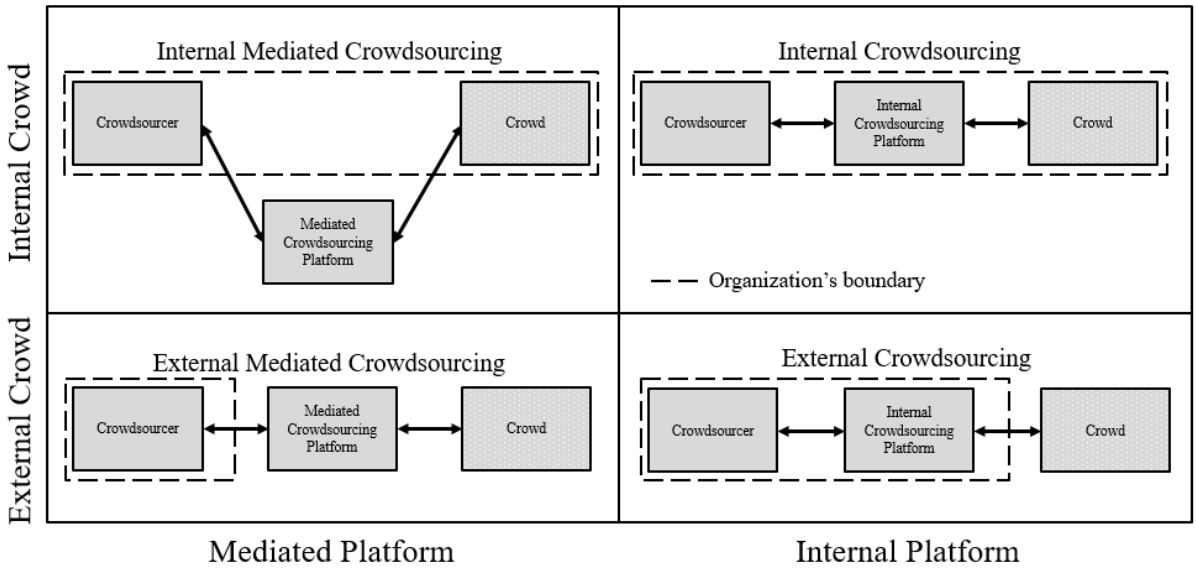

Figure 3. Crowdsourcing Settings (based on Blohm et al., 2014)

have certain significant differences (Zuchowski et al. 2016a). A central difference between internal and external crowdsourcing is the relationship between crowdsourcer and crowd. In internal crowdsourcing, members of the crowdsourcer's organization, for instance employees with employment contracts, assemble the crowd. In external crowdsourcing, every individual of the outside world could be part of a crowd, increasing anonymity and decreasing the link between the crowd and the crowdsourcer (Simula and Vuori 2012). Consequently, the external crowd is able to choose their working time and location more freely (Durward et al. 2016a). In the context of internal crowdsourcing, the employees in the crowd perform tasks of crowdsourcing initiatives within the line of their everyday responsibilities and cannot choose their own crowdsourcing time and location freely (Bonabeau 2009; Lopez et al. 2010). Based on this central difference in the relationship between crowdsourcer and crowd, the nature

of conducting crowdsourcing initiatives varies extensively (Zuchowski et al. 2016a). In internal crowdsourcing, the crowdsourcer can be in a superior role with respect to the crowd. The external setting does not have such a traditional understanding of hierarchy, because the external crowd has a high level of independence towards the crowdsourcer and acts based on a mainly voluntary basis (Benbya and Van Alstyne 2010; Denyer et al. 2011; Zuchowski et al. 2016a). For example, the task allocation in internal crowdsourcing has greater similarities with traditional task assignments compared to external crowdsourcing (Zogaj and Bretschneider 2014), because the internal crowdsourcer is also operating through traditional hierarchies and structures with the purpose of distributing tasks to the crowd. Furthermore, the crowdsourcer of internal crowdsourcing covers the complete range of governance, which entails the determination and control of the processes with the crowd directly. In an external setting, the crowdsourcer can transfer tasks to an intermediary such as setting up crowdsourcing initiatives or the support during the initiatives, which provides the crowd with potential questions. Moreover, the first evaluation of the crowd's submissions can be conducted through the intermediary, which can decrease the amount of workload for the crowdsourcer tremendously (Leicht et al. 2016a; Simula and Ahola 2014). Finally, these differences between internal and external crowdsourcing lead to a different motivation of the crowd. Thus, the two different crowds require different concepts and motivational approaches (Meloche et al. 2009; Simula and Ahola 2014).

2.1.2 Crowd Work

The contributors in a crowd can reflect a broad range of individuals with different backgrounds. Reasons for participation vary on a personal basis such as amusement or recreation, social interaction between participants or remuneration benefits. Durward et al. (2016a) assessed forms of digital work with a focus on crowdsourcing. Their assessment derives the understanding of crowd work through the term "work", which they understand in general as an effort to create services and goods. In the sphere of term work, they find gainful employment, which is working in order to create income. The gainful employment can be conducted in a digital manner meaning working "digitally" in order to create income. In this context, crowd work is a form of digital gainful employment, as depicted in figure 4.

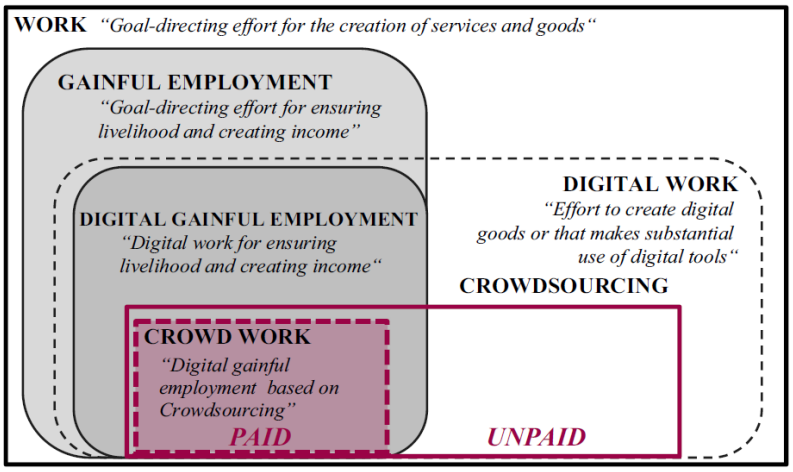

Figure 4. Classification of Crowd Work (Durward et al. 2016a)

Against this background, contributors can participate in crowdsourcing initiatives with or without pay. Crowdsourcing without pay could be initiatives, such as creating Wikipedia articles or uploading content on YouTube and are not considered crowd work. Durward et al. (2016a) found in their research that Alter (2013) described some activities of individuals in a crowd as crowd work already, which seemed to be a form of gainful employment with pay. Therefore, these individuals were named crowd workers, creating digital goods and services by using digital tools. Durward et al. (2016a) defined crowd workers more precisely as contributors that:

(1) receive remunerations for their activities in the crowd with lower intrinsic motivation.

(2) ensure substantial parts of their income through crowdsourcing.

(3) are self-employed and not by the crowdsourcer directly.

Furthermore, Durward et al. (2016a) developed the definition in the context of external crowdsourcing only. Due to the major difference between internal and external crowdsourcing highlighted above, the definition should be altered in the three parts, whereby internal contributors:

(1) receive remunerations, not directly from their activities in the crowd, but indirectly through their paycheck, because they conduct crowdsourcing during the working hours. In addition, the motivation is mostly intrinsic. The employees participate, because they are interested in the crowdsourced task (Knop and Blohm 2018a; Leicht et al. 2017).

(2) follow their everyday responsibilities and crowdsourcing is so far only a part of it. Therefore, the internal crowd workers do not ensure substantial parts of their income in crowdsourcing (Leicht et al. 2017).

(3) are not self-employed, but by the crowdsourcer (Leicht et al. 2017).

2.2 Application Fields of Internal Crowdsourcing

The theoretical background continues with illustrating application fields in order to enable the reader to understand the diversity of the principle and the scope application fields in the dissertation addressing the research gaps depicted in chapter 1.1.

2.2.1 Crowdtesting

Internal crowdsourcing can be applied in the field of crowdsourced software testing or crowdtesting, which uses a large pool of contributors in a crowd to test software in real environments using their own devices (Leicht et al. 2017). Contributors conducting crowdtests are also called crowd testers. Since crowdtesting derives from traditional software testing, there are different settings, such as functional testing or usability testing (Stol and Fitzgerald 2014b). Within these settings, the crowd testers conduct software tests and submit software issues of the test object to the crowdsourcer. These crowdtests often have a competitive nature. If a crowd tester submits a software issue, which was submitted previously by another crowd tester, the submission is not accepted by the crowdsourcer (Leicht et al. 2016a). Therefore, crowdtesting belongs to the archetype “Crowd solving” (Geiger et al. 2012). The outcome might be different (e.g., crowd testers find different software issues), meaning it is heterogeneous. In addition, the outcome is non-emergent. Each outcome can have diverse values, such as high or low severity, and gains value on its own, not requiring other submissions to gain value.

Crowdtesting provides a range of advantages for a crowdsourcer. Firstly, external crowdtesting adds capacity to a testing department and support it during periods of high workload. Secondly, internal crowdtesting enhances traditional user acceptance through integrating employees in the process of testing new internal software. Thirdly, crowdtesting with potential customers can create a relationship between them and the crowdsourcer. It can increase customer satisfaction and loyalty by involving them in the testing process (Leicht et al. 2017). Fourthly, crowdtesting can be prepared and conducted in a short period of time, helping crowdsourcers under pressure. Finally, crowdtesters mostly use their own devices to conduct crowdtests. By doing so, a

crowdtest can cover a high diversity of devices in real life and increase the coverage in a real life environment (Leicht et al. 2016b).

2.2.2 Crowdsourced Innovation

Early research provided knowledge regarding the positive outcomes of open innovation (Fey and Birkinshaw 2005; Laursen and Salter 2006). Recent research highlighted the necessity to build crowdsourcing capabilities to use the innovative advantages internally with employees (Foss et al. 2011; Lüttgens et al. 2014). Subsequently, using the crowdsourcing principle for innovation initiatives internally showed to be an effective principle in order to increase the efficiency of a company's innovation process (Lüttgens et al. 2014). For example, IBM brought together thousands of employees in order to brainstorm and bring forward new ideas for products (Bjelland and Wood 2008). These "Innovation Jams" produced a large amount of ideas, using the wisdom and creativity of the crowd (Lüttgens et al. 2014; Martinez and Walton 2014). IBM evaluated and slowly developed these ideas further and were able to make an innovative difference in the portfolio from a long term perspective (Bjelland and Wood 2008).

Other internal innovation activities supported by the crowdsourcing principle showed to be effective. Deutsche Telekom for example integrated 350 employees in a crowd for innovation foresight activities. The crowd detected changes in the market and documented it, allowing managers to interpret the changes and derive responses. Finally, Deutsche Telekom addressed 200 new changes in the market, which allowed them to interpret such changes that were in the stage of a weak signal. Most of the changes were detected, because of the internal crowd's input. The internal crowd foresight involved a high diversity of expertise from the crowd, enabling an effective interpretation of the signals. Consequently, Deutsche Telekom was able to produce forecasts that are more precise and enabled managers to use the information with the purpose of deriving adequate managerial responds to the changes (Rohrbeck et al. 2015).

2.2.3 Other Applications of Internal Crowdsourcing

The principle of internal crowdsourcing can be applied in various activities within business processes and the possibilities range from the beginning from the supply chain to the end as well from the primary to support activities (Blohm et al. 2014). Bosch used an internal crowdsourcing platform, integrating employees as a crowd to redefine and specify definitions of a logistics dictionary. The crowd were employees of the logistics

department and required precise definitions of terminology that enable them to cooperate with other logistic departments. However, some definitions were not common knowledge, precise enough or shared amongst the different logistic departments. Thus, Bosch included employees to improve these definitions. Through the principle of internal crowdsourcing, they could include employees from many different countries, covering vast parts of the global logistic departments, who cooperated to specify the definitions. As a result, the crowd produced 343 articles by 91 authors, which were used by 2854 employees (Zuchowski et al. 2016b).

Moreover, Deloitte developed an internal crowdsourcing platform, which provided employees with a large pool of experts, enabling them to find expertise for certain problems more easily. Finally, 5124 employees joined the pool of experts, which created 394 groups to address certain fields of problems. The application of the internal crowdsourcing was highly diverse, depending on the required expertise for a problem. The platform was a success for Deloitte, providing a possibility to find internal expertise more efficiently by providing a space to discuss, share information and problem solving (Riemer and Scifleet 2012).

2.3 Requirement Engineering

This chapter introduces the theoretical concept of requirement engineering used as an initial step answering the first research question of the dissertation in chapter 4, which derived requirements of internal crowdsourcing systems as a foundation for the development of the design principles.

Requirement engineering focuses on the identification of goals that should be achieved by an IT artefact, the operationalization of the goals and the responsibilities involved. Therefore, the process includes an analysis, elicitation, specification, assessment, negotiation, documentation and evolution (Van Lamsweerde 2000). In addition, the process design of requirement engineering is a cooperative, iterative and incremental process, which should ensure the fundamental understanding of the relevant requirements, a consensus of the stakeholders and a document stating the specified requirements (Pohl 2007). In requirements engineering, the requirements include specific stakeholder needs (Hull et al. 2011), but also conditions that are required for building as well as establishing a IT artefact (Knop et al. 2017). The outcome can result into requirements with specific stakeholder needs (Mandviwalla and Olfman 1994).

Against this background, requirements have to answer three questions (Van Lamsweerde 2000):

(1) Why is the IT artefact needed, asking for the goal?

(2) What are the features of the IT artefact, asking for the functionalities?

(3) How is the system constructed, revealing the constrains?

2.4 Design Principles

The research goal of the first research question is to fill the lack of design principles by developing them, which are explained generally in the following. Design knowledge can have a variety of forms with differing levels of abstraction, including constructs, methods, models, technological rules, design principles or design theories. An important form presenting design knowledge, which passes beyond instantiations and is applicable outside of a limited context, are design principles (Chandra et al. 2015; Gregor and Hevner 2013; Gregor and Jones 2007). Against this background, design principles reflects knowledge about instances of a class of IT artefacts, representing a rule or standard of conduct (Hevner and Chatterjee 2010; Sein et al. 2011). In a more general perspective, design principles can be considered as laws, guidelines, biases, and general design considerations (Lidwell et al. 2003). In a more detailed perspective of Gregor (2006), the IS research taxonomy of theory types categorizes design principles as a class of theory for design and action. This type of theory provides explicit prescriptions, such as methods, techniques, principles of form and function, in order to construct an artifact. A design theory includes a range of components, such as principles of form as well as function defining the structure, organization, and functioning of the design product or design method (Chandra et al. 2015; Gregor and Jones 2007). Therefore, design principles are important, because:

(1) they reflect and communicate important design knowledge.

(2) they enable a higher level of abstraction, go beyond singular settings and generalize prescriptive knowledge.

(3) they capture construction and description of an IT artefact as well as technological rules in the process of the development of more comprehensive bodies of knowledge or design theories (Chandra et al. 2015; Gregor and Hevner 2013).

In sum, design principles can encapsulate design knowledge and conceptualize it as a primary format for formalizing design knowledge. Gregor and Hevner (2013) see design principles as a way for communicating nascent design knowledge and as an important form of knowledge communication within mature design theories (Gregor and Hevner 2013; Gregor and Jones 2007; Heinrich and Schwabe 2014).

2.5 Adaptation of Internal Crowdsourcing

In the following chapter, the dissertation has a closer look at the adaptation of internal crowdsourcing in order to provide the theoretical background for research question two regarding adaptation barriers. Initially, this chapter specifies the context of adaptation in IS implementation and explains the phase, where adaptation barriers occur in general. Further, the dissertation addresses adaptation barriers in order to connect them to internal crowdsourcing and describes how the dissertation applies it to detect adaptation barriers.

2.5.1 IS Implementation According to Cooper and Zmud

Avoiding IT implementation failure is important, costs of IS failure and implementation are estimated in the high billion dollars per year (Dalcher and Genus 2003). An important step towards successful IT implementation was the model of the IT Implementation Process of Cooper and Zmud (1990). The process supported a transparent approach to implementing IS and aided in avoiding mistakes during the process. It was based on previous work, such as Kwon and Zmud (1987) model of IT implementation activities and Lewin (1952) change model. Cooper and Zmud (1990) structure the IT Implementation Process according to six phases:

- *Initiation*: The process begins with scanning the organization for problems and potential IT solutions to solve them. At the end of this phase, each problem should be matched with an appropriate solution.
- *Adoption*: After the initiation, the adoption follows with negotiations with regards to receiving organizational backing for the solution's implementation. Finally, a decision to invest should be found.
- *Adaptation*: Preceding adoption, the IS needs to be adapted to the organization by ensuring its development, installation and maintenance as well as appropriately training the personal. Consequently, the IS is available in the organization.

- *Acceptance*: The personnel of the organization get introduced and motivated to commit to the IS. Therefore, the IS is employed in the organizational work context.
- *Routinization*: Focuses on encouraging a normal usage of the IS in the organization. At the end, the governance system of the organization is adjusted to the IS.
- *Infusion*: The organizational performance achieved an increased effectiveness through the implemented IS. In this regard, the IS is applied to the fullest of its potential.

As depicted in chapter 1.1, companies still struggle to adapt internal crowdsourcing to their organization. In the following, the dissertation explains what these adaptation barriers are, what their impact is and how they occur.

2.5.2 Adaptation Barriers in Internal Crowdsourcing

Many companies try to transform the internal workforce through internal crowdsourcing. In this context, for example, the CEO of Daimler declared to transform 20% of Daimler's employees into an internal crowd for different innovation initiatives (Zetsche 2017). Nevertheless, assembling and managing such a large crowd is a difficult challenge, because of the organizational transformation. Another example includes Allianz UK Group, who designed an internal crowdsourcing platform as a large pool generating ideas to drive innovation. While the design and implementation of the internal crowdsourcing platform was relatively easy, the organization required eight years in order to adapt fully the new work mode into their business operations capturing all the benefits created from internal crowdsourcing (Benbya and Leidner 2016). The adaptation was lengthy because it represents an important cultural change, which needs guidance in order to overcome the adaptation barriers. Within scholarly literature, adaptation barriers are critical incidents, challenges as well as risk factors preventing or complicating the adaptation of IS, as in internal crowdsourcing. They are derived from organizational, communicational or legal incidents or risk factors (Bannerman 2008; Knop and Blohm 2018a; Lüttgens et al. 2014; Malhotra et al. 2017). For example, most personnel are not familiar with internal crowdsourcing as a new mode of digital work organization since it contrasts the traditional hierarchal mode of instructions by direct supervisors. It requires time for the management to transform the mind of employees. They have to work in a new work mode with a more open and democratic environment.

The mode needs a shift from the traditional, hierarchical, as well as formal mode to a decentralized work mode with egalitarian communication structures (Zuchowski et al. 2016a). Therefore, The Allianz UK Group required eight years to overcome the adaptation barriers of internal crowdsourcing. The organizational process of overcoming the barriers is required for understanding and adapting internal crowdsourcing, which will finally lead to new knowledge and the intended cultural change. Thus, organizations have to face the barriers and also learn from the process of removing the barriers.

Against this background, existing research assessing internal adaptation barriers is fairly limited. The assessment frameworks applied in the past in order to detect adaptation barriers did not refer to comprehensive theories but were rather based on reviews of crowdsourcing literature only. For instance, Erickson et al. (2012) referred in their theoretical framework to the crowdsourcing literature. They derived the "crowd" (Di Gangi and Wasko 2009; Stewart et al. 2009), "crowdsourcing benefits" (Anthes 2010; Poetz and Schreier 2012) or "negative impacts" (Bonabeau 2009; Jouret 2009). It was found that there are two generic barriers for adapting internal crowdsourcing, namely *organizational perceptions of value* and *organizational practice*. The first generic barrier describes a need for altering the perception of the crowdsourcing value in companies to increase acceptance for the application of internal crowdsourcing. Furthermore, the article points out that the executive leadership required leads to increase awareness as well as create incentives proactively, generating participation of the internal crowd. In addition, Zuchowski et al. (2016a) describe the potential reluctance of important employees, because they need to adapt to the new mode of work, internal crowdsourcing. Thus, management of corporate culture and change is a central role during the process of adapting internal crowdsourcing (Zuchowski et al. 2016a). Finally, Malhotra et al. (2017) derived seven barriers for internal crowdsourcing. These barriers cover participation and collaboration in stable operations. Hence, the research community found only a few adaptation barriers for internal crowdsourcing. Important adaptation barriers potentially remain unknown, which prevents organizations of overcoming adaptation barriers of internal crowdsourcing and learning from the experience. The learning process is required to capture the benefits of internal crowdsourcing and guide the system to stable operations (Knop and Blohm 2018a).

2.6 Socio-Technical Systems Theory

After providing the background of the principle crowdsourcing and its scope in the dissertation, the chapter builds on the following pages the understanding of the socio-technical system theory applied for the first research questions and describes the connection to crowdsourcing.

2.6.1 Origin of the Socio-Technical Systems Theory

Information Systems are known for being socio-technical systems (Beese et al. 2015). The STS theory illustrates system design as a procedure, which includes social and technical aspects affecting the functionality and usage of IT-based systems (Baxter and Sommerville 2011). The general nature of such a system relies on a broad range of non-linear and dynamic mechanisms that are related to the social and technical subsystems (Beese et al. 2015). The theoretical perspective of STS is currently among one of the most extensive bodies of conceptual and empirical literature for work design applications (e.g., Mumford 2006; Sykes et al. 2014). Literature shows researchers applying the STS theory in order to analyze systems with complex interactions between humans, technology and the environmental aspects of a work system (Baxter and Sommerville 2011). In the STS lens, these systems have four basic socio-technical components (Beese et al. 2015; Lyytinen and Newman 2008). According to Lyytinen and Newman (2008), *actors, tasks, structure,* and *technology* are related with each other and embedded in the organizational environment*,* which drives and influences change (Beese et al. 2015; Knop et al. 2017).

Nevertheless, according to recent studies, information systems (IS) are seen as complex STS, in which humans are a part of social subsystems while IT artifacts of technical subsystems, both interacting in order to process information (Beese et al. 2015; Lyytinen and Newman 2008). In this context, crowdsourcing establishes a specific form of IS, which results into informational products and services for internal or external customers by profiting from the potential of a crowd (Geiger and Schader 2014). Based on this background, the STS lens seems to be an appropriate theoretical perspective to assess internal crowdsourcing systems comprehensively to derive design principles for this new form of work organization (Knop et al. 2017).

2.6.2 Internal Crowdsourcing as a Socio-Technical System

Zuchowski et al. (2016a) describe internal crowdsourcing as an IT-enabled group activity initiated by an open call for participation in an organization. According to the definition and the nature of STS theory, internal crowdsourcing illustrates a complex work system for several reasons. Firstly, it reflects a competitive, collaborative, or networked group-activity of several *humans* (Zhu et al. 2014). Secondly, it represents a *technology*-enabled phenomenon including the usage of both generic social media (e.g., wikis, blogs) (Stocker et al. 2012) as well as specialist tools (e.g., a scanning tool for weak signals on change to support the corporate foresight activities) (Rohrbeck et al. 2015). Thirdly, internal crowdsourcing occurs in organizational contexts as a specific environment (Simula and Vuori 2012). Therefore, with the consideration of current IS research (Beese et al. 2015; Lyytinen and Newman 2008), we illustrate the four components of internal crowdsourcing as a socio-technical system (Knop et al. 2017):

- **Actors:** Describes enterprise members and main stakeholders conducting the internal crowdsourcing initiatives, including their influences and motivation.
- **Task:** Illustrates the internal crowdsourcing systems goals and purpose as well as the manner in which the crowdsourcing initiative is conducted within the enterprise.
- **Structure:** It covers the concepts of communication, authority and workflow of the system. In addition, structure addresses both the normative dimension (norms, values, and the general role expectations) as well as the behavioral dimension, (concepts of behavior such as humans communicate, conduct authority, or work in the crowd of the internal crowdsourcing system).
- **Technology:** It describes tools or problem-solving artefacts such as work evaluation and computers, which represent parts of the internal crowdsourcing system.

Nonetheless, one can find organizational conditions, which may lead to potential challenges to acceptance and make use of internal crowdsourcing systems and therefore influence the four STS components (Erickson et al. 2012). For instance, the retention of hierarchical privileges as well as resistance from certain stakeholders may affect the structure of an internal crowdsourcing system. In addition, some personnel in the organization might not possess the required competences for a specific internal crowd and thereby limit the potential number of contributors.

Moreover, the distinct nature of internal crowdsourcing must be considered in order to design the four STS components and decide which aspects are the most important for a particular situation. Crowdtesting is an important field of application in practice since the recent development of IT-enabled businesses and a great increase in the hardware market (Leicht et al. 2016c; Zogaj et al. 2014). Against this background, STS in combination with the understanding of crowdsourcing will support the dissertation to answer the first research question.

2.7 Technochange Theory

Finally, the theoretical background describes the theoretical lens that supports answering the second research questions. It describes the technochange theory in general terms and links the theory to the basic principle of the dissertation "crowdsourcing".

2.7.1 Overview of Technochange

Markus (2004) describes technochange as a technology-driven organizational change that addresses organizational performance of a socio-technical system. In this perspective, they developed the technochange management lens, which combines the technological as well as the change management perspective in IT projects. Thus, technochange projects affect a range of different aspects, such as the link between benefit, risk, planning, results, behaviors, management competences, resources and operational issues (Fearon et al. 2013; Harison and Boonstra 2009; Knop and Blohm 2018a; Markus et al. 2000; Rerup Schlichter and Kraemmergaard 2010). In the specific socio-technical perspective, technochange influences employee satisfaction, user acceptance, organizational performance as well as process design (Fearon et al. 2013; Jackson and Philip 2005; Knop and Blohm 2018a; Seng et al. 2010). These links and influences are important, because they trigger major organizational changes and create high-risk situations for the organizations. The great complexity of such changes leads to the risk factors. Thus, taking only either the change management or the technological perspective into account could possibly result in misalignment between the organizational culture and the IT solution, thereby lacking in the use of the potential of organizational change as well as IT-solutions. Technochange enables an environment in organizations that enhances the organization and technology iteratively (Jackson and Philip 2010; Knop and Blohm 2018a). The process describes the iterations in four phases of the technochange project (Markus 2004):

(1) *Chartering phase:* The idea of the technochange project was proposed, approved and funded.

(2) *Project phase:* The technochange project derives the solution and designs or purchases the technology. The project phase ends by going live with the solution.

(3) *Shakedown phase:* The technochange project initiates the operation according to the technochange idea and solution. The Shakedown phase aims to overcome the issues in the operation and to stabilize it.

(4) *Benefit Capture:* The technochange project enables the capture of the solution's benefits.

2.7.2 Internal Crowdsourcing as a Technochange Process

An internal crowdsourcing project can be described through the technochange perspective (Knop and Blohm 2018a). Therefore, the four phases of Markus (2004) can be described as an internal crowdsourcing project (Knop et al. 2017):

(1) Chartering phase: A company develops the idea of using an internal crowdsourcing system in order to achieve a goal and capture its benefits. The internal crowdsourcing system could be applied for crowdsourced software testing, innovation management or other application fields.

(2) *Project phase:* The company designs the internal crowdsourcing system with the required technology, such as communication and platform, structure, like role model, actors, such as employees in the crowd and finally task, solving a specific problem.

(3) Shakedown phase: The company starts operating the internal crowdsourcing system by letting the crowd test software or create innovative ideas. In the process of initiation, the system requires constant development in order to improve the efficiency of the system.

(4) Benefit Capture: After the company developed the internal crowdsourcing system further, it can finally capture the benefits of internal crowdsourcing and solve the original problem efficiently.

At the end of the theoretical background, the dissertation established the basic principle of the thesis "crowdsourcing" and lined out its focus. Finally, this chapter introduced the theoretical lenses and concepts to assess the two research questions. The dissertation

connected the theoretical concepts with the principle crowdsourcing and illustrated how they support the research goal.

3 METHODOLOGICAL BACKGROUND

The methodological background provides the reader the overview for the chosen research approach, depicting the applied research methods and the reasoning of the application regarding answering the research questions.

3.1 Qualitative Research Approach

The research approach of this dissertation focuses on a qualitative research approach with constitutive methods. The overall goal of the dissertation, based on the aforementioned identified research gaps, is to derive design principles for internal crowdsourcing systems, to assess adaptation barriers and identify possible solutions in order to overcome and learn from them. Against the background of the research goal, the dissertation follows an *exploratory qualitative approach.* As qualitative research has seen an increase of popularity in IS research, it received a legitimate reputation as a viable research method in the discipline (Sarker et al. 2013). The exploratory qualitative approach is appropriate when assessing social-technical interactions and arising issues, such as in internal crowdsourcing(Goh et al. 2011; Vlaar et al. 2008). In addition, such approaches examine complex structures, which become apparent in socio-technical systems, between different actors as well as IT tools. Deriving design principles and assessing adaptation barriers in a socio-technical system, as seen in for example an internal crowdsourcing, includes a range of different actors including the crowdsourcer and the crowd, interacting with a range of different IT-tools. Subsequently, the application of a qualitative research approach in the dissertation is suitable.

3.2 Applied Research Methods

3.2.1 Action Design Research

The ADR research method derives solutions for classes of problems, which are relevant in practice and enables a systematic specification of design knowledge addressing a real life problem (Gregor and Jones 2007; Von Alan et al. 2004). The research method focuses on a common understanding through including practitioners improving iteratively IT artefacts, which solve the given problem (Sein et al. 2011). The

combination of theoretical understanding of conducting research with practical as well as context related knowledge deepens the assessment and studies the practical problem in its ecosystem (Davison 2001; Kohler et al. 2011; Street and Meister 2004). The ADR method creates prescriptive understanding by developing, evaluating as well as reflecting IT artefacts in the organizational research contexts (Knop et al. 2017). Combining the STS theory with the application of the ADR method provides the dissertation an abstract goal image of the artifact, the internal crowdsourcing system, that will be designed to address the real-life problem and enables deriving the design principles. As the STS theory illustrates system design as a procedure, which includes social and technical aspects affecting the functionality and usage of IT-based systems (Baxter and Sommerville 2011), it predefines the abstract and important main components, which structures the ADR design process. The literature review for the internal crowdsourcing system requirements will be structured according to the STS components leading to the concepts of the system building blocks and finally the design principles. By doing so, the application of STS enables the dissertation to follow the research method of ADR, which inherently combines theoretical understanding with practical as well as context related knowledge, which aims at deepening the analysis of the practical problem in its ecosystem (Davison 2001; Kohler et al. 2011; Street and Meister 2004).

The dissertation applies action design research (ADR) to develop design principles for internal crowdsourcing systems (Sein et al. 2011) answering the first research question. The ADR method appears appropriate, due to the problem of Design Research (DR) separating the design and evaluation phase of an IT artefact. Therefore, it does not fulfil the requirement of build-in relevance as well as rigor design cycles (Sein et al. 2011). On the one hand, ADR is a combination of the benefits of Action Research (AR), connecting theory with practice through a comprehensive cycle of design as well as evaluation in order to address a -life problem in practice. On the other hand, it includes the benefits of Design Research (DR), which develops prescriptive design understanding by building as well as evaluating IT artefacts (Sein et al. 2011). The dissertation designs an IT artefact, the internal crowdsourcing system, as a solution for a class of problems, which bares relevance for practice with regard to AR as well as derives systematic specification of design understanding with regard to DR (Gregor and Jones 2007; Von Alan et al. 2004). Finally, ADR allows the dissertation to develop the generated design knowledge further and derive design principles for the investigated

problem class (Giessmann and Legner 2016; Sein et al. 2011). Therefore, this dissertation relies on Sein et al.'s (2011) concept of IT artefacts. It suggests ADR as the most suitable method to achieve its goals, since it wishes to address a class of problems by applying a comprehensive cycle of design and evaluation in order to develop design principles (Bitzer et al. 2016). The dissertation suggests receiving robust design principles for internal crowdsourcing systems because ADR enables systematic specification of design knowledge (Gregor and Jones 2007; Von Alan et al. 2004) and enables a complementary combination of theory as well as practice achieving comprehensive knowledge (Knop et al. 2017).

The dissertation proceeds in several ADR steps in order to develop the design principles as depicted in figure 5.

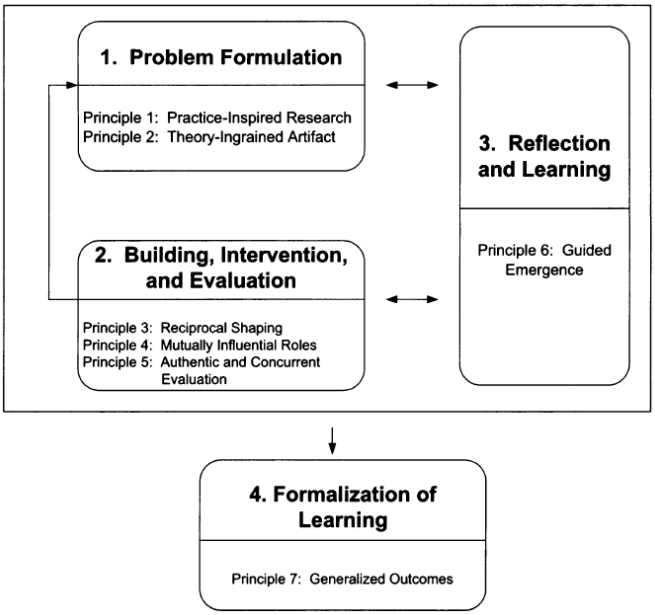

Figure 5. The Action Design Research Method (Sein et al. 2011)

Firstly, the author defined the problem of the Swiss BankCorp integrating up to 216 internal end users into the software test process within the *Problem Formulation* phase and derived the goal state of the crowdsourcing system. Secondly, we conducted within the *Building, Intervention and Evaluation* (BIE) phase, three BIE cycles in order to derive requirements, conceptualize and finally operationalize the internal crowdsourcing system. Thirdly, we summarized the findings and reflected how the system addresses the problems of the bank within the *Reflection and Learning* phase. Finally, we derived design principles in the *Formalization of Learning* phase, by abstracting the findings summarized in the Reflection and Learning phase.

Evaluation Categories of Crowdsourcing

A crowdsourcer designs an internal crowdsourcing system in order to benefit from crowdsourcing advantages. Therefore, the dissertation derives evaluation categories for the ADR process from the crowdsourcing advantages by a literature review. The review revealed specific advantages and evaluations of crowdsourcing systems. The dissertation conducted the literature review according to Webster and Watson (2002) and Vom Brocke et al. (2009). The literature review searched in major databases and focused on crowdsourcing literature including the keywords: "Crowdsourcing" and "System" or "Crowd Work System" or "Crowd testing." Papers were included within the analysis when they addressed specific advantages and evaluations of crowdsourcing.

The crowdsourcing principle improves problem solving by increasing the quality and quantity of the outcome (Afuah and Tucci 2012). Firstly, the outcome quality increases through contributors of the crowd overcoming internal or external borders by self-selecting the problems they solve to match their skills and expertise, creating high-quality solutions (Afuah and Tucci 2012; Stol and Fitzgerald 2014b). Secondly, crowdsourcing increases the outcome quantity. The large number of contributors in a crowd can provide many solutions, which reduces the risk of not receiving satisfactory input. Hence, the dependence on few sources can be deemed relatively limited (Afuah and Tucci 2012; Schenk and Guittard 2009). Finally, the crowdsourcing principle leads to faster time-to-market, because crowdsourced projects are able to tap the resources of the crowd through technology-connected systems. The access to a mass of technical talent can lead to follow-the-sun development across time zones and parallel development. (Gaspoz 2011; Hoßfeld et al. 2011; Stol and Fitzgerald 2014b; Zuchowski et al. 2016a). To surmise, increased quality, reduced risk through quantity, and faster time-to-market are three evaluation categories that enable an assessment of crowdsourcing systems with regard to the advantages of the crowdsourcing principle (Leicht et al. 2016b).

No.	Evaluation Category	Description
1	Quality	Crowd contributors overcome internal or external borders by self-selecting the problems they solve to match their skills and expertise, creating high-quality solutions (Afuah and Tucci 2012; Stol and Fitzgerald 2014b)

2	Quantity	Many solutions are provided where the risk of not receiving satisfactory input and dependence on few crowd contributors as sources can be deemed relatively limited (Afuah and Tucci 2012; Schenk and Guittard 2009)
3	Time	Projects tapping the resources of the crowd are characterized by a faster time-to-market (Gaspoz 2011; Hoßfeld et al. 2011; Stol and Fitzgerald 2014b; Zuchowski et al. 2016a)

Table 1. Evaluation Categories of the Crowdsourcing Principles

Project Setting

The ADR approach was pursued with Swiss BankCorp that developed new software that is used by every employee for daily business operations. The company already has had experience in integrating its end users (i.e., employees in the single banks working with the system) in the software testing process of its enterprise applications that the bank used to invite to the headquarter for testing. Nevertheless, the bank faced the problem that the current testing process does not integrate enough employees to reach an adequate test coverage and software quality. Consequently, the ADR approach intends to increase the integration of end user testing by introducing the principle of crowdsourcing and build an internal crowdsourcing system for software testing. It would integrate more employees into a testing process and provide access to tests essentially creating a platform for the documentation and evaluation of software issues. The Swiss BankCorp did not possess design knowledge in regard to internal crowdsourcing systems. For this reason, the bank set up an interdisciplinary team that consisted of crowd testing researchers, executive test managers, senior test management, and defect management experts, as well as test service delivery specialists in September 2016. In order to support the bank's conceptualization of the internal crowdsourcing system and formalize the learning in design principles, the dissertation structured the research project according to the ADR approach.

3.2.2 Multiple Case Study

The case study research method applies when (a) the research questions starts with "why" or "how", (b) the researcher possesses no or little control regarding behavioral

events and (c) the focus of research addresses a contemporary phenomenon. Against this background, a case study examines a contemporary phenomenon in its real-life environment, even more so if the boundaries between environment and phenomenon are not clearly separable. In addition, the case study design and data collection require a data triangulation, which assists in addressing the technical condition. In this perspective, a case study can appear as a single or multiple case study and be applied as a method of evaluation (Yin 2013).

Nonetheless, such case studies have procedural characteristics with many variables of interest, multiple sources of evidence, theoretical propositions as guiding collection and an analysis of data. Therefore, they can be used as qualitative or quantitative method with explanatory, exploratory or descriptive character. The decision of character depends on the richness of the propositions in related theories of the topic in the study. The richer the theories, the more explanatory the character of the study. The level of generalization of the study's outcome is related to the appropriate development of the preliminary theory or study design. Furthermore, the mode of generalization is a theory-related analytic generalization rather than a statistical one. Consequently, an analytic generalization from one or more cases is possible (Yin 1994).

The dissertation addresses its second research question by applying a multiple case study research design with an explorative character. The method is appropriate because the dissertation assesses a contemporary phenomenon, namely internal crowdsourcing in a real-life context, whose boundaries between such phenomenon and its context are not entirely evident. The context of the study is the organizational framework of the companies, in which the internal crowdsourcing systems operates. This makes a case study suitable for studying complex social phenomena (Eisenhardt 1989; Maxwell 2008; Yin 1994). Therefore, it can be applied for studying internal crowdsourcing, as it represents a complex socio-technical phenomenon (Geiger and Schader 2014; Zuchowski et al. 2016a). Finally, the multiple case study approach allows the dissertation to retain the holistic as well as meaningful characteristics of the unit of analysis, i.e., companies overcoming adaptation barriers in internal crowdsourcing (Yin 2003).

Applying the research method multiple case study with the technochange theory is beneficial, because technochange provides a rich experience of potential barriers to IT projects. On one hand, the theory enables the multiple case study to track down the

adaptation barriers in the different cases. For instance, the semi-structured interviews were guided by the theory in order to seek and identify adaptation barriers (Markus 2004). On the other hand, the theory supports classifying the barriers found by explorative research results. For instance, identified adaptation barriers through workshop results, document or data analysis were classified by the technochange theory.

Application

Since adaptation barriers of internal crowdsourcing are not that well understood, we applied a multiple case study research design with three companies overcoming adaptation barriers of internal crowdsourcing. We analyzed one lead case (A) in-depthly, which shows and reflects circumstances of everyday business conditions (Yin 1994) and chose two additional cases (B & C) to assess whether the same challenges and solutions can be found in other cases as well. Companies use internal crowdsourcing for many different purposes, such as in the innovation process or knowledge management. We focused on companies using internal crowdsourcing in similar projects (in our cases they test software) because they can illustrate the core adaptation barriers of internal crowdsourcing. Using an internal crowd for testing software, also known as crowdtesting, is a complex task and therefore shows all possible challenges related with internal crowdsourcing. Software testing is a reoccurring (Leicht et al. 2017) task which thereby supports the detection of these challenges and increases related understanding.

The case selection was derived from the research question. In order to assess adaptation barriers in internal crowdsourcing the general setting had to be comparable. Therefore, in all cases the usage of Crowdsourcing had to be new to the organization making the Technochange lens necessary. In addition, the crowdsourcing initiative had to be comparable, such as being conducted internally as well as using the same application, Software Testing. Furthermore, the crowd had to be comparable. In all three cases the crowd was employees from different ages, culturally diverse and at least a middle-sized crowd. Finally, the test object had to be comparable. Therefore, the three cases had a test object that was middle to large sized. Based on these comparable factors the dissertation believes to provide a case selection that enables the multiple case study to derive robust results.

Case	Description
A - BankCorp	In the lead case A, we investigate adaptation barriers for internal crowdsourcing in the context of a bank, called BankCorp. The company used to integrate feedback from internal end users in the testing efforts of its enterprise applications. In 2016, the bank decided to integrate employees more efficiently by using the crowdsourcing principle. This initiative recently became a part of the standard testing process of the IT department.
B - InsureCorp	In case B, we examine the challenges from InsureCorp, a Swiss insurance company. InsureCorp had first-hand experience in a pilot project regarding crowdtesting. Then, the company decided to build a new internal crowd for ad-hoc projects. The company is currently running the internal crowdtesting system.
C - IndustryCorp	In case C, we explore the challenges of an industrial enterprise in Switzerland with a global network, IndustryCorp. This company had also first-hand experience in a pilot project regarding crowdtesting and decided afterwards to invest in an internal crowdtesting system for ad-hoc projects. The internal crowdsourcing system is currently in use.

Table 2. Overview of investigated Case Studies

Data Collection

Between September 2016 and March 2018, the three cases drew information from diverse arrays of multiple data sources (Creswell 1998). The data sources include 19 semi-structured, in-depth interviews with a duration of about 40-80 minutes, discussing the adaptation barriers and solutions, which are presented in detail with subsequent examples further down. Additional sources included observations of the project management, such as accompanying them in different meetings, like workshops and trainings. In addition, we analyzed project documentation, namely monthly status updates, project concepts and communication transcripts of crowd tests. Furthermore, we analyzed data from the platform from 18 test iterations from the lead case, for instance, amount and level of software issues or amount of participants (Eisenhardt 1989). The lead case also includes a survey with 109 employees of the crowd regarding the work in the crowd and their acceptance of this new work mode.

In chapter 3, the dissertation illustrated the research methods to answer the research questions and discussed the reasoning of the application. ADR enables the dissertation to develop the design knowledge further and derive design principles, addressing the

first research question (Giessmann and Legner 2016; Sein et al. 2011). Furthermore, the dissertation answers the second research question by applying a multiple case study, which assesses the contemporary phenomenon, adaptation barriers in the real-life context of internal crowdsourcing retaining meaningful characteristics of the unit of analysis (Yin 2013).

The dissertation continues presenting the lead case study of "BankCorp", in which describes how internal crowdsourcing may serve as means to restructure work processes in a large and company-wide projects and to illustrate the transformation process that is associated with the systematic usage of internal crowdsourcing with this project.

4 DEVELOPING DESIGN PRINCIPLES FOR INTERNAL CROWDSOURCING SYSTEMS

In chapter 4, the dissertation addresses the first research question, supported by the STS theory, lined out in chapter 2.3. It applies the ADR method depicted in chapter 3.2, developing design principles based on requirements derived for internal crowdsourcing systems in the context of a Swiss bank, BankCorp. According to Gregor (2006), design principles provide prescriptions for constructing an artefact, such as an internal crowdsourcing system. They describe material properties of a technical artefact and how it should be designed or what components it possesses (Chandra et al. 2015; Rhyn and Blohm 2017). In order to derive them, the dissertation followed the ADR phases below.

4.1 Problem Formulation

The research is driven by the Swiss BankCorps' need of a new software testing method as an addition to the conventional software testing. In order to develop an understanding of the organizational problem and adequately define the challenges, the dissertation conducted two interviews with two of the banks' senior managers who were responsible for the crowdtesting project and held a workshop of two hours with three crowdsourcing researchers and five of the bank's testing experts. The following conclusions were reached based on these interviews and workshops. Firstly, the quality of the software needed to be increased by integrating end users to extend the use of internal know-how. At the current state, important software issues are detected at a later stage of the testing process, due to integrating end users quite at the end of the development process. The bank could not integrate employees from different branches located all over the country

sufficiently because employees had to travel hours to the headquarter in order to participate in internal testing. The bank addressed this challenge by involving employees from different departments and areas of Switzerland through the distributed nature of crowdsourcing. Employees would be able to join the testing process via their computers at their normal working place. Secondly, the bank had not enough resources for an adequate testing coverage, leaving an increased risk of potential mistakes in the company's software. In addition, the department did not have the resources to conduct sufficient software tests after the launch of a product. The experts planned to address this problem, by expanding the coverage of the testing activities by increasing the number of testers. The crowdsourcing system would include a crowd of 216 employees, eliminating potential blind spots regarding the software's functionality. Thirdly, the test department needed more and faster testing cycles. Thus far, the testing department has not been able to set testing cycles in a short and fast enough manner. Some test cycles took too long to prepare. In order to address this, the bank intended to increase the speed of execution for single testing cycles for getting feedback concerning the quality of the software on a weekly basis through testing with the crowd of integrated employees with the crowdsourcing principle. The challenges of the Swiss BankCorp are illustrated in table 3 below.

No.	Challenge	Description
1	Integration of employees	Insufficient software quality due to inability of integrating appropriate employees to the test process in order to use expert knowledge and identify software issues early
2	Adequate coverage	Inadequate coverage of software testing during and after the development process due to a lack of resources
3	Fast test cycles	Inability of preparing and conducting test cycles quickly, as well as setting a suitable amount of test cycles

Table 3. Challenges of the Swiss BankCorp

4.2 Building, Intervention, and Evaluation (BIE)

In the BIE phase, the dissertation conducted three cycles. In the first BIE cycle, it derived the necessary requirements from literature and practice. The dissertation evaluated the first BIE cycle formatively regarding the comprehensiveness of the crowdsourcing system requirements. In the second BIE cycle, it focused on defining, deriving and

conceptualizing the single components. The dissertation then evaluated it formatively regarding the feasibility of the single building blocks. In the third BIE cycle, it finally operationalized the internal crowdsourcing system and evaluated the system summatively according to the three evaluation categories of crowdsourcing, which are explained in detail further down in the third BIE cycle.

4.3 First BIE Cycle – Requirements

In the first BIE cycle, the dissertation derived requirements for a crowdsourcing system by conducting a literature review and a series of workshops with employees of the Swiss BankCorp. These were necessary given that requirements define the systems' goals, it's features or functionalities and also determine how a system is constructed, with further regard to also restricting potential constrains (Van Lamsweerde 2000; Zave 1997). The evaluation focused on the set of requirements formatively by interviewing external crowd testing experts regarding comprehensiveness.

The literature review revealed specific requirements for crowdsourcing systems, which were structured according to the STS components. The dissertation conducted the literature review according to Webster and Watson (2002) and Vom Brocke et al. (2009). The literature review searched in six databases: Business Source Premier, Econ Lit, JStor, Science Direct database, AIS electronic library and the ACM digital library. Firstly, the review used keywords with focus on crowdsourcing including: "Crowdsourcing" and "System" or "Crowd Work System" or "Crowd testing." Secondly, the dissertation included also related research fields of crowdsourcing into the literature review: "Open Innovation", "Co-Creation", "Collaboration", "Peer-to-Peer" and "Sharing Economy". Papers were included within the analysis when they addressed one or more of the basic components of STS. In total, the literature analysis reviewed 187 papers and 84 of them discussed aspects related to requirements of crowdsourcing systems. As a result, the literature review derived and consolidated ten specific requirements.

These requirements were further refined and extended in two workshops at the Swiss BankCorp (each around 120 minutes). Participants included three researchers with vast experience in crowd testing, a test management expert, a defect management expert, and two test service delivery specialists. The group of experts assessed the ten requirements, further detailed them and added five new requirements (noted with *italic* writing in table 4 below), leading to 15 requirements in total. Finally, the dissertation evaluated the

obtained requirements formatively with three crowdsourcing experts who use internal crowdsourcing for software testing in their own organizations on a monthly basis. They evaluated the list of requirements in 30 to 45 minutes interviews. The experts agreed on the 15 requirements but added details to the existing ones (noted with underlined writing in table 4 below). The requirements are depicted in table 4, which lead to conceptualizing the building blocks of the associated STS components in the second BIE cycle.

Structure	
1. Crowdsourcing Workflow (Hetmank 2013; Wagner and Majchrzak 2006; Yan et al. 2014; Zogaj et al. 2015)	The system shall have a clearly defined workflow.
2. Crowd Contributor Compilation and Support (Hetmank 2013; Wang et al. 2015; Yan et al. 2014; Zogaj et al. 2015)	The system shall have a possibility for user registration, the formation of groups, enabling the coordination and assisting crowd contributors and *a process of building a crowd.*
3. Task Specification (Arias et al. 2000; Feller et al. 2010; Geiger et al. 2012)	The system shall provide specific information and evaluation criteria on the task as well as gather it on an information page.
4. Crowd Communication Patterns (Gerber and Hui 2013; Kazman and Chen 2009; Shanmugam and Durugbo 2015; Skopik et al. 2012)	All participants shall be able to communicate during the process, with the p*ossibility to send messages with attachments*. *The system shall enable different groups for communication, i.e. bilateral or group*. The test manager shall be able to mute the communication of the process.
5. Crowd Contribution Management (Feller et al. 2010; Saxton et al. 2013; Thuan et al. 2015; Yan and Wang 2013)	The system shall provide a possibility to evaluate, select, aggregate, and compare the contributions as well as *filter the unusable results during the evaluation process. Reports shall be identifiable, and* defects shall be assignable to a developer.
6. Task Allocation Management (Geiger et al. 2012; Geiger and Schader 2014; Malhotra and Majchrzak 2014; Thuan et al. 2015)	The system shall select crowd contributors for tasks and grant access to them.

7. *Crowdsourcing System Role Model*	*The system shall define clearly duties, competences and responsibilities for different roles of actors i.e., crowd contributors, test and defect managers*
Actors	
8. Crowd Contributor Expertise (Feller et al. 2010; Geiger and Schader 2014; Kohler 2015; Skopik et al. 2012; Yan and Wang 2013)	The crowd contributors shall have adequate expertise for the assigned tasks.
Technology	
9. Tool Usability (Geiger et al. 2012; Rehman et al. 2015; Simic et al. 2015; Tung and Tseng 2013)	The system shall provide a possibility to give access to the test, to document a defect and capture videos of how crowd contributors use the software. The system shall define the structure of the contributions clearly and *provide a good usability for unexperienced crowd contributors.*
10. Knowledge Repository (Ind et al. 2013; Liang et al. 2013; Rehman et al. 2015; Yan et al. 2014)	The system shall store information, such as test cases or defect reports. It shall provide automated analytics, identifying and marking duplicates. The data security of the system shall provide anonymity *and grant access to the information only to the individuals with the required authority.*
11. *Reliability and Performance*	*The system shall be a reliable, stable, robust, error free and accessible environment. The performance shall have short reaction and loading time.* The system shall provide a constant and flexible access for the test and defect manager.
Task	
12. Crowdsourcing System Purpose	*The system shall generate output as planned, for instance defects (i.e. functional defects), feedback (i.e. mistakes in test cases) and meta data (i.e. title, defect type, severity, occurrence*

	statement, description, attachments, crash log, software, hardware and provider information).
13. Crowd Contributor Incentivization (Doan et al. 2011; Erickson et al. 2012; Morgan et al. 2011; Thuan et al. 2015; Yan et al. 2014)	The system shall provide appropriate incentive mechanisms for the crowd (i.e. financial compensation, learning opportunities and social factors).
14. *Short test cycles*	*The system shall enable short test iterations and create test cycles flexibly.*
15. Different Testing Types	*The system shall enable explorative software testing and software testing with test cases.*

Table 4. Requirements of Crowdsourcing Systems

4.4 Second BIE Cycle – Conceptualization

In the second BIE cycle, the dissertation conceptualized the single building blocks of the internal crowdsourcing system, based on the requirements derived in the first BIE cycle. A team of the bank's service deliverable experts, managers of the testing department and crowdsourcing researchers conducted four internal workshops (each around 120 minutes) in order to conceptualize the system's single building blocks. In table 4, the dissertation describes the general concept and application of the building blocks of the case, structured according to the five STS components. Finally, the dissertation evaluated these building blocks formatively regarding their feasibility by six test managers with vast testing experience that were not involved in conceptualizing the building blocks in a fifth workshop (90 minutes). The test managers added one building block and detailed others (noted with underlined writing in table 5 below).

Building Block	General Concept	Application in the Case
STS Component - Structure		
Crowd Segmentation Requirements: 2, 6	The crowd segmentation describes the structure of the crowd and segments the employees in different groups to enable an allocation of an appropriate group of crowd contributors to a specific task.	The system segmented the crowd according to the contributor's affiliation of bank departments. This segmentation would enable the system to match specific tasks to the appropriate and specialized knowledge of the single contributors of the crowd.
Role Model Requirements: 4, 7	The Role Model of the system consists of different roles for crowdsourcing systems including duties, competences and responsibilities.	The system has five roles. *PMO (Project Management Officer):* Plans and coordinates test iterations. Assembles the crowd and is responsible for crowd activities. *Test Manager:* Creates and supplies information to the crowd. Contacts crowd and is responsible for supervision during test. *Crowd Tester:* Accesses the system and conducts the testing according to specifications. *Defect Manager:* Evaluates and validates the results of the crowd. (S)/he is responsible for transferring the results to the IT department. *Crowd Enabler*: Teaches the crowd how to conduct a test in the system and is responsible for enabling the crowd sufficiently.

Crowdsourcing Workflow Requirements: 1, 3,4, 5, 6	The overarching Crowdsourcing Workflow structures the process in several steps, illustrating how single crowdsourcing initiatives are performed within a system.	The workflow of the bank consists of seven main phases: **1.** The IT department selects the tasks for the crowd according to minimal requirements of the test object quality and stability. **2.** The PMO prepares the task on the crowdsourcing platform. **3.** The crowd contributors receive invitations for tests, which they can accept or not. **4.** The PMO allocates the tasks to the appropriate crowd. **5.** The crowd tests the bank's software and documents all defects with support of the test managers if needed. **6.** Input gets evaluated by defect manager. **7.** The defect manager filters the input and imports the relevant input to the conventional IT department.
Alignment with Organization Requirements: 14, 15	A crowdsourcing system is a part of a bigger organization. The Alignment with Organization links the system with the organization on the strategic and organizational level.	Internal crowd test iterations are aligned with the test iterations of the IT department, because the crowd tests are used as a complementing part in the general testing efforts of the IT department. For instance, when practical expertise of the crowd is needed for a test iteration, the IT department requests crowd tests.
System Interface Requirements: 1, 5	The System Interface links the system with the organization on the operational and technical level.	Automated interface transfers test cases or defect reports of the crowd when needed, between the crowd test system and the IT department. For instance, for the crowd test preparation the test cases get transferred from the IT department to the crowd processing platform.

STS Component - Actor		
Crowd Building Requirements: 2, 13	The Crowd Building follows a community building process with different measures to persuade potential contributors to join the crowd.	The case applied one measure, an announcement on the intranet platform of the company, asking to join the crowd. After the bank built up a crowd of 216 employees, it took down the announcement due to sufficient participants.
Crowd Contributor Expertise Requirements: 8	The Crowd Contributor Expertise depicts an appropriate set of expertise and skills of crowd contributors that enables them to conduct specific tasks of the crowdsourcing system successfully.	The crowd testers use special software in their daily business and gather specific expertise as well as skills necessary to conduct the testing tasks of the system with respect to the test object.
Crowd Contributor Enablement	The Crowd Contributor Enablement trains and enables individual contributors to understand and conduct tasks of the crowdsourcing system successfully.	The crowd testers were introduced in a 1.5 days onboarding program to the crowd testing system by practicing with the specific IT tools and process of the system. In addition, the program introduced the test object due to its complexity.
STS Component - Technology		
Crowd Processing Platform	The Crowd Processing Platform is the main environment for the crowdsourcing activities. The main	Permits access to the test cases of the test iterations and enables the work processing. It provides possibilities for documenting defects as well as evaluating the input of the crowd.

Requirements: 1, 9, 11	steps of the workflow run on it and process the tasks of the system.	
Crowd Communication Tools Requirements: 4, 9, 11	The Crowd Communication Tools enable the communication between the different actors in the system.	Communication tools send invitations for certain tests to pre-defined receivers and provide an overview of who accepted the invitation or not. In addition, e-mails, chat messaging and video calls are possible before, during and after a test iteration.
Knowledge Repository Requirements: 9, 10, 11	The Knowledge Repository stores general information of the system regarding workflow, tools and crowdsourcing initiatives. This information can support the crowd or inform outsiders.	The crowd can access an area on the intranet, where different information is available. For instance, information concerning dates of test iterations, contact information of the support, summaries of test results, templates or explanations of tools and a description of the test process.
STS Component - Task		
Task Goal and Purpose Requirements: 12	The crowdsourcing system is designed to conduct specific tasks in order to fulfil a certain goal or purpose.	The purpose of this system is to conduct tasks, which lead to receiving input from the crowd regarding defects of the software based on their practical experience, which is missing in the IT department.
Crowd Contributor Incentivization Requirements: 13	A crowdsourcing system possesses Crowd Contributor Incentivization. The range of incentives can address a diversity of	The main incentives in the crowd testing system are the intrinsic framing of the importance of the task and the opportunity to learn. The task is important for the crowd because, they will have to use the test object in daily business. Therefore, the

	contributors and motivate them to participate.	crowd wishes to learn about the test object, gain early experience and improve it to be prepared for its implementation.
Definition of Contribution Requirements: 3, 12, 14, 15	Internal crowdsourcing systems can produce different contributions according to the crowdsourcing archetypes. Each system has to define the intended contribution and design the system accordingly to increase the success of the system.	The case defined the type of its task contribution according to "Crowd Solving". Firstly, given it is heterogeneous, diverse contributions of the crowd are possible (i.e., a tester does not find the same defect as other testers). Secondly, contributions are non-emergent or independent, a defect found has value on its own (i.e., the value of a single defect does not arise only through combining all defects).

Table 5. Building Blocks of Crowdsourcing System

4.5 Third BIE Cycle – Operationalization

Within the third BIE cycle, the dissertation operationalized the internal crowdsourcing system, based on the building blocks conceptualized in the second BIE cycle. A team of service deliverable experts, managers of the testing department and crowdsourcing researchers conducted two internal workshops (each around 100 minutes) in order to operationalize the system.

System Operationalization. In November 2016, the bank operationalized the internal crowdsourcing system for software testing. Within this system, building blocks were linked or built on each other. In the beginning, the bank built the crowd of 216 contributors from different departments of the bank through broadcasting a call for participation on the intranet page of the company as described in the building block "*Crowd Building*". The crowd building is linked to the "*Crowd Contributor Incentivization*" building block, because incentivization factors persuade potential contributors to sign up to the crowd, such as intrinsic framing of the task or learning opportunities. While the crowd signed up, it needed to be segmented in order to allow for the matching of appropriate contributors from the crowd to specific tasks, according

to the "*Crowd Segmentation*" building block. The test object required certain expertise to be tested. As the contributors gathered such certain expertise through their daily work in their specific department, the crowd was segmented according to their expertise, as described in the "*Crowd Contributor Expertise*" building block. The system predefined the segmentation criteria and included it in the sign-up form for the crowd. After the crowd signed up and was segmented, the building block "*Crowd Contributor Enablement*" became relevant. Each of the crowd contributors were trained appropriately in a 1.5 days onboarding program in order to enable contributors to participate in crowd tests. The onboarding program consisted of two parts. Firstly, the crowd was briefed regarding the test object, where the information provided was new for them and very complex due to its large size. Secondly, the onboarding program introduced the contributors to the crowd testing workflow and the relevant tools of the system. The crowd building, segmentation and enablement were the base for future crowd tests, since the crowd was ready to conduct them.

Within the timeframe of November 2016 and April 2017, the Swiss BankCorp conducted 18 weekly crowd test iterations in the internal crowd testing system. A standard weekly crowd test iteration would follow throughout the "*Crowdsourcing Workflow*" building block which would (1) start with the transfer of the crowd test instructions of the IT department to the crowd testing PMO, stating what part of the test object would be in the scope of the next crowd test. This step of the crowdsourcing workflow interacts with the building blocks "*Alignment with Organization*" and "*Task Goal and Purpose*". The purpose of the system was to complement and align the general testing efforts of the IT department with crowd tests, where the expertise of the crowd would be required. After receiving instructions, the PMO would discuss the test scope and arrange the responsibilities of the specific test procedure with executive crowd test managers, corresponding to the "*Role Model*" building block. Usually, four to six crowd test managers supported the crowd in the weekly crowd test iterations with each 10 to 20 contributors. After the briefing of the managers, the PMO (2) invited 60 to 180 contributors of the crowd per test iteration according to the expertise needed within the different areas of the test object as defined in the test scope, which again depicts the involvement of the "*Crowd Contributor Expertise*" and "*Crowd Segmentation*" building blocks in the system. The contributors would (3) find a link to access the "*Crowd Processing Platform*" for the test iteration in the invitation and conduct test cases for one day regarding the test object that were stored on the platform. During the crowd test,

the communication tools, as described in the "*Crowd Communication Tool*" building block, provided the communication. If a contributor had questions, the test manager would give support via the communication tools or the contributor could find general information in the "*Knowledge Repository*", such as explanations of tools or templates. In one test iteration, the crowd would detect between 50 to 300 software issues, depending on the scope of the crowd test iteration and maturity of the test object. After the test iteration, a crowd result manager would follow the "*Role Model*" by (4) evaluating the results of the crowd, according to the "*Definition of the Contribution*" and (5) transfer the accepted results to the database of the IT department, as illustrated in the "*System Interface*" building block. The workflow is depicted in figure 6.

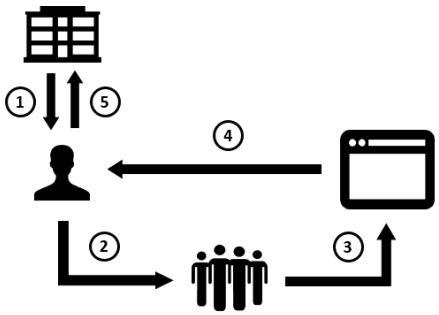

Figure 6. The Workflow of an Internal Crowdsourcing System

Evaluation. In third BIE cycle, the dissertation sheds light on the performance of the internal crowdsourcing system by evaluating the system summatively according to three evaluation categories based on Leicht et al. (2016b): Quality, Quantity and Time, as stated in table 6. According to Afuah and Tucci (2012) as well as Stol and Fitzgerald (2014b) the first category "Quality" covers the challenge "Integration of Employees", because following the crowdsourcing principle, employees integrated in the crowd overcome internal or external borders and self-select the problems they solve to match their skills as well as expertise, creating high-quality solutions. The category "Quality" possesses three sub evaluation categories. Firstly, "Task Allocation", which addresses the crowdsourcing principle leading to high quality results through adequate self-selection of the crowd (Erickson et al. 2012; Zuchowski et al. 2016a). Secondly, "Quality of Results", which respects directly the quality of the contributions of the crowd, due to expert knowledge of the contributors (Boudreau and Lakhani 2013; Erickson et al. 2012; Ford et al. 2015; Prpić et al. 2015; Stieger et al. 2012; Zuchowski et al. 2016a). Thirdly, "Employee Acceptance", describes the gain in quality through employee acceptance, due to increased motivation and competence regarding the system

(Brabham 2008; Soukhoroukova et al. 2012). According to Afuah and Tucci (2012) as well as Schenk and Guittard (2009) the second evaluation category "Quantity" covers the challenge "Adequate Coverage" of the Swiss BankCorp, as the challenge of insufficient coverage is related to their argument stating that many solutions decrease the risk of not receiving satisfactory results. The "Quantity" category possesses two sub evaluation categories: "Quantity of Results", addresses the importance of receiving many results and "Quantity of Integrated Employees" which reflects the link between the number of contributors in the crowd and amount of results submitted by the crowd. A bigger crowd possibly finds more software issues, as stated by Raymond (1999) given enough eyeballs all bugs are shallow, and potentially submits more results than a smaller crowd receiving a higher coverage (Blohm et al. 2013; Ipeirotis et al. 2010; Poetz and Schreier 2012; Stol and Fitzgerald 2014a). According to Gaspoz (2011) and Zuchowski et al. (2016a) the third evaluation category "Time" addresses the challenge "Fast Test Cycles", as the challenge of preparing test cycles quickly and flexibly follows the argument that crowdsourcing enables a faster time-to-market. The "Time" category carries two sub evaluation categories "Time for Preparation" and "Time for Execution". The two sub categories illustrate the time and effort required from the initial plan to the test execution with evaluation of a crowd test (Kuek et al. 2015; Simula 2013; Stol and Fitzgerald 2014a; Stol and Fitzgerald 2014b).

No.	Evaluation Category	Challenges of BankCorp	Sub Evaluation Category	Literature
1	Quality	Integration of Employees	a. Task Allocation b. Quality of Results a. Employee Acceptance	(Afuah and Tucci 2012; Boudreau and Lakhani 2013; Brabham 2008; Erickson et al. 2012; Ford et al. 2015; Prpić et al. 2015; Soukhoroukova et al. 2012; Stieger et al. 2012; Zuchowski et al. 2016a)
2	Quantity	Adequate Coverage	b. Quantity of Results c. Quantity of Integrated Employees	(Afuah and Tucci 2012; Blohm et al. 2013; Ipeirotis et al. 2010; Poetz and

				Schreier 2012; Stol and Fitzgerald 2014a)
3	Time	Fast Test Cycles	a. Time for Preparation b. Time for Execution	(Gaspoz 2011; Hoßfeld et al. 2011; Kuek et al. 2015; Simula 2013; Stol and Fitzgerald 2014a; Stol and Fitzgerald 2014b; Zuchowski et al. 2016a)

Table 6. Evaluation Categories and Challenges of the Swiss BankCorp

Data Sources. In the evaluation category "Q*uality*", the dissertation evaluated task allocation, quality of the submissions and employee acceptance. For the task allocation and employee acceptance, it conducted on the one hand a survey with employees from the crowd, asking if the allocated tasks matched their skills and regarding their acceptance of the system. On the other hand, the dissertation conducted three interviews with contributors of the crowd, two with test managers and one with the PMO regarding the allocation of tasks to expertise of the crowd. The evaluation of the quality of submission focused on data of the platform as well as interviews with two test managers and the PMO. The dissertation examined whether the crowd found important issues. Furthermore, for the category "*Quantity*", it interviewed two test managers as well as the PMO regarding the quantity of employees in the crowd and the quantity of submissions. In addition to the interviews, the dissertation relied on data from the platform in order to assess the number of employees in the crowd and quantity of the submissions. Finally, it focused the evaluation of the "*Time*" category on the amount of time spend by the test managers while preparing and conducting a test. As data sources, the dissertation used two interviews with test managers and one with the PMO as well as data from the platform. All data sources of the third BIE cycle are summarized in table 7.

Evaluation Category	**Sub Evaluation Category**	**Data Sources**
Quality	a. Task Allocation b. Quality of Results	- Interviews with 3 contributors, 2 test managers and the PMO (a, b, c) - Data from the platform (b) - Survey with over 100 employees (a, c)

	c. Employee Acceptance	
Quantity	a. Quantity of Results b. Quantity of Integrated Employees	- 2 test managers and PMO interviews (a, b) - Data from the platform (a, b)
Time	a. Time for Preparation b. Time for Execution	- 2 test managers and PMO interviews (a, b) - Data from the platform (a, b)

Table 7. Data Sources

Quality. In the "Quality" evaluation category, we assessed the "Task Allocation", "Quality of Results" and "Employee Acceptance", as depicted in table 7. According to the interviews with the contributors, test managers and the PMO the task allocation mechanism of the internal crowd testing system worked successfully. Most of the interviewed employees were matched to tasks that did fit their expertise. Only within a few exceptions, employees stated that they were matched with tasks that did not fit to their expertise. This happened especially in the end the project, when the size of the crowd decreased.

Regarding the "Quality of Results" a test manager estimated 30% of the submissions were categorized as "out of scope". These submissions originated from testers having an unrealistic expectation of the test object, because they possessed no or not much experience in software testing. Some testers expected a more mature test object and did not understand that the test object was still a work in progress. The other 50% of the submissions were estimated being categorized as "works as designed". For instance, the crowd expressed opinions how to change the software in order to adapt the test object closer to their personal taste or opinion. These opinions were only respected in a few instances, because the software was a standard software, which could be altered only to a certain extent. The final 20% of the submissions were new software issues, not found by any other process and transferred from the crowdtesting platform to the IT department.

According to the data of the platform, the percentage of new software issues that were transferred vary between the different departments of the bank and test managers ranging from 50,5% to 13,5% resulting in an overall average of 32,5%, which are 1’672 out of 5’146 software issues until January 2018. From these 1672 transferred software issues 748 were rejected, which left 924 accepted issues or 18% in total, as in figure 7.

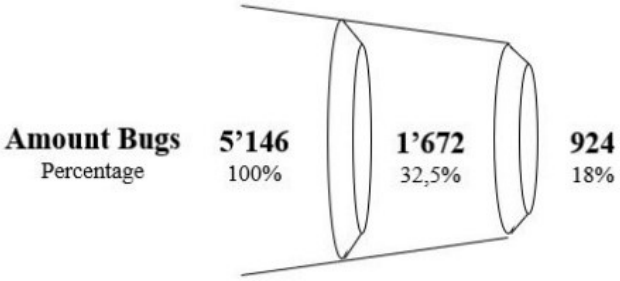

Figure 7. Amount of Bugs found

The severity of the 924 issues was, 0 “Blocker”, 8 “Critical”, 179 “Major”, 669 “Minor” and 68 “Trivial”. According to the PMO, these 18% of software issues, submitted by the crowd brought high value. The new perspective of the crowd could discover software issues, which were difficult to those detect by other means. The quality of the submissions overall was good, which would address the challenge of the bank namely quality through integrated employee expertise, successfully. The crowd had a different perspective to the test object, finding software issues that traditional testing processes did not find. The crowd would think and act differently, due to their professional background being an operational expert in a special department of the bank, compared to traditional software testers.

Furthermore, the dissertation conducted a survey to collect data from the contributors of the crowd in order to examine the “Employee Acceptance” regarding internal crowdtesting. In sum, a total of 118 out of 216 internal crowd contributors submitted their completed questionnaire, of which almost half were female (48,30 percent). The internal crowd contributors were between 19 and 56 years old, and on average, they were approximately 36 years old. Given that there was an average seniority of 11,5 years (time working for the bank), the internal crowd consisted of rather experienced employees. The majority of 78,8 percent of these internal contributors were employed on a full-time basis but participated in the crowdtesting project only on a half-day basis (87,30 percent). In addition, more than one third of the internal crowd had an academic background (33,90 percent) and 35 percent were in a management position.

The dissertation used a five-point Likert scale for all items to examine the perceptions of internal crowd contributors as "Employee Acceptance". In general, the internal crowd contributors did not feel any computer anxiety (1,31), meaning that working with computers did not generate feelings of uncomfortableness or fear in terms of using such technology. Rather, they characterized themselves as creative and playful regarding the use of IT (3,79). Moreover, the ease of use of the internal crowd testing system has been perceived as very high (4,04), which means that the interaction with the internal crowdtesting system was clear and understandable. Regarding the test object, the internal crowd contributors only occasionally consulted the users' manual of the test object or asked their colleagues on how to operate the test object (3,15). Although the technical operation of the system has been perceived as relatively simple, the internal crowd contributors experienced the nature of the actual testing activities as being task demanding (3,56). Consequently, the employees needed an average of 6.66 test iterations until they felt more secure in terms of how to conduct the testing activities. However, even though it had taken relatively long to learn the required skills and knowledge, internal crowdtesting subsequently was perceived as an instrument that empowers the employees (3,93). In this perspective, the internal crowd contributors had mastered the skills necessary for their testing tasks and felt self-assured about their capabilities to perform the tests. Furthermore, due to the internal crowd testing, the employees experienced significantly more autonomy in determining how to do their jobs. They perceived considerable opportunities for independence and freedom in how to work. This might be one reason why the employees were even to an extent proud to be an internal crowd tester and saw themselves as a part of the crowd testing community. Thus, the perceived identification with these crowd testing activities (3,91) and the "Employee Acceptance" has been very high. The results of the summative evaluation are illustrated in table 8.

Quality a. Task Allocation b. Quality of Results c. Employee Acceptance	a. Task Allocation: Most contributors expertise matched the test cases. b. Quality of Results: • Out of 5'146 software issues submissions 1'672 were transferred to the IT department (32,5%) • Out of 1672 transferred software issues 748 were rejected and 924 accepted (18% in total) • Severity from the 924 accepted issues: 0 "Blocker", 8 "Critical", 179 "Major", 669 "Minor" and 68 "Trivial".

	c. Employee Acceptance: • 118 out of 216 crowd contributors participated at the survey • Half were female (48,3%) • Contributors were on average 36 years old • Average seniority of 11,5 years • 78,8% were full time employed and participated in crowd testing half day (87,3%) • Contributors did not feel any computer anxiety • Ease of use of the internal crowd testing system was perceived as very high • Contributors experienced the actual testing activities as demanding • Contributors needed an average of 6.66 test iterations until they felt more confident • Contributors felt empowered through crowd testing

Table 8. Evaluation of Category "Quality"

Quantity. In the "Quantity" evaluation category, the dissertation assessed the quantity of results and integrated employees, as depicted in table 8. In the timeframe of November 2016 and April 2017, the system was able to integrate and enable 216 employees, whom participated in the testing efforts of the internal crowd testing system. The Swiss BankCorp stopped the integration process at 216 employees, because the senior management regarded the crowd size as sufficient to cover all main expert areas of the test object. Between November 2016 and April 2017, the system organized 18 crowd test iterations, where the crowd of 216 contributors conducted 3'391 test cases and submitted 2'143 software issues. In the first nine iterations, between 8 to 54 contributors participated in a crowd test, conducting 475 test cases and submitting 548 software issues. In the following nine crowd test iterations, the number of participating contributors, conducted test cases and submitted software issues had increased. Between 53 to 120 contributors participated in a crowd test, conducting 2'916 test cases and submitting a total of 1'595 software issue. Between May 2017 and January 2018, the crowd continued testing and submitted other 3'003 software issues, which resulted in a total of 5'146 software issues.

The internal crowd testing PMO assessed the quantity of the system regarding contributors, test cases as well as software issues and further stated in the interview that the process worked successfully. The system integrated enough crowd contributors that

conducted sufficient test cases and submitted adequate software issues in order to reach a suitable coverage of the test object with regard to the second challenge of the Swiss BankCorp "Quantity – Adequate Coverage", as seen in table 9.

Evaluation Category	Results
Quantity a. Quantity of Results b. Quantity of Integrated Employees	a. Quantity of Results between November 2016 and April 2017: • 18 crowd test iterations • 3'391 conducted test cases • 2'143 submitted software issues • First 9 iterations: a. 8 to 54 contributors per crowd test b. 475 test cases conducted c. 548 software issues submitted • Next 9 iterations: d. 53 to 120 contributors per crowd test e. 2'916 test cases conducted f. 1'595 software issues submitted • Until January 2018 the crowd submitted 5'146 submitted software issues b. 216 Employees integrated

Table 9. Evaluation of Category "Quantity"

Time. In the "Time" evaluation category, we assessed the required time for preparation and execution of test iterations, as depicted in table 10. The interviews with the test managers from the internal crowd testing system showed that the preparation for an eight hours crowd test iteration would require on average one hour. Finally, after eight hours of crowd testing, a test manager would generally require three hours on average for the evaluation of the crowd test day. According to the test management and the PMO, they were able to prepare and set up crowd tests quickly and flexibly, addressing the challenge of the bank successfully, as depicted in table 10. The setup of crowd tests on short notice gave the testing process the advantage to be flexible and fast when needed. Moreover, the testers saved time during the execution phase, because they could conduct the tests from their daily workspace or from home. Therefore, the testers did not have to travel to the headquarter of the Swiss BankCorp like in the past but could use most of their time for testing. As a result, the crowd testing system could integrate employees, who were not able to join the testing efforts due to long distance, extending the pool of potential expertise. In contrast, crowd tests required more support by the test management and PMO compared to traditional testing efforts. The support provided was

often regarding the test cases, which were sometimes difficult to understand. Another situation that required assistants sometimes, where issues with the infrastructure that occurred, for instance, when the system was not stable.

Time a. Time for Preparation b. Time for Execution	a. 1h of Preparation on average Crowd tests are prepared and set up quickly and flexible. b. 8h of Execution and 3h for evaluation on average During execution the contributors save time, but the test management requires more attention.

Table 10. Evaluation of Category "Time"

4.6 Reflection and Learning

The aim of the dissertation is to better understand the design of internal crowdsourcing systems and to derive design principles for this artefact by generalizing it to a class of problems (Giessmann and Legner 2016). This section reflects the most important design learnings from selected STS components of the internal crowdsourcing system.

As described in the literature review, there are several requirements for a crowdsourcing system. Consolidating these requirements, the dissertation was able to identify 15 distinct requirements necessary to design a crowdsourcing system and structured them according to the central elements of socio-technical system theory. When designing the internal crowdsourcing system, these 15 requirements build the basis for further designs. The workshops and interviews with the experts were necessary in order to add knowledge, because important requirements were not found in the literature. Some requirements had to be translated to the context of internal crowdsourcing and further detailed for practical use. By doing so, the review followed Gregor and Jones (2007), who stated that knowledge from the field and the experience of practitioners is capable of informing design research (Ebel et al. 2016). Based on the requirements, the dissertation conceptualized the building blocks of the internal crowd testing system.

In the process of conceptualizing the system's single building blocks, the dissertation conducted four internal workshops (lasting approximately 120 minutes each). The result produced 14 building blocks that were conceptualized by a team with diverse expertise. The assortment of expertise was necessary in order to ensure a comprehensive concept of the system is created. This aspect became more transparent after the evaluation, which was conducted by test managers. The expertise of test managers was not represented in the initial conceptualization team, which led to the addition of new conceptual

knowledge to some existing building blocks and the conceptualization of a new, the fourteenth block. Based on these final building block concepts, the team designed the internal crowdsourcing system. Below, the dissertation reflects and highlights the key most important learned findings regarding the design of the internal crowdsourcing system.

1. Task Goal and Purpose and **Alignment with IT Department.** The dissertation started the design of the system by developing the "task goal and purpose" component of the internal crowdsourcing system. The design focus of the system was centered on the task goal and purpose of the project, which the management of the bank defined precisely and also described as the challenges of the company above in table 2. Therefore, the internal crowdsourcing system solves challenges by conducting specific tasks in the system. If the system should address new challenges, potential adoption costs are to be expected. The more a new challenge differs from the original one, the higher the adoption costs would be for conducting new tasks in the system. For instance, in this case, the system tests software with an internal crowd. If the company decides to use the system differently, such as conducting an innovation jam with an external crowd, the system must be adapted with a certain amount of costs. Furthermore, a learning was that the purpose of the crowdsourcing system is linked with its environment and would address the "Alignment with IT Department" component. The system receives its tasks by the IT department and sends back the results. Therefore, the crowdsourcing system acts as a complementing system to the efforts of the environment, which must be aligned and considered. Furthermore, if the system changes due to new challenges, the interface between the system and its environment must be assessed and potentially redesigned. It is possible that the communication between the system and its stakeholders in the environment change or new stakeholders occur.

2. Crowd Segmentation, Crowd Contributor Expertise and **Crowd Building**. After designing the system, the dissertation derived the specification of the crowd that would actually conduct the work, namely in the "Crowd Segmentation" building block. The segmentation of the crowd followed the different fields of expertise of the employees. By doing so, the crowd covered all testing domains of the software and the employees could contribute their expert knowledge to the test process. In this line of thinking, a learning was that the design of the component "Crowd Segmentation" is linked with the component "Crowd Contributor Expertise". Another learning showed that the segmentation of an internal crowdsourcing system derives from the goal and purpose of

the system. Therefore, a new purpose or task of the system is expected to change the segmentation of the crowd. In this line of thinking, a system should collect initially as much information from the contributors in the crowd as possible in order to be able to adapt the segmentation to new challenges and tasks as flexibly as possible. The final learning was that the "Crowd Building" must be aligned to the crowd segmentation concept. The Swiss BankCorp looked for potential employees according to the segmentation concept and used the intranet of the company as communication channel for acquiring the crowd. In addition, a system should consult relevant stakeholders regarding the participation of the crowd in the crowdsourcing initiative beforehand, for instance the work council and supervisors. The purpose of doing this is to prevent internal problems with the relevant stakeholders, especially when the crowd contributors would conduct crowdsourcing initiatives during the working hours. It is possible that certain stakeholders would not want employees to spend time on such a project or would not agree to such work methods in general.

3. Crowdsourcing Workflow and **Crowd Contributor Enablement**. The dissertation gathered learnings at six steps of the crowdsourcing workflow. Firstly, the learning was that an initial "Crowd Contributor Enablement" was necessary in order to ensure a successful integration of the crowd contributors into the crowdsourcing workflow. The enablement would ensure that the contributors find their way to the crowdsourcing initiative through the links in the invitations at the correct time. Furthermore, it would enable the crowd contributors to use the tools for an initiative, to find important information on the platform, to conduct the tasks appropriately, to communicate with the responsible persons if necessary and to submit an adequate result according to the predefinition. A learning was that a crowd includes contributors with different levels of IT skills, from low to high. The "Crowd Contributor Enablement" ensures that even a person with low IT skills is able to conduct a crowdsourcing initiative and contribute successfully in the crowdsourcing system. Secondly, the process requires sufficient invitation confirmations of appropriate contributors in order to proceed further. This might include an active approach by sending friendly reminders to the contributors that did not send a response thereby highlighting that a task and workload could be potentially considered. Thirdly, when the platform is set for an initiative, the PMO opens the communication channel between the crowd and the crowdsourcing managers, by adding all crowd contributors with the appropriate specification that confirmed the invitation to the channel. A learning was that a bilateral and group communication

would be necessary. On the one hand, one would use the bilateral communication for individual questions that concern mostly specific tasks between a crowd contributor and management. Additionally, bilateral communication should also be possible between two contributors. It enables contributors to help each other, decreasing the need for supervisorial support by the management. On the other hand, one could use group communication, if the management had to pass on general information that concerned the whole crowd. Fourthly, one starts the crowdsourcing initiative at a predefined time, which was communicated in the invitation. At this point, the complexity of accessing a crowdsourcing initiative became apparent. What would be advantageous is the provision of an access link in several spots, which decreases potential issues of the crowd accessing the initiative, for instance, within the invitation and additionally in the communication channel created for the initiative. Fifthly, after several crowdsourcing initiatives, it became apparent that the community management of the crowd during, as well as after, an initiative requires more effort and work than initially anticipated. Therefore, a crowdsourcer should strive to allocate sufficient personnel for managing the crowd. In addition, after several crowdsourcing initiatives, the community management workload during an initiative decreases due to increased experience of the crowd contributors; while the workload after an initiative might increase due to decreasing motivation of the crowd. Sixthly, a learning was that the assessment of crowd initiative final results requires more time than from a professional team. In other words, if the crowd documents the submitted results less accurate it requires more time to assess and verify the crowd results compared to professional testers. Even though, these issues decrease over time, because the contributors gather more experience, it leads to an increased effort.

4. Crowd Contributor Incentivization. The "Crowd Contributor Incentivization" can be based on different incentives, for instance the curiosity and interest towards the crowdsourcing task. In this case, the crowd was interested in learning about the test object in the initiative, which the contributors would use in their future day-to-day business. Other potential incentives could be financial or social ones. The dissertation found that the internal crowdsourcing system should address a range of different incentives, because every contributor reacts to different incentives. Providing a larger range of incentives would include many different contributors in the crowd and may incentivize them in a long-term perspective. Furthermore, another learning was that in a context of internal crowdsourcing, which has only a limited pool of potential

contributors, a longitudinal motivation concept would be necessary. For instance, providing changing tasks to the contributors, because if they were regularly confronted with the same task and the crowd was not big enough to rotate the task, the motivation of the crowd would decrease and not participate in the future.

5. Role Model. Based on the learnings the dissertation derived a general role model for internal crowdsourcing with the duties, competences and responsibilities, depicted in table 11. In this context, the learning was that one person could take over more than one role. For instance, one person could manage the crowd operationally during the crowd test as a Crowd Manager and assess the submissions of the crowd afterwards as a Crowd Result Manager too.

Role		**Description**
Crowd Project Management Officer (PMO)	Duties	• Coordinating the crowd activities through all crowdsourcing iterations • Planning the crowd iterations • Defining and selecting the crowd contributors needed for an iteration • Providing first level support during the crowd activities • Writing a summary of the crowd activities and results
	Competences	• Assembling the required crowd tasks of a crowd iteration • Designing the crowd iteration (e.g. collaborative or competitive work style) • Contacting crowd contributors directly
	Responsibilities	• Planning, coordinating, specifying and managing the community of the organizational crowd
Crowd Contributor	Duties	• Reacting to the invitations to crowd activities • Conducting crowd activities • Submitting results as specified • Answering questions concerning submissions
	Competences	• Accessing to crowdsourcing tools • Providing open feedback according to specified task

	Responsibilities	• Conducting crowd activities comprehensively according to specifications
Crowd Manager	Duties	• Supervising the operative crowd contributors during crowd activities • Creating and supplying general information about crowd iterations • Conducting a briefing with the crowd PMO for each crowd iteration • Supporting crowd contributors on a first level • Creating a status of the test for the PMO
	Competences	• Contacting crowd contributors directly
	Responsibilities	• Supervising the crowd contributors during a crowd iteration
Crowd Result Manager	Duties	• Assessing the submissions of the crowd contributors
	Competences	• Validating and classifying the results of the crowd iterations • Contacting crowd contributors directly
	Responsibilities	• Transferring adequately and orderly crowd outcomes to the organization
Organization	Duties	• Administrating and organizing all crowd activities in the organization • Giving initial impulse for crowd iterations • Briefing the crowd PMO concerning next crowd iterations
	Competences	• Instructing new crowd iteration • Receiving the final results of the crowd iterations
	Responsibilities	• Overviewing all areas that require crowd activities • Supplying crowd activity requests for the iterations

Table 11. General Role Model of the internal Crowdsourcing System

6. Technology. In the domain of technology, the dissertation found that it is advantageous to use technological components for the crowdsourcing system, which are already available within the organization. Consequently, the internal crowdsourcing system could ensure that every contributor would have access to all required tools and

software on their normal computer at work without license or compatibility issues. Additionally, many contributors would be potentially acquainted to the tools and software, which improved the initial enablement of the crowd to the crowdsourcing system. Moreover, it was also found that it is possible to use standard software and adjust them to the requirements of crowdsourcing, in our case crowd testing. Finally, another finding was that an internal crowdsourcing system would require "Crowd Communication Tools", for the pre-, during and after-initiative communication, a "Knowledge Repository", as a database and a "Process Platform", which provides the crowd with a place to conduct their tasks.

4.7 Specified Learning – Design Principles

Sein et al. (2011) formalize the findings in the fourth stage of the ADR. In light of this formalization, the dissertation develops these further to general design principles for a class of field problems and consolidates them according to the STS components. The class of problems is to organize the work and integrate expertise of employees through designing an internal crowdsourcing system. Five design principles were identified that support practitioners and researchers. Afterwards, the dissertation evaluated the design principles in two iterations. In the first iteration, three interviews were conducted with internal crowdsourcing PMO's from three different companies applying crowdtesting. The last evaluation iteration was conducted with three internal crowdsourcing experts outside of crowdtesting in order to abstract towards other application fields of internal crowdtesting, for instance innovation management.

The first design principle "Balanced Specification between Task Precision and Standardization", which is based on the first "Reflection and Learning", increases the quality of the system's output through balancing the principle's characteristics "Precision" and "Standardization". On the one hand, "Precision" defines the specification of the internal crowdsourcing system precisely enough, adapting the system continuously to specific tasks and therefore, increasing the system's performance. On the other hand, the characteristic "Standardization" tends to reduce complexity of the system using standard solutions in order to enable flexible adaptation of the system to different tasks. As a result, the internal crowdsourcing system conducts precisely described tasks successfully with a balanced flexibility to adapt to new tasks, supporting the "Quality" challenge, as depicted in table 12.

STS Component		**Design Principle**
Task	**No. and Name**	**1. Balanced Specification between Task Precision and Standardization**
	Goal	This Principle aims at increasing the quality of the system's output by defining a balanced specification of the system between precision and standardization.
	Description	a. Precision: Precise Task definition and continuous definition-oriented design b. Standardization: Reduced complexity through a balanced degree of standardization
	Output	A system that addresses precisely described tasks successfully and flexibly.
	Addressed Challenge	Quality

Table 12. First Design Principle

The second design principle "Systematic Fit of Task and Crowd", which is based on the second "Reflection and Learning", increases the success of the system aligning an appropriate crowd with tasks of the system. The principle follows two characteristics "Comprehensiveness of Information" and "Allocation". The former addresses the diversity of information, such as demographic information or expertise of the crowd, as basis for a crowd segmentation and allocation. In addition, the system's design collects a large quantity of information of the crowd, in order to be able to adapt flexibly to other tasks, which need a different basis of information. The second characteristic "Allocation" aligns the appropriate crowd with the task of the system and therefore, leads to a successful fit between expertise of the crowd and task of the system, which addresses the challenge "Quality", as depicted in table 13.

STS Component		**Design Principle**
Task	**No. and Name**	**2. Systematic Fit of Task and Crowd**

	Goal	This Principle aims at increasing the success of the system through matching the crowd with tasks.
	Description	a. Comprehensiveness of Information: Diversity of information types and quantity of information b. Allocation: Alignment of task and appropriate crowd
	Output	Successful fit between task and expertise of the crowd contributor.
	Addressed Challenge	Quality

Table 13. Second Design Principle

The third design principle "Integrative Hybrid System of Traditional and Crowdsourcing Culture", which is based on the third and fifth "Reflection and Learning", aims at integrating the stakeholders of the system successfully through its three characteristics "Consensus", "Hybrid Hierarchy" and "Organizational Care". The "Consensus" characteristic describes a system design that integrates the accordance of the stakeholders in the system regarding the participation of the crowd in internal crowdsourcing initiatives. The crowd contributors participate voluntarily, the direct subordinates agree to the participation of their employees, but the higher management and work councils support the initiatives as well. The "Hybrid Hierarchy" integrates hierarchies of two modes of work into one system. On the one hand, the traditional and rather vertical hierarchy still influences, to some extent, the processes in the internal crowdsourcing system. On the other hand, the internal crowdsourcing systems introduces a new understanding of a rather horizontal hierarchy into the organization. The characteristic "Organizational Care" depicts a design with a comprehensive enablement process for the crowd, introducing them to the new mode of work and its respective IT tools. In addition, the design supports the crowd during and after the internal crowdsourcing initiatives, such as answering questions or receiving and assessing feedback. The final characteristic "Code of Conduct" accompanies design elements of the traditional system into the new design of the system. For instance, some behavior or communication patterns (e.g. organization specific terms or acronyms) of the traditional system are also important in the new internal crowdsourcing system. Consequently, the integrative hybrid system enables the successful participation of the

stakeholders in the internal crowdsourcing system, addressing the "Quality", "Quantity" and "Time" challenges, as depicted in table 14.

STS Component		**Design Principle**
Structure	**No. and Name**	**3. Integrative Hybrid System of Traditional and Crowdsourcing Culture**
	Goal	This principle aims at a successful integration of stakeholders.
	Description	a. Consensus: Permission for participation of employees from the management and other stakeholders b. Hybrid Hierarchy: Integration of traditional hierarchy and new self-selection c. Organizational Care: Comprehensive enablement process and support for the crowd d. Code of Conduct: Behavior and communication according to company code of conduct
	Output	Integrative system enables the successful participation of stakeholders.
	Addressed Challenge	Quality, Quantity, Time

Table 14. Third Design Principle

The fourth design principle "Social Sustainability", which is based on the fourth "Reflection and Learning", increases the commitment of the crowd through four characteristics: "Sustainability", "Variety", "Governance" and "Reliability". The first characteristic illustrates that long-term motivation drivers are important in the system design for the participation of the internal crowd. Potential contributors for the crowd are limited to the employees of the company only. Therefore, a long-lasting commitment through long-term motivation is crucial. The characteristic "Variety" describes a design with a diverse set of incentives for the participation of the crowd. Each individual is attracted by different incentives. Thus, the system design provides a range of diverse incentives in order to attract as many potential contributors for the crowd as possible. The "Governance" characteristic depicts a system, which frames the expectation of the contributors in the crowd from the beginning and continues to do so during the initiatives further down the line. Against this background, the system design avoids

disappointment or misconceptions of crowd contributors that could lead to a decreasing motivation and size of the crowd. The final characteristic "Reliability" implements consistently a reliable community management in the system design, which conducts initiatives professionally, meaning that the crowd can rely on the internal crowdsourcing system. For instance, if an initiative is planned, then the crowd relies that it will be conducted, in a timely manner and without technical disturbances. As a result of the design principle, the system achieves a successful and long-lasting commitment of the crowd for initiatives, submitting more and better contributions over time, which addresses the challenges "Quality" and "Quantity", as depicted in table 15.

STS Component		**Design Principle**
Actor	**No. and Name**	**4. Social Sustainability**
	Goal	This Principle aims at increasing the sustainable commitment of the crowd.
	Description	a. Sustainability: Long-term motivation driver for the participation of the crowd b. Variety: Divers set of incentives for the participation of different crowd contributors c. Governance: Framed expectation of the contributors in the beginning and throughout the initiatives d. Reliability: Consistent implementation of a reliable community management in a professional system
	Output	The successful and long-lasting commitment of the crowd increasing the quality and quantity of submissions.
	Addressed Challenge	Quality, Quantity

Table 15. Fourth Design Principle

The final design principle "Intuitive Usability", which is based on the sixth "Reflection and Learning", aims at the successful usage of technology of the system by the crowd through three characteristics: "Intuitivism", "Homogeneity" and "Familiarity of Tools". The first characteristic describes a system with tool designs for the crowd, which are as simple and intuitive as possible. Some crowd contributors originate from non-IT related professions. The more the crowd can use the tools of the internal crowdsourcing system

without introduction, the higher the potential for a successful introduction and usage. The second characteristic "Homogeneity" illustrates the homogenous interfaces between the different technological parts and tools of the system design. The crowd cannot tell the different technological parts and tools apart, perceiving it as "one" system, which decreases the risk of problems while switching between tools and increases the potential successful usage. The final characteristic "Familiarity of Tools" depicts a system design, which applies some tools that are already familiar to the crowd contributors, due to application in their everyday work. If the crowd uses tools that they know from other work fields already, then the introduction and usage is possibly more successful. In general, the design principle leads to a successful introduction and usage of the technology in the internal crowdsourcing system to the crowd, addressing the challenges "Quality", "Quantity" and "Time", as depicted in table 16. The intuitive technology enables the crowd to submit more contributions with better quality in a smaller amount of time.

STS Component		**Design Principle**
Technology	**No. and Name**	**5. Intuitive Usability**
	Goal	This Principle aims at the successful usage of technology of the system by the crowd.
	Description	a. Intuitivism: Design as simple and intuitive as possible b. Homogeneity: Homogenous interface c. Familiarity of Tools: Usage of available solutions
	Output	Successful introduction and usage of the technology in the system to the crowd.
	Addressed Challenge	Quality, Quantity, Time

Table 16. Fifth Design Principle

Overall, the dissertation in hand developed five design principles that support the design of an internal crowdsourcing system. The dissertation allocated the design principles according to their affiliation to the STS components, as depicted in figure 8. According

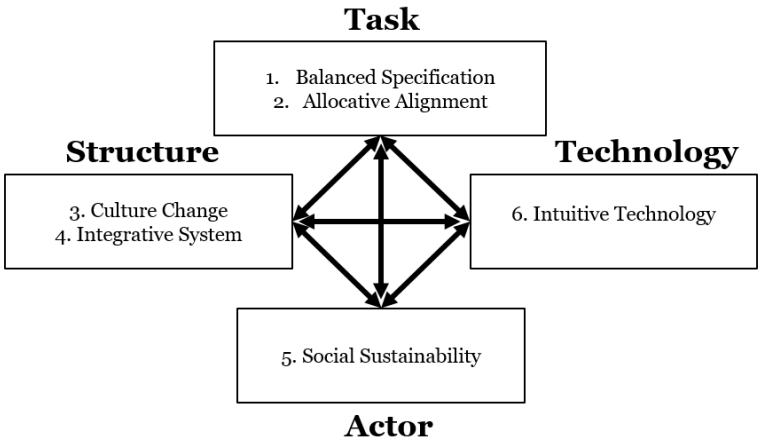

Figure 8. Design Principles according to the STS Components

to the STS theory the components are interrelated (Baxter and Sommerville 2011; Lyytinen and Newman 2008), which is also the case for internal crowdsourcing systems. For instance, the balanced specification principle of the task STS component affects the technology principle. The system may apply more specific crowdsourcing tools or instead, more standardized tools. Furthermore, the technology principle has an impact on the integrative system principle of the structure STS component. The more intuitive the technology, the more successful the integration of the crowd into the system. The culture change principle of the structure STS component is related to the social sustainability principle of the actor STS component, because an unsuccessful culture change would lead to a decreased size of the crowd, which makes social sustainability more difficult. To surmise, following one design principle for designing the system is necessary with respect to the other STS components and their design principles, because the principles are all interrelated.

5 ADAPTING INTERNAL CROWDSOURCING SYSTEMS

After designing an internal crowdsourcing system, a company needs to focus on rolling it out in the organization successfully in order to capture the benefits. Thus, identifying and overcoming the adaptation barriers are crucial for the success of the internal crowdsourcing system (Knop and Blohm 2018a). This chapter of the dissertation will focus on the adaptation barriers and potential solutions to overcome them, answering the second research question. In order to do so, the chapter analyzes the lead case of

BankCorp in-depthly, which shows and reflects circumstances of everyday business conditions in detail. In the following subchapters, two additional cases are added to assess and depict how the same challenges and solutions can be found in other cases as well.

5.1 Adaptation Barriers in BankCorp

BankCorp is one of the leading retail banks in Switzerland and has a strong focus on its domestic market. It is active in all regions of Switzerland with 9'200 employees and 3.7 million customers. The bank embarked on a major, company-wide software development project and developed a new business software that will be used by almost every employee on a daily base. As a bank, the organization faced strict regulatory requirements in terms of reliability, security, and quality of the software. However, during the development process, the managers of the project team recognized that they run short of resources for testing the software and they will have to integrate additional workforce for testing purposes to meet the regulatory requirements, i.e., they had been able to exhibit that each and every bit of the software has been extensively tested. Thus, the bank started to introduce internal crowdsourcing from the end of 2016 to integrate end users, i.e., the employees in the single banks, in a large-scale testing process. As the introduction of internal crowdsourcing addresses technical aspects through new platforms and IT-tools, as well as a change management aspect, due to the new nature of work organization, it constitutes a technochange project starting with the its first phase:

Chartering Phase (Idea proposed, approved and funded): BankCorp already had experience in integrating its employees in the testing process of its enterprise applications. The bank used to invite its employees to its headquarter for software testing. Nevertheless, the bank faced the problem that this "traditional" testing approach was costly, did not scale up, and was too inflexible to account for the highly variable testing needs of the software development project. This was particularly the case in the early phases when larger software development updates frequently created ad hoc testing needs. In short, this traditional approach was inadequate for reaching a sufficient product quality and required a far too lengthy time-frame for improving quality through software testing. Finally, the software was a commercial software solution that required extensive customization with respect to the banks business processes and products. Thus, potential software testers required deep knowledge of the bank's business

operations and products; knowledge that frequently resided in different departments and required a form of connecting numerous knowledge bases in the departments.

Consequently, the bank introduced an internal crowdsourcing platform for leveraging its software testing operations. However, internal crowdsourcing did not replace traditional software testing operations. It was rather installed to complement these software testing tasks to integrate the collective knowledge and the workforce of the bank's employees. Table 17 summarizes the main problems of BankCorp's traditional end user testing approach and illustrates how internal crowdsourcing may mitigate them.

Problem	**Description**	**Internal Crowdsourcing Solution**
Inadequate quality	Insufficient quality of software due to lack of resources for testing	Additional workforce from the crowd covered more software
Slow process	Inability of preparing and conducting software tests quickly	BankCorp could use crowd workers flexibly and did not require much time to deploy them
Weak integration of employees	Inability to Integrate employees to the test process and use their expert knowledge identifying software issues early	The IT-enabled approach of internal crowdsourcing simplified the integration of many employees that brought their expertise early to the test process from different departments

Table 17. BankCorp's Problems

Project Phase (Solution developed): The bank acquired a crowd of 216 employees that tested the software on a weekly basis for a period for over a year. On average, a crowd of 90 employees tested the software in two four-hour tests taking place on Thursday afternoon and Friday morning. The crowd was assembled with respect to their expertise according to the five main product areas of the bank (i.e., credit and loans or retirement provisions), to ensure that the crowd had sufficient business knowledge for testing the software properly. For each product area, a weekly test was conducted. For managing the entire crowdsourced software testing process, a crowdsourcing management was installed. The crowdsourcing management served as interface between the crowd and the software testing teams in the software development project It helped these teams to

identify “crowdsourceable” software testing tasks and to transform them into specific tasks that the crowd had to test in the weekly tests.

The crowdtesting process had three general steps: (1) Based on the specific testing tasks, the crowdsourcing management assembled an appropriate crowd of employees out of the pool of available testers. On average, about 15-20 employees participated in a crowdsourced software test of a product area. The participation of the crowd was voluntary and carried out during regular working time. Due to reasons of compliance, no financial rewards were offered to the crowd for participation. (2) The actual software testing was performed via a dedicated crowdsourcing platform that provided access to the software testing tasks, an interface for documenting software bugs and other issues that needed to be fixed. The system provided various communication channels that enabled the crowd to directly exchange and discuss upcoming problems during the single test iterations, as well as centralized communication means with which the crowdsourcing management could share information with all participating testers. During the single tests, the crowd was supported by technical experts (subject-matter-experts in the parts of the software that have been tested) to support the crowd in their testing tasks. (3) Finally, crowdsourcing managers evaluated all documented bugs and software issues after the tests. Verified bugs and software issues were then forwarded to the software development project’s prioritization process from where they were put on the software’s development roadmap, as depicted in figure 9.

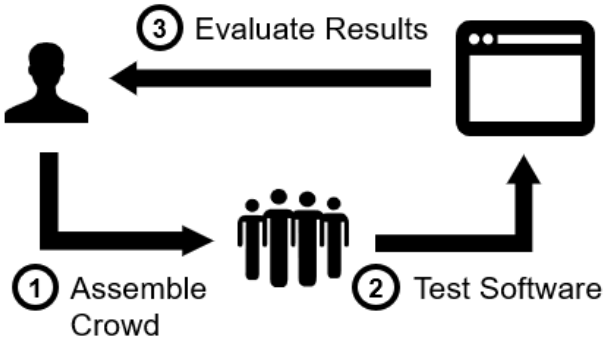

Figure 9. Crowdtesting Process

Shakedown Phase (Starts operating and troubleshoots problems): For many employees the internal crowdsourcing was a very new experience and required a change in their work mode as well as an acquisition of new skills, as depicted in table 18.

Problems	Traditional Setting	Internal Crowdsourcing Setting
New IT capabilities	Colleagues know each other and work face-to-face	Colleagues only available online and remotely. Need to build up new digital communication channels and capabilities to conduct work online only.
Switching between settings	Traditionally the work was conducted mostly in one place or with similar tools and processes	Facing extra efforts by switching between the two settings with very different needs
New work distribution	Hierarchical work distribution with traditional incentive mechanisms	Familiarize with a more democratic and egalitarian communication with a rather horizontal hierarchy and new incentives

Table 18. Troubleshoot Problems

New IT capabilities: In a traditional work setting, most colleagues know each other and their direct supervisors, working together face to face. The hierarchical structures and roles are clear. Supervisors with authoritative competences define the tasks, which do not change dynamically. In contrast, in the digital work setting of internal crowdsourcing, colleagues were only available online and remotely. The employees had to build up new digital communication channels to the crowd and crowdsourcing management, learn how to interact in new social relationships online, and adapt to a different style of receiving feedback. Moreover, the employees had become adapted to the new tasks, i.e. software testing, because they originated from jobs with lower IT requirements. Thus, they had to learn new IT capabilities in a digitally mediated setting. In the beginning, their tasks and responsibilities were not clear and were defined during the progress of the project.

Switching between settings: The crowd conducted the new tasks parallel to the everyday job in the bank, which led to employees switching between the two worlds: internal crowdsourcing and traditional work. This means the employees faced switching costs, because they had to arrange and cater to the needs of these two worlds.

New work distribution: The employees experienced a new way of work distribution. They participated voluntarily in the crowd tests, which changed the direct supervisor role since the crowdsourcing management has no direct, rather unclear, managerial authority towards the crowd workers. Thus, the crowdsourcing management could not

decide who takes part in which internal crowdsourcing initiative. The difference in hierarchical structure in internal crowdsourcing to traditional work changes the communication to a more democratic and egalitarian pattern. Traditional enforcement disappears or changes significantly. Consequently, the motivational concept changes from one that is driven by traditional remuneration and authority to a new motivational concept that is based on more personal relationships and intrinsic incentives. The new way of work distribution requires the management to plan with respect to potential suboptimal performance by the crowd and ensure through the new communication and motivation the availability of sufficient employees in the internal crowdsourcing initiatives.

Benefit Phase (Continuous improvements and capture of benefits): Nevertheless, the management integrated 216 employees successfully into the crowd that conducted crowd tests for 14 months and submitted more than 5'000 documented software issues. Without the extensive support of the crowd, the bank could not have accomplished the development of this major software, which is now in used in daily practice by every employee. The success of the internal crowdsourcing project lead to the decision to turn the project into an internal service that offers crowdsourced software testing on a regular basis. In this context, the management extends and standardizes internal crowdsourcing for it to be implemented and used in the company beyond the original project, which opens the service of the crowd to new projects and departments in the future. In the following section below, the adaptation barriers of internal crowdsourcing the bank faced will be illustrated in more detail.

5.2 Adaptation Barriers in Internal Crowdsourcing

We identified eight different adaptation barriers in the four technochange phases, as depicted in table 19. In the table provided further below we described these in more detail.

1. Supervisor stakeholders reluctant of employee's participation in internal crowdsourcing	The crowdsourcing management must make sure that the supervisors of the crowd workers, the high management, and the work council approve of internal crowdsourcing.
2. Build up a crowd of employees	In internal crowdsourcing, the crowdsourcing management (CPMO and CM) must attract many employees directly and on a voluntary basis to the crowd.
3. Hyped expectations of the crowd	The crowdsourcing management faces the challenge of accompanying the expectation development of the employees, from the peak of inadequate expectations at the beginning towards the reality of crowdsourcing.
4. Lacking integration into existing business and work processes	New IS lead to standalone systems that can make an efficient integration into the processes of the company difficult, facing inefficient workarounds and interfaces between the standalone internal crowdtesting system and the IT department.
5. Inadequate IT capabilities of crowd workers	The management must lift the IT and workflow capabilities of crowd workers to a minimum level, enabling the use of crowdsourcing IT tools and workflow.
6. Parallelism of work settings	A common adaptation barrier of employees is switching between the analog everyday work and the digitally mediated work setting of the internal crowd, which can increase the stress level and may be exhausting.
7. Developing new incentivization structures	The challenge is to develop a new incentivization structure that can motivate employees in the new work mode, due to the lack of traditional authority as well as the voluntary nature of the crowd's participation in initiatives.
8. Find a new way of delegating work	The crowdsourcing management must learn the difficult act of delegating business tasks to the crowd according to the new mode of work. Some managers delegate to the crowd incomprehensibly for crowd workers, because they were not aligned with the needs and capabilities of the crowd.

Table 19. Adaptation Barriers in Internal Crowdsourcing

1. Superior stakeholders reluctant of employee's participation in internal crowdsourcing. Internal crowdsourcing permits organizations the ability to fundamentally rethink how to distribute work, which requires the approval of the

superior stakeholders and therefore is part of the initial Chartering phase of the technochange process. In traditional working environments, employees are usually situated within clear and well-organized hierarchical structures that are directly associated with a given business unit, department, and/or team. A direct supervisor is in charge and can directly steer and instruct the working activities of individual employees. In internal crowdsourcing however, the crowdsourcing management (e.g., the CPMO at BankCorp) must attract a large number of employees directly that participate on a voluntary basis. Building up such crowd that serves as flexible resource pools that can be used in an on-demand fashion may create various tensions. While top management may be more open to such approaches, direct supervisors of the employees that are willing to act as crowd workers may be reluctant to internal crowdsourcing since such structures may be regarded as loss of resources and power and in particular, if internal crowdsourcing initiatives are conducted during regular working hours. Thus, some of them might reject the idea of their staff joining the crowd and do not allow them participating in crowd initiatives. In addition, work councils might be sensitive regarding concerns of potential exploitation of employees as well as a deterioration of working conditions.

InsureCorp faced similar problems when it introduced internal crowdsourcing. The company provides health insurance to nearly two million customers in Switzerland and has more than 3'000 employees. Participation was voluntary; however, it was planned to conduct crowdsourcing within regular working hours on top of the employee's regular duties. Thus, the organization's worker council dictated that the entire crowdsourcing initiative should be designed such that participation of individual employees should not take longer than half an hour per week. In addition, participating crowd workers had to confirm that they have the confirmation of their direct supervisor that they can participate. Working out these boundaries for participation in internal crowdsourcing was an initial challenge for building a pool of crowd workers and took several months as it started a series of political discussions regarding how InsureCorp should generally deal with internal crowdsourcing.

2. Build up a crowd of employees. The internal crowdsourcing management must reach and create attention among employees as potential crowd workers for joining the crowd for future initiatives. In this context, the management must propose the idea of working in the crowd to the employees, which constitutes a part of the Chartering phase. The management must build an active crowd that provides a sufficient size and diversity of

adequate employees that can conduct a range of different tasks in the initiatives. This may be challenging since internal crowdsourcing is usually quite unknown to employees. They need to be educated about the approach in the first instance as well as be motivated to join. In a traditional environment, the management allocated or received employees for a new department based on authority. In internal crowdsourcing, however, the crowdsourcing management must attract a large number of employees directly and on a voluntary basis to the crowd. The direct and voluntary acquisition of a large number of employees constitutes a new way of resource allocation in a company, which brings a new challenge to the management in terms of how to motivate an employee to join the crowd on a voluntary basis.

The employees of InsureCorp were new to the planned internal crowdsourcing initiative. Most of them never heard of the term crowdsourcing and had difficulties to understand that the concept would work inside the boundaries of InsureCorp. The management was new to the concept as well. They did not know how to motivate the employees to join the crowd and what incentives as well as measures were the most effective.

3. Hyped expectations of the crowd. Many of employees have highly inflated expectations and envision a more innovative, more democratic, more autonomous, and more thrilling way of working that can only be disappointed by the course of time. Therefore, the crowdsourcing management faces the challenge of managing the employee's expectations systematically so that all employees may build a better fitting picture of the reality of internal crowdsourcing. This challenge is part of building and developing the crowd; therefore, it is part of the Project phase of the technochange process. In particular, managers of internal crowdsourcing initiatives are required to provide sufficient information at the beginning to the crowd regarding the specific way of working as well as their responsibilities in the upcoming initiatives in order to enable the crowd to anticipate its part in the initiatives properly. If crowd workers have a very different idea of the concept and the real task, it bares the risk of negative surprises that would shape the image of internal crowdsourcing leading to a decreasing participation and quality of the obtained outcomes.

For instance, BankCorp tested a company-wide standard software that was customized to the needs of the bank. At the beginning, it was not clear to all participating crowd workers that the software could not be changed fundamentally, as it could only be adapted in the range of the customization parameters. This was quite demotivating for

many crowd workers, as they believed that their feedback was not implemented and valued. Such a mismatch was primarily caused by wrong expectations regarding the task of software testing. For instance, the crowd took a substantial role in functional software testing. This type of testing is primarily driven by very well-defined testing tasks that need to be executed precisely and not by freely exploring a novel software and providing feedback about one's perceptions and thoughts. Furthermore, it is quite repetitive as many testing tasks need to be carried out again after each major change at the software to ensure functionality of the software. Thus, many of the highly positive expectations of the crowd workers were disappointed when they recognized that crowdsourcing is not only fun but may also involve hard and cognitively demanding work. Following the ideas of Gartner's Hype Cycle (Steinert and Leifer 2010), the management of the crowdsourcing initiative had the challenging situation of first attenuating a peak of inflated expectations and then to go through a valley of disillusionment, before crowd workers developed realistic expectations.

4. Lacking integration into existing business and work processes. Internal crowdsourcing is a new work mode conducted on a digital platform, which requires an efficient integration into an organization's surrounding business and working processes. Therefore, developing an integrated system that interacts properly with the stakeholders is part of the Project phase. In our cases, internal crowdsourcing was started as independent "standalone systems". While this may initially help to start internal crowdsourcing quickly and provides a high flexibility for the application of the approach to different business domains, it hampers an efficient integration into the processes of a company. Consequently, the crowdsourcing managers face inefficient workarounds and interfaces between the standalone internal crowdsourcing system and the rest of the organization. More severely, the outcome of an internal crowdsourcing initiative is often characterized by a large number of contributions of the crowd – many of them being very similar or exact duplicates. These standalone structures and processes are just not made for absorbing and processing such an overload of information. Consequently, the outcomes of internal crowdsourcing approaches can frequently be made usable with only a very high manual effort.

For instance, InsureCorp needed to broadcast task instructions and related information from the organization to the internal crowdsourcing system and back. As the internal crowdsourcing was a standalone system, this information had to cross IS interfaces. However, not having systematic processes for the interfaces here led to many, repeated,

manual and highly time-consuming interactions. InsureCorp sent invitations to the crowd workers for an initiative, which crossed the interface of the internal crowdsourcing system to the company system. These invitations ended up in the spam filter and the information was lost. The management had to invite the potential crowd workers manually then.

5. Inadequate IT capabilities of crowd workers. Inadequate IT capabilities and new workflows for the crowd are a common adaptation barrier in internal crowdsourcing, when the systems start to operate, because internal crowdsourcing is an IT-enabled system. Troubleshooting such challenges of the operating system is part of the Shakedown phase of the technochange process. Managers of internal crowdsourcing initiatives face a crowd with a high diversity of personal, educational, and socio-demographic backgrounds. While most of them are unproblematic for the introduction of internal crowdsourcing and may highly contribute to the success of such initiatives, highly diverging IT capabilities may have a big impact on the successful usage of internal crowdsourcing. This is particularly the case given that some employees originate from jobs that do not require high IT capabilities. For example, some crowd workers did not possess basic IT capabilities and workflow understanding of an internal crowdsourcing system. Some crowd workers bring high IT capabilities and subsequently mastered the IS tools of communication and the new workflow quickly. The management must lift the IT and workflow capabilities of crowd workers to a minimum level, enabling them to use crowdsourcing IS tools and workflow. Otherwise, some crowd workers will not be able to conduct internal crowdsourcing tasks and cannot submit contributions.

For instance, some crowd workers of InsureCorp had low IT and workflow capabilities submitting results that were not part of their work scope and had no value. These crowd workers did not understand the elementary workflow and goal of the initiative. Consequently, they could not contribute valuable submissions to the internal crowdsourcing initiative.

6. Parallelism of work settings. Internal crowdsourcing is a new environment for most crowd workers. They are only partly active in the crowd, while performing their regular everyday job for the rest of their working time. As a consequence, there is a parallelism of work settings. Switching between the everyday work and the completely digitally mediated work setting of internal crowdsourcing, may add complexity and increase the

stress level. To troubleshoot this challenge of managing the switch between the traditional and digital setting constitutes an aspect of the Shakedown phase. Therefore, the crowdsourcing management must prepare the crowd workers with necessary skills to be capable of working in the new internal crowdsourcing setting, which facilitates the constant switching between both modes of working if participation in internal crowdsourcing becomes a regular task. As opposed to the crowd workers regular job, in which they directly interact with clients or colleagues, internal crowdsourcing is a challenging work situation. Crowd workers work alone on the computer with no direct face-to-face interaction and exchange. They need to integrate themselves into an emerging community of crowd workers, building new digitally mediated working relationships and to internalize the frequent implicit code of conduct and directives in internal crowdsourcing initiatives. In addition, the tasks to be performed on internal crowdsourcing might differ highly in comparison to a crowd workers regular job and may be constantly changing in such a manner that leads crowd workers have to adapt to a new task during each participation.

For instance, IndustryCorp faced this adaptation barrier. IndustryCorp is a Swiss company that produces and sells sanitary products with almost 12'000 employees in around 50 countries. Crowd workers of IndustryCorp had everyday jobs very different to crowdsourcing, explaining and selling the products to clients. The crowd testing initiative was a very new experience. The crowd workers had to test a mobile app that their customers used on their cellphone. This mobile app supports customers getting information regarding products or ordering spare parts. Crowd workers around the world tested this application in their different language versions using a range of different cellphone types. In order to do that, they needed a quiet room to focus on the crowd testing effort, because in the everyday workspace many colleagues use a cellphone to speak to their clients. The switch always needed a certain timeframe for the adjustment to get into the new working mode. The crowd workers had particular trouble in terms of dealing, evaluating and documenting bugs and software issues. Constantly searching for as well as finding a suitable location and switching to the new digital mode of work without face-to-face contact was perceived as stressful.

7. Developing new incentivization structures. Internal crowdsourcing replaces the traditional hierarchy and authority with a new, a more democratic and egalitarian way of working. This change derives the challenge to develop a new incentivization structure that can motivate employees in the new, more voluntary based work mode, to ensure a

sustained participation. The crowdsourcing management must learn a new way of incentivizing the employees, which requires time to master. This presents a continuous process of improvement and an ongoing adjustment of new incentives in the system; thus, it belongs to the Benefit phase of the technochange process. A quintessential challenge that is faced concerns the fact that the management has limited possibilities to test different incentive structures, because in internal crowdsourcing, the potential pool of crowd workers is limited to the employees only. If an employee loses interest in participating in the crowd, it becomes increasingly difficult to replace the employee, because the number of potential replacements is limited.

For instance, the crowdsourcing management of IndustryCorp faced a crowd that complained about various issues such as doing the repetitive tasks, being confronted with boredom and the persistent thought of ending the participation in internal crowdsourcing. Others did not see the purpose or benefit of the initiative on a personal level, prioritized the daily work responsibilities higher and decided not to join the internal crowdsourcing initiatives. As the internal crowdsourcing management had no direct authority, they had to soon create a solution for motivating the crowd, because the crowd already started to shrink and lose some if its capacity, which is needed to conduct the initiatives successfully and avoid such negative consequences.

8. Find a new way of framing work. The origin of internal crowdsourcing initiatives are tasks from the business functions of the company. Thus, the crowdsourcing management must learn the difficult act of framing tasks from the business for the crowd according to the new mode of work. This includes how to decompose greater tasks from business into smaller ones that are applicable for single crowd workers. In addition, the management must identify what is a comprehensible language for a crowd. However, some managers frame internal crowdsourcing initiatives incomprehensibly for crowd workers, because they were not aligned with the needs and capabilities of the crowd. As a result, the crowd workers could not (or only fairly poorly) conduct the tasks of the initiative. This challenge is a continuous challenge in terms of how to improve the framing of tasks for the crowd; therefore, it belongs to the Benefit phase.

For instance, BankCorp created the crowdsourcing instructions of the task automatically and delegated them to the crowd. On the one hand, the crowd did not understand the IT-specific vocabulary used by the program, because most of them did not originate from IT-related jobs. On the other hand, the instructions were not updated according to the

development of the project. They were created at the beginning of the project and were not adapted to the evolving developments of the project later on. Consequently, the steps in the instructions no longer matched the actual project. Therefore, the crowd workers needed more time to conduct the initiatives, which reduced the number of tasks they could accomplish.

5.3 Solutions to overcome Internal Adaptation Barriers

After setting an internal crowdsourcing system into motion, adaptation barriers will occur in the organization. To overcome them, the organization has to derive adequate solutions for each challenge. Thus, for each adaptation barrier illustrated above, specific solutions were presented and applied in the main case in question and was further confirmed by the other companies in these cases. Table 20 illustrates an overview of our recommendations to overcome the aforementioned identified adaptation barriers structured according to the technochange phases.

1. Receive approval for internal crowdsourcing	The crowdsourcing management finds arguments to convince direct supervisors to let employees to join the crowd and conduct internal crowdsourcing tasks during the working hours, such as an appropriate period of time.
2. Find measures to create the crowd	The management attracts sufficient employees for the internal crowdsourcing crowd by running a campaign in the company in order to build up the crowd.
3. Create clear expectations upfront	The management should meet and manage expectations through a communication concept explaining clearly the role of the crowd worker and the crowds influence on the initiative before the first internal crowdsourcing involvement.
4. Bridge the two worlds effectively	The internal crowdsourcing initiatives are often conducted in a standalone system, which requires efficient interfaces with respect to the rest of the company.
5. Enable the crowd through training and support	The management needs to ensure the minimum level of IT capabilities through adequate training and support, especially since some crowd workers may not originate from IT related occupations.

6. Support the crowd to switch between crowdsourcing and traditional work settings	Some crowd workers experience the constant switch between the crowdsourcing and traditional setting as stressful and exhausting. As counter measurements proper training and relocation of crowd workers should be provided.
7. Design a concept to keep the crowd motivated	In order to address decreasing motivation of the crowd, the management should design a motivation concept with many different incentive measures.
8. Apply a new mode of framing work	Managers must learn a new way of framing tasks for the crowd and how to translate business needs to crowdsourcing tasks.

Table 20. Solutions to Overcome Challenges

1. Receive approval for internal crowdsourcing. The crowdsourcing managers must ensure an organizational setting, where the employees can join the crowd. The organizational setting must avoid hierarchical issues with superior stakeholders of the crowd workers participating during the working hours when proposing the idea of internal crowdsourcing, which defines it as an aspect of the Chartering phase of technochange. The crowdsourcing management must find arguments to convince superior stakeholders to permit employees to join the crowd and conduct internal crowdsourcing tasks during the working hours. It is important to explain the superior stakeholders that crowdsourcing increases the experienced empowerment of employees and quality of the product, due to integration of a broader set of expertise. Another aspect that must be considered is the direct agreement of the amount time spent by the crowd worker in initiatives with their direct supervisor. It is important to find an agreement on how much time the direct supervisor can bare his employees spending in the crowd.

The crowdsourcing management InsureCorp stated clearly that everybody who was interested in joining the crowd must receive a written permission from their direct supervisor to avoid hierarchical problems in the organization. This had also the advantage that the employees themselves negotiated the amount of time in the crowd with their supervisor in a decentral and flexible manner. Finally, the crowdsourcing management contacted the work council of the company and discussed the internal crowdsourcing initiative. After agreeing on the framework, the council supported the initiative with respect to certain aspects such as informing crowd that conducting crowd tests after work hours would not be tolerated. According to the work council, this agreement would protect potential exploitation of employees.

2. Find measures to create the crowd. The crowdsourcing management can attract sufficient employees for the internal crowdsourcing crowd by finding new and effective measures in the company to build up the crowd. This is a new way of receiving enough work force for the crowdsourcing management, because they have to find measures that attract employees on a voluntary basis. Such measures could manifest as a single mechanism or a campaign bundling different measures that can be divers. However, they must attract attention to the initiative, must be long enough in place and transport the required information, such as a range of reasons and advantages of participating (fun, opportunity to learn, etc.) as well as the contents or goals of the initiative. If the measure or campaign caught enough attention of potential crowd workers and they found the advantages to participate convincing, the crowd will reach the goal size as well as diversity. Given that this solution provides measures to propose employees joining internal crowdsourcing, it is part of the Chartering phase.

InsureCorp found an effective measure by placing a banner on the landing page of the company's intranet for weeks. The employees use the intranet every day for several internal operations. Therefore, placing the internal crowdsourcing measure in the intranet ensured most employees saw the banner, attracting sufficient attention amongst potential crowd workers. The banner stated the goal of the initiative, testing the new intranet. It proposed that some advantages for the participating employees could be that they would have the opportunity to be amongst one of the first to see the new intranet and that they could assist in changing the new intranet according to their needs. These advantages addressed the incentives of curiosity and having an empowered impact on the intranet. In addition, the banner stated that the initiative would require the help of the employees to achieve the successful implementation of the intranet, addressing the loyalty and the social sense of community of the employees. The measure was very successful, attracting 8% of the company's employees to join the crowd, which was more than initially needed.

3. Create clear expectations upfront. A gap between the expectations of the crowd and the reality of a crowdsourcing initiative can negatively shape the crowd's performance. Therefore, the crowdsourcing management should meet and manage expectations through a clear and empathetic communication form towards the crowd. Managers of internal crowdsourcing initiatives should anticipate the evolving "hype cycle" amongst employees and develop a comprehensive and direct communication form that should first focus on attenuating inflated expectations and then focus on

mitigating disillusion and sustaining motivation. In the first phase of disillusion, the communication should clearly explain the role of the crowd worker before the first internal crowdsourcing initiative. For instance, for this initial phase, managers should communicate a clear crowdsourcing vision and mission and explain in a clear and distinct manner the exact goal of the initiative, the precise role of the crowd workers, their duties and responsibilities. The clarification of reality of internal crowdsourcing may increase the acceptance for negative aspects, because the crowd workers are adequately more prepared to confront them. In the second phase of disillusion, the communication of the crowdsourcing managers should focus on motivating the crowd workers, for example by emphasizing the opportunity to learn new things, giving them a sense of social inclusion in the crowd, and proactively highlighting the achievements that the internal crowdsourcing initiative could already obtain. Consequently, the properly equipped crowd could conduct the initiatives more effectively and thereby more able to provide better submissions. They have a deeper understanding of their task and what is expected of them and they are willing to invest their workforce appropriately. While the internal crowdsourcing system is being built, the crowdsourcing managers frame the expectation of the crowd. Therefore, this solution is a part of the Project phase of the technochange process.

BankCorp's crowdsourcing management, for example, communicated as explicitly as possible the role of the crowd workers and their responsibilities in the initiative, which stated that they were supposed to find software issues during the crowd test. This helped some crowd workers, because they never conducted software testing before and hesitated to document software bugs. In this context, the crowdsourcing manager explained to the crowd workers before participating in the first crowd test that they should imagine being in the engine room of the software development, looking at the software before it is completed. The software would be completed as if all software issues were found and they should help in their finding process. This illustrative metaphor helped the crowd workers understand their role more clearly. The managers also explained the limits of the crowd's contribution, i.e., that they could not accept fundamental change requests of the software, because the software was a standard software with strong constraints regarding what could be changed. Hence, the crowdsourcing management avoided surprising the crowd workers as it was not possible accept all issues and to also give them direct feedback about the implementation of their contributions.

4. Bridge the two worlds efficiently. Internal crowdsourcing initiatives are often introduced as a standalone system, which requires efficient interfaces to the remainder of the company. Therefore, the management should establish automated interfaces between the internal crowdsourcing system and the company. The automated solution should migrate and exchange information automatically from the internal crowdsourcing system to the main system and vice versa. The automatization is most effective when focusing on the parts of the system that are responsible for the largest work effort of the crowdsourcing management, such as the transfer of task instructions or crowd submissions. The information should appear at the correct spot and in the appropriate form on the other side of the interface. The automatization of these transfers would be the most effective means of usage allowing for the integration of the internal crowdsourcing system into the company environment while foremost reducing the time investment of the management. The automation of the interface between the internal crowdsourcing system and the main company system is an important aspect that requires attention while designing the system. Therefore, this solution is part of the Project phase.

For instance, BankCorp programmed different interfaces for certain parts of the internal crowdsourcing system including transferring the instructions of the tasks to the crowdsourcing platform or transferring the contributions of the crowd to the company. In light of legal requirements with respect to the compliance, it was important that the automated interface transferred the complete information of the initiative results to the company, such as the current quality of the software.

5. Enable the crowd through training and support. Before participating in internal crowdsourcing initiatives, employees should be trained with respect to the tasks, the workflows, and the crowdsourcing platform, which is particularly important for employees that have only a limited understanding of IT. In general, the crowdsourcing management should use or design a crowdsourcing platform and surrounding workflows that are as easy and intuitive as possible or are already known by most employees in order to avoid IT-related difficulties. Additionally, the crowdsourcing management should explain important and complicated steps to prevent misunderstandings and additional work for the crowd workers. Furthermore, the crowdsourcing managers should offer a first-level support for crowd workers regarding the internal crowdsourcing system, especially during a crowdsourcing initiative but also outside such initiatives. The result of an adequate training and support would be an enabled crowd that participates effectively in crowdsourcing initiatives and who submits

valuable results. The training and support serve to troubleshoot problems after the system is in place, making it a part of the Shakedown phase of the technochange process.

For instance, the crowdsourcing manager of IndustryCorp would specifically explain precisely to the crowd the workflow step of documenting a software issue. In the manager's experience, this step would be the most difficult for the workflow for the crowd. The manager presented the crowd how to document an issue appropriately and afterwards, the crowd workers had to subsequently document themselves an issue and the manager would finally check their documentation. In addition, the crowdsourcing manager was always available to the crowd, either on premise or via communication devices. Furthermore, the test manager produced videos and written manuals, which crowd workers could access on a central platform to have access to required information.

6. Support the crowd to switch between crowdsourcing and traditional work settings. Some crowd workers experienced the constant switch between crowdsourcing and the traditional setting as cognitively demanding and exhausting. The management should provide additional support for the crowd, such as facilities that are adequate for the crowd worker. If the crowd worker can focus on conducting the internal crowdsourcing tasks without interruption and an appropriate level of silence, the level of stress decreases further. To support the crowd to troubleshoot switching problems is part of the Shakedown phase.

For instance, some crowd workers of BankCorp went to a quiet room in the office, where no one raised the level of noise inappropriately. Others used rooms that were physically far away from their everyday work to avoid interruptions from their colleagues. Moreover, some crowd workers do not possess access to the same facility possibilities and hence negotiated with their direct supervisors to conduct internal crowdsourcing in a home office setting to achieve the same level of silence without interruptions.

7. Design incentives to keep the crowd motivated. To address decreasing motivation of the crowd workers the crowdsourcing management should design various incentives that keep the crowd motivated over time. The mechanisms of motivation for a crowd of internal employees diverges from traditional work settings, because they have different concepts of authority and communication. Therefore, the crowdsourcing management should consider different ways to motivate the crowd, because the crowd is a diverse assembly of individuals that are triggered by different types of motivation. There are some effective types of extrinsic motivation, such as financial compensations including

payments or prizes to win. However, these intrinsic types can be drivers, offering alternative possibilities to motivate crowd workers(Blohm et al. 2018) with respect to the following:

1. Curiosity. The curiosity motivation provides opportunities to learn or experience something new during the internal crowdsourcing initiative.
2. Social exchange. Social motivation provides possibilities to interact with peers (i.e., other crowd workers) and the atmosphere of social inclusion.
3. *Reputation*. Reputation motivation provides opportunities to distinguish oneself from other crowd workers which could be in a challenge.

The constant adjustment in terms of motivating the crowd is a continuous process that requires improvement and is therefore part of the Benefit phase of the technochange process.

For instance, the InsureCorp tried to address as many types of motivation as possible. To address social exchange motivation, they organized informal meetings with refreshments and snacks for the crowd with the purpose of affording the respective colleagues an opportunity to socialize in real life and to also have a chance to express gratitude for the participation. In addition, the company sent e-mails after each initiative to thank each crowd worker personally. These social events were important because they could build a personal relationship with the other crowd workers. The managers had the chance to meet and become much better acquainted the crowd workers and subsequently, a sense of community among the crowd as well as between the workers and the management was established. Through this sense of community, the managers could understand the needs of the crowd and motivate the crowd workers better. The personal connection to the crowd and the atmosphere of community created a sense loyalty, which helped the managers to better reach and activate unmotivated crowd workers as well as convince them to participate in the crowdsourcing initiatives. Finally, the crowd sourcing managers tried to address curiosity motivation of the crowd by creating interesting and varied tasks and also attempted to avoid boring and repetitive mundane modes, such as test new things or software that will be used by the employees. As a result, InsureCorp experiences a crowd that shows a high motivation leading to a higher participation in initiatives and results that are more valuable.

8. Apply a new mode of framing work. Some instructions of internal crowdsourcing initiatives seemed incomprehensible for crowd workers, due to misalignment of the tasks and the needs as well as capabilities of the crowd. Managers must learn a new way of framing tasks to a crowd, how to translate business needs to crowdsourcing tasks. They should avoid overly detailed instructions for crowdsourcing initiatives. In order to achieve these aims, the following two points should be implemented. Firstly, instructions should be created with lower granularity and simpler language, avoiding technical terms, which would bare the advantage that the crowd understands the instructions more clearly and can conduct the initiative without major comprehension problems. Secondly, instructions with lower granularity gives more freedom to the crowd to interpret the initiative and add their own personal perspective. The personal perspective of crowd workers is one of the major advantages of internal crowdsourcing, because the crowd can think differently, act differently and therefore contribute valuable and innovative input regarding a certain task. In addition, the precise instructions needed to be updated regularly if changes in the crowdsourcing initiative occurred. Otherwise, the instructions do not describe the reality of the initiative anymore. Therefore, the crowd workers would confront problems in the execution of the initiatives, which decreased the motivation and finally the participation of future initiatives. Following our solution, crowdsourcing managers learn how to frame task successfully for the crowd, where the crowd workers add their valuable personal perspective to the submissions. Since the learning process of framing tasks successfully for the crowd is an ongoing effort, because each new initiative carries new challenges of framing, it constitutes a solution of the Benefit phase.

BankCorp had two issues regarding the delegation of business needs to crowdsourcing tasks and applied two measures as a reaction. Firstly, the managers altered the instructions towards a lower granularity and gave as much freedom to the crowd workers as possible. Consequently, the managers required less time for the preparation. In addition, the crowd could use its expertise more effectively by following the tasks according to their personal best practice adding their personal perspective to the initiative. Through the crowd's interpretation, the crowd workers could add valuable input to the task, which was originally not considered during the creation of the instructions. Secondly, the bank introduced briefings with the crowd before each crowdsourcing initiative. In these briefings, the management could point out and clarify complicated parts and vocabulary of the instructions beforehand. Especially due to the

origin of most crowd testers being not from IT-related occupations, this measure cleared up several misunderstandings in the tasks. Consequently, the crowd could participate in more complicated internal crowdsourcing tasks and submit valuable contributions.

5.4 Recommendations for Standardization of Adaptation Barriers

The dissertation offers four overreaching recommendations regarding standardization. These are the next steps after introducing and overcoming the adaptation barriers, because standardization activities aim at improving an already operative system (Virili 2003). These recommendations assist managers and other leaders in charge of internal crowdsourcing in scaling and standardizing the initiative to capture the advantages of internal crowdsourcing further, as depicted below. The recommendations were derived during the research process assessing adaptation barriers and their solutions. The results provided not only insights into barriers and solutions, but also gave insights into to further steps that arise after the solutions were in place, standardization mechanisms leading to a more stable system.

Recommendation	Description
1. Support management evaluation through machine learning	The management evaluation should be supported by standardized machine learning algorithms that filter the results of internal crowdsourcing initiatives.
2. Let the crowd take over	To scale the potential of internal crowdsourcing further, the management should leave certain management tasks to the mass of the crowd.
3. Manage the crowd as a flexible resource pool	To use the internal crowd as a flexible pool of workforce a crowd requires active management, or the crowd dies slowly.
4. Build a service center	The experience of the internal crowdsourcing management needs to be bundled in one center to provide an internal crowdsourcing as a service.

Table 21. Recommendations for Standardization

1. Support management evaluation through machine learning. The largest potential for standardization in internal crowdsourcing lays in the support of the crowdsourcing management's evaluation of the initiative results. The big share of management work in internal crowdsourcing lies in processing and evaluating the crowd's submissions. The crowd submits a large number of submissions, many submissions are either similar or duplicates. Others are simply not valuable. In general, internal crowdsourcing initiatives

often create too much information that the crowdsourcing management or other participating stakeholders cannot evaluate efficiently. A standardized machine learning algorithm for all internal crowdsourcing initiatives is available to support the crowdsourcing management and reduce the bottleneck of available management resources.

The evaluation of contributions was a major challenge at the beginning of InsureCorps first attempts to internal crowdsourcing. Each software test that built on the collective workforce of internal employees resulted in a two-day effort in working through the sum of contributions by the crowdsourcing management. The company calculated 200 issues for around 8 hours of manual work. When internal crowdsourcing initiative grew and became increasingly used by numerous software development projects, InsureCorp embarked on a text mining system, which automatically identifies duplicates and sorts out many invaluable submissions. The text mining system runs on standard machine learning algorithms that assesses and filters the written submissions of the crowd efficiently as well as directs the focus of the management to the more valuable results. The text mining system reached a precision of 94.5% and found 83.3% of the duplicates.

2. Let the crowd take over. To scale the potential of internal crowdsourcing further, the crowdsourcing management should leave certain management tasks to the mass of the crowd, in order to set management capacity free. Therefore, the management should involve the vast pool of crowd workers in support and evaluation tasks to set more management capacities free. During the internal crowdsourcing initiatives experienced crowd workers can support less experienced ones or they can support the crowdsourcing management evaluating the results of the initiatives.

For instance, BankCorp integrated experienced crowd workers that mastered the tools and workflow of the internal crowdsourcing system in the support efforts of the management during an initiative. These experienced crowd workers have been promoted to a “Moderator” role and can now directly support less experienced crowd workers in navigating this new mode of working. This is particularly important during single testing iterations, where the “Moderators” answer questions in a live chat. In addition, the bank integrated experienced crowd workers that showed a good understanding of the software-testing task as “Quality Assurance” for supporting the evaluation process. The experienced crowd worker would pre-filter the large number of submissions and direct the focus of the crowdsourcing managers on the valuable

contributions. As a result, the collective workforce of the crowd is utilized to relieve the crowdsourcing management.

3. Manage the crowd as a flexible pool of resources. A crowd can serve as an effective pool of workforce, which the organizations can use very flexibly. In order to use a crowd in this manner, it requires further standardization that also involves systematic community management (Preece and Maloney-Krichmar 2005). A crowd needs active management otherwise the interest and participation decrease over time, such that the crowd dies slowly. Part of the active community management is the keeping the crowd on board with the project through training and support during the initiatives as described above. What is quintessential is availability to the crowd via chat or phone allowing for a clear and close communication with the crowd. Another part of the community management is the part outside the active initiatives. Organizing tester community events and keeping the crowd up to date with newsletters or lesson learned information from past initiatives.

For instance, InsureCorp constantly creates new challenges, even if no official initiatives are planned, to keep the crowd busy and interested. In addition, the management provides a platform for a sense of community, by making the crowd workers feel involved in a community, which results in a more active crowd showing a greater level of loyalty towards the initiatives where they act quicker to tasks that the management organized. Furthermore, the management organizes events for the crowd workers to meet in real life and connect. Following this perspective, the management also provides a setting, where the crowd can interact outside the initiatives. As a result, the management faces an active crowd that shows higher participation and loyalty during the actual initiatives that are organized flexibly, submitting contributions that are overall more valuable.

4. Build a service center for internal crowdsourcing. The experience of the internal crowdsourcing management needs to be bundled into one central point of contact to provide an internal crowdsourcing service, which does not require building a new crowd for each stakeholder that wants to use internal crowdsourcing or complete redesign of new internal crowdsourcing initiatives. Therefore, the center must define a standardized onboarding process for internal customers, which enables new customers to follow a precisely defined initiative process, which accounts for what problems one can expect an internal crowd and which has a clear idea of the deliverables that can be expected.

Consequently, the internal crowdsourcing center turns internal crowdsourcing experience into reusable knowledge.

For instance, the CPMO of IndustryCorp created a service center that allows access to hundreds of internal crowd workers that can help solving problems for other departments. The CPMO briefs potential internal customers regarding the possibilities of the crowd to solve problems, organizes and conducts the initiative if an internal customer decides to proceed with the crowd. Finally, the CPMO hands over the deliverables of the crowd to the customer.

The dissertation addressed in chapter five the second research question by deriving eight adaptation barriers of internal crowdsourcing in a multiple case study. In addition, solutions were discussed based on the results of the different cases. Finally, the dissertation provided the reader recommendations for standardization in order to navigate the internal crowdsourcing system further towards a stable operation.

6 TEACHING CASE: LEVERAGING THE INTERNAL WORK FORCE THROUGH CROWDTESTING

The main objective of the teaching case is to fulfill an educational goal. It sets a context with a rich narrative, reducing the complexity of the real-life case and focusing on essential aspects in order to create a learning experience. This educational case confronts students with the possibilities and challenges of internal crowdsourcing as a potential solution for challenges in the digital transformation process. In contrast to cases in research, the students do not learn through an academic research assessment but through a rich narrative the basic principle of the dissertation “crowdsourcing”. They address assignment questions making decisions regarding design and adaptation barriers, applying crowdsourcing to solve problems.

First, the teaching case reduces complexity and focuses on the essential aspects, which leads to a new prioritization of the dissertations outcome. It concentrates on the core elements of the results contributing to a transparency that points practitioners to the important first steps of designing and guiding an internal crowdsourcing system to stable operations. In addition, the transparency through the prioritization of the research outcome in combination with the limitations of the dissertation guides scholars to important future fields of research. Second, the teaching case provides the dissertation a summarizing perspective. The teaching case depicts the main building blocks of the

design principles and the central adaptation barriers. Second, the teaching case provides a new contribution by reflecting the dissertation in a new perspective. The students should not only describe the characteristics of internal crowdsourcing, but also critically evaluate how it can support internal business initiatives in general, not only crowdtesting or crowdsourced innovation. The teaching case drives students to identify internal problems that could be solved by internal crowdsourcing and reflect the management challenges of organizations that derive from the transition of the traditional work mode to the new work mode internal crowdsourcing. This objective touches the research questions of the dissertation and connects them with the greater picture of digital transformation.

6.1 Introducing the Case of BankCorp

BankCorp was confronted with a range of different challenges due to the process of digitalization whereby several managers of BankCorp worked on solutions to overcome them. One particular person in BankCorp was Pete, head of software development. Since he arrived at the IT department of BankCorp 9 years ago, the department faced increasingly intensified challenges due to the digital transformation. Two main problems were the complexity of quality assurance and increased IT introductions to employees. Firstly, digitalization posed a challenge to IT departments because they were encountering a more dynamic environment, shorter product life cycles and customers expecting a higher quality standard of software, such as intuitive usability. In addition, the fast-growing hardware market and segmentation of devices, such as smart phones, laptops or tablets, increased the complexity of software testing additionally. Thus, the need for quality assurance increased tremendously. Secondly, the dynamic process of digitalization confronted employees of the bank with an increasing amount of software for their everyday work because internal processes were gradually digitized. For instance, employees were faced with digital platforms such as intelligent enterprise systems (e.g., Enterprise Resource Planning or Customer Relationship Management) or social collaboration platforms, such as instant messaging (e.g., Slack or Microsoft Teams), social networking (e.g., Workplace by Facebook or IBM Connections) and group collaboration tools (e.g., Atlassian Confluence or Microsoft SharePoint). Against this background, the IT department received more responsibilities regarding digitalization challenges, such as an increased quality assurance and introduction of IT

tools to employees, leading to a widening gap between tasks and available resources (Engelbrecht et al. 2017; Liang et al. 2007).

During the planning stage of the projects for the following year, Pete realized that a specific project, developing a new core banking system, exceeded his pool of resources greatly due to its great volume and scope. It was a high priority project, which meant he had to find a solution to conduct it successfully. As Pete could not expect a major increase of resources, he started to look for means to meet his challenges. On a Thursday afternoon, Pete was exploring an IT fair in Zurich, Switzerland, looking for an approach that might help address the challenges of the IT department he managed. After screening the program of the IT fair, Pete decided to visit a presentation of a start-up called Test Alpha, which would give first insights regarding the potential of crowdsourced software testing, also known as crowdtesting. Pete learned that crowdtesting proposes a task to a crowd via an open call (Blohm et al. 2013; Blohm et al. 2018) and uses the wisdom of this crowd to find issues in software more rapidly by specifically using the sheer mass of people in the crowd, which leads to a faster time-to-market for a product (Simula 2013). He found it interesting that the sheer mass in a crowd could be scaled up or down flexibly, which would be useful for him due to the dynamic demand in his projects he had to plan. Moreover, crowdtesting generates high quality results because of the collaborative nature and the diversity of the crowd (Prpić et al. 2015). Empowered by IT-based infrastructure, individuals with diverse backgrounds and expertise could join the crowd, adding to the competence pool. Therefore, the crowd is capable of even finding software issues that are only visible to individuals with specific expert knowledge. In Pete's opinion, this might help him with his first problem namely complex quality assurance (Afuah and Tucci 2013). After listening to the presentation for a while, Pete realized that crowdsourcing is essentially a new principle of organizing workforce. On the one hand, crowdtesting would enable his IT department to integrate additional workforce to IT operations such as software testing and meet his widened scope of projects. On the other hand, this new way of organizing workforce could help Pete with his second problem, increased IT introduction. Crowdtesting would integrate a large group of employees to the crowd and confront them with new IT tools early in the development process. This way, Pete might increase the acceptance of new IT tools among the employees, which are the end users, because they would be involved in the development process from an early stage on. In addition, the large group of end users

could already gather experience before the official introduction of the IT tools, which might ease this introduction on an operational level in the bank.

In light of the aforementioned background, Pete contemplated the idea of using a crowd to address his two main problems in the IT department. Firstly, he might increase the resources of the department and add their expertise to the talent pool which would address the complex quality assurance. Secondly, by integrating a large group of employees from other departments into the crowd and confront them with new IT tools early on, he would address his second problem, increased introduction of IT to employees (Zuchowski et al. 2016a).

6.2 BankCorp

BankCorp is the second largest and one of the most traditional retail banks in Switzerland. It was founded more than a century ago and employs over 10,000 employees. BankCorp is running a large branch network offering financial services to its customers. BankCorp's main competition are regionally based banks, which have close relationships with their customers through their regionally based outlets. BankCorp has a very high reputation in Switzerland, especially as a stable, reliable and forward-thinking bank. BankCorp's main services are payment as well as retirement and private savings, where it lies close to the Swiss market leader. One third of the Swiss citizens and half of the companies in Switzerland are customers of BankCorp. Even though BankCorp's reputation is also described as forward thinking, the technology of the core banking system was not up-to-date, leading to strategic disadvantages. Based on this, Pete was instructed to develop a new and dynamic core banking system which would meet the needs of today's competition on the market.

The core banking system is a major IT artefact and the heart of the bank. Most operations run on this IT system. Developing a new core banking system would be a project with direct supervision of the bank's board, requiring large resources. Therefore, the two units Pete had in mind, software development and testing, received additional external staff. The project would face specific project problems that are related to the general challenges of digital transformation. Before continuing with and committing to the new solution, namely crowdtesting, Pete knew he had to conduct further research and properly assess the actual short to mid-term potential of crowdtesting for the core banking project as well as for the mid to long-term potential for BankCorp in general.

6.3 Internal vs. External Crowdsourcing

As Pete started his research on crowdtesting, he reflected on the change he had witnessed during his career due to digital transformation. New communication and information technologies transformed almost every field of his work. This radical change particularly evident in terms of how internal tasks were coordinated and how performance processes were designed. Through new communication technology and the Internet, the company set up IT hubs around the world, which could collaborate indifferent to location or time. Due to the time differences, the teams worked non-stop and continuously developed the concepts further. When Pete left his office, another team would pick up his work on the other side of the globe. In this perspective, Pete believed that crowdtesting would be the next step of the digital transformation, changing how work was coordinated through a decentral crowdsourcing principle that could address new challenges.

While researching, Pete could outline some important advantages of crowdtesting, such as fast access to specialized knowledge (Prpić et al. 2015), shorter product development cycles or higher quality of the task outcome (Jette et al. 2015). If a task required special knowledge, a company could look for this knowledge in the crowd efficiently across departments or organizational boundaries. In addition, one could parallelize tasks and leverage the mass of a crowd. Many people in the crowd would work on tasks at the same time, decreasing the product development cycles. Furthermore, the allocation modus based on self-assessment by the crowd linked knowledge with specific tasks, leading to higher quality as a result. People in the crowd with expert knowledge that matched with the task would be found efficiently. Pete found two main crowdtesting settings, internal and external crowdtesting. Both are based on the main principle of crowdsourcing, but the nature of the crowd differs significantly. Internal crowdtesting hosts its crowd entirely internally of the organizational boundaries and consists of internal employees only. By contrast, external crowdsourcing would access a large crowd that consists of people that are not part of the organization.

Learning about crowdtesting, Pete realized that each setting had its specific advantages concerning the general bank and specific project problems. Firstly, an external crowd can cover a greater range of devices and software versions, such as cell phones or tablets, due to its size leading to a greater coverage advantage in terms of the complexity of the software quality in general compared to an internal crowd.

Secondly, the internal setting would support the increased IT introduction to employees, because the employees were involved in the development and testing process. Therefore, the employees could gather experience in an early stage, which further eased the introduction of the final version and increased the acceptance. An external crowdtesting setting would not support such an effect, because the external crowd did not constitute internal end users. Therefore, their experience would not be advantageous to the bank during the introduction of the IT tool.

Thirdly, regarding the specific core banking project problems, external crowdtesting would be able to integrate a larger group of people in its crowd, leading to a quantity advantage. Internal crowdtesting is limited to the employees of BankCorp, whereas in the external setting every individual inside and outside BankCorp is a potential contributor in the crowd.

Fourthly, internal crowdtesting would be more suitable regarding the problem of addressing the lack of expertise of testers. The internal crowd of employees from different departments of the bank would be able to cover the important parts of the core banking system with in-depth expert knowledge from their everyday work and find more software issues which would lead to a higher software quality. An external crowd would not be able to incorporate the same bank specific knowledge and, therefore, could not generate the same output quality.

Finally, the core banking system would be tested with numerous clients' information and data from the bank. Everyday tasks of the employees involve client information. Testing with an external crowd would expose sensitive client information to a crowd who were barely bound to BankCorp or who were maybe bound by Non-Disclosure-Agreements (NDA). In addition, if the first issue of confidentiality could be resolved by other measures, the main problem was in fact that no client information could leave the organizational boundaries of BankCorp by Swiss bank law.

The advantages and disadvantages of the different crowdtesting settings are depicted below in table 22 (Knop et al. 2017; Leicht et al. 2016b):

Problem	**Advantage**	**Disadvantage**
1. Complex Quality Assurance	*External crowd* can cover a greater range of devices and software versions, such as cell	*Internal crowd* can only cover a limited diversity of devices because of the smaller

General Problem	phones or tablets, due to larger size of the crowd.	quantity of people. In addition, employees share mostly similar devices from their employer.
2. Increased IT Introduction *General Problem*	*Internal crowd* was involved in the development and testing process, gathering experience in an early stage, which further eases the IT introduction and increases the acceptance.	*External crowd* does not increase the IT introduction, because they leave the sphere of the organization after accomplishing their tasks.
3. Inadequate Quantity of Software Testers *Project Problem*	*External crowd* can integrate a larger group of people in its crowd leading to a quantity advantage because the external setting could integrate people from all over the world.	*Internal crowd* can only integrate a limited number of people, because they are limited to the number of employees. Therefore, it can reach a limited coverage only.
4. Lack of Expertise of Testers *Project Problem*	*Internal crowd* can cover the parts of the core banking system with in-depth expert knowledge and find more software issues leading to a higher software quality.	*External crowd* is less probable to be able to provide a specific expertise, which is related to a specific organization, because they mostly lack the expertise from inside the organization.
5. High Data Confidentiality *Project Problem*	*Internal crowd* would not expose sensitive client information to external staff and, therefore, comply with the Swiss bank law.	*External crowd* would expose sensitive information to external people and, therefore, not comply with the Swiss bank law.

Table 22. Advantages and Disadvantages of the Crowdtesting Settings

Based on Pete's assessment of the advantages and disadvantages of the specific crowdtesting settings, he believed that the advantages of internal crowdtesting outweighed the external setting in the core banking project. He considered the

"Increased IT Introduction" and especially the "Lack of Expertise of Testers" as well as "High Data Confidentiality" problems as being of particular importance because complying with the law and the expertise of the crowd would be crucial for the project's success, leading to a higher software quality. Moreover, Pete was convinced to be able to integrate sufficient employees within the internal crowd and achieve a crowd large enough to neutralize the advantage of the external setting with regard to the project problem "Inadequate Quantity of Software Testers".

6.4 Internal Crowdsourcing as Organizational Change

After choosing internal crowdtesting as the appropriate setting for the core banking project, he asked himself how internal crowdtesting, as a new mode of work, would change the bank (Leicht et al. 2017; Leimeister et al. 2016). It took a while for Pete to understand that internal crowdtesting represents a complex system of socio-technical relationships between the employees of the crowd as well as the organizational unit engaging in crowdtesting (Geiger and Schader 2014) and takes into account both social and technical factors influencing the functionality and usage of IT-based platform solutions (Baxter and Sommerville 2011). For Pete, such a socio-technical system involved a complex interaction between humans and technological aspects of a work system (Baxter and Sommerville 2011), consisting of the following three basic socio-technical components (Beese et al. 2015; Lyytinen and Newman 2008).

Actors: Include organization's members and main stakeholders who carry out or influence the internal crowdtesting projects, such as Pete, his IT managers as well as the employees in the crowd.

Structure: Covers systems of authority and workflow. It further includes both the normative dimension, such as values, norms and general role expectations as well as the behavior dimension, as patterns of actors to exercise authority or work within the internal crowd. This includes the workflow of the internal crowdtesting system and the different authorities, responsibilities and roles of Pete's IT managers as well as the crowd.

Technology: Technology denotes tools as problem-solving inventions, like measuring instruments and computers that compose part of the internal crowdsourcing system. Pete realized that an internal crowdtesting system would require IT tools, such as communication tools and a platform for the crowd to test the core banking platform.

For many employees internal crowdtesting would be a very new experience and would require a change in their work mode as well as an acquisition of new competencies. In a traditional work setting, most colleagues know each other and their direct supervisors, working together face to face. The hierarchical structures and roles are clear. Supervisors with authority define the tasks, which do not change dynamically. In contrast, in the digital work setting of internal crowdtesting, colleagues would only be available online and remotely. The employees would have to build up new digital communication channels with the crowd and the crowdtesting management of Pete, learn how to interact in new social relationships online and adapt to a different style of receiving feedback. In addition, the employees would have to get used to the new tasks, i.e. software testing because they originated from jobs with lower IT requirements. Thus, they would be required to learn new IT competences in a digitally mediated setting.

The crowd would conduct the new tasks parallel to their everyday job in the bank which would lead to employees switching between the two worlds: internal crowdtesting and traditional work. The employees would face switching costs because they would have to arrange the needs of the two worlds. Finally, the employees would experience a new way of work distribution. They would participate voluntarily in the crowd tests which would change the direct supervisor role because Pete's crowdtesting management would have no direct, rather unclear managerial authority towards the crowd (Zogaj and Bretschneider 2014). Thus, the crowdtesting management could not decide who should take part in which internal crowdsourcing initiative. The difference in hierarchical structure in internal crowdsourcing to traditional work would change the communication to a more democratic and egalitarian pattern (Zuchowski et al. 2016a). Traditional enforcement would disappear or change significantly. Consequently, the motivational concept would change from one that is driven by traditional payment and authority to a new motivational concept that is based more on personal relationships and intrinsic incentives (Durward et al. 2016b; Simula and Ahola 2014). The new manner of work distribution would require Pete's management to plan with slack and ensure through the new communication and motivation the availability of sufficient employees in the internal crowdsourcing initiatives. In his research Pete found a range of intrinsic motivators that would help motivate the internal crowd (Blohm et al. 2018) including:

Curiosity. The curiosity motivation gives opportunities to learn or see something new during the internal crowdsourcing initiative.

Social exchange. Social motivation provides possibilities to interact with peers (i.e., other crowd workers) and the atmosphere of social inclusion.

Framing. The framing motivation places the crowdsourcing task in a light of purpose whereby the task is important to the crowd worker or the company.

Reputation. Reputation motivation provides opportunities to distinguish oneself from other crowd workers, which is a challenge.

At the end of Pete's research, he realized that designing a functioning internal crowdtesting system would not be the only challenge. The further second challenge would be guiding the employees in the crowd towards the new mode of internal crowdtesting, organizing the workforce differently and managing the cultural change in the bank. To face both complex challenges successfully, Pete decided to contact Test Alpha, the company he encountered at the IT fair in Zurich.

6.5 Getting Started: Building a System for Internal Crowdtesting

The next week, Pete organized a meeting with Test Alpha and some colleagues from BankCorp. The meeting commenced with a discussion illustrating the core banking project and addressing the problems the project faced to this point. Pete expressed his expectations regarding the support crowdtesting might contribute to the project, based on his knowledge gathered through his research. During the discussion, Test Alpha helped him to formulate realistic goals for the internal crowdtesting system. They agreed that BankCorp would need internal crowdtesting as a new software testing method, which would be an addition to the conventional software testing. Consequently, they defined three project goals.

Firstly, the quality of the core banking system should be increased by integrating end users to extend the use of internal know-how. At the current state, important software issues were detected at a late stage of the testing process, due to integrating end users quite at the end of the development process. Up until this point, BankCorp could not integrate employees from different branches located all over the country sufficiently, because employees had to travel hours to the headquarter to participate in internal testing. Test Alpha explained that the bank could address this goal by involving employees from different departments and areas of Switzerland through the distributional nature of crowdsourcing. Employees would be able to join the testing process via their computers at their normal working place. Pete assumed that enabling

employees to add their expertise through the distributed nature of internal crowdsourcing would respect the project problem "Lack of Expertise of Testers" and the general problem "Increased IT Introduction" adequately.

Secondly, the bank did not have enough resources for an adequate testing coverage, leaving an increased risk of potential mistakes in the bank's new core banking system. In addition, the department did not have the resources to conduct sufficient software tests after the launch of a certain financial product. The team planned to address this problem by expanding the coverage of the testing activities by increasing the number of testers in the crowd. The internal crowdsourcing system would include a crowd of more than 200 employees, eliminating potential blind spots regarding the software's functionality. Pete considered that integrating more than 200 employees in the crowd would sufficiently address the project problem "Inadequate Quantity of Software Testers".

Thirdly, Pete explained that the test department needed more and faster testing cycles. Thus far, the testing department was not able to set testing cycles shortly and quickly. Some test cycles required a lengthy preparation time. To address this, Test Alpha suggested that BankCorp could increase the speed of execution for single testing cycles and test on a weekly basis through testing with the crowd of integrated employees with the crowdsourcing principle. Pete thought that increasing the amount of test cycles would also affect the quantity of initiatives in which employees tested the core banking system and, therefore, it addressed the project problem "Inadequate Quantity of Software Testers" as well. The goals of BankCorp are illustrated in table 23 below.

No.	**Goal**	**Description**	**Solved Problem**
1	Integration of Employees	Sufficient software quality due to integrating appropriate employees to use their expert knowledge and identify software issues early	*Lack of Expertise of Testers* and *Increased IT Introduction*
2	Adequate Coverage	Adequate coverage of the core banking system during and after the development process	*Inadequate Quantity of Software Testers*

3	Fast Test Cycles	Preparing and conducting a suitable amount of test cycles quickly	*Inadequate Quantity of Software Testers*

Table 23. Goals of the Internal Crowdtesting System

At the end of the meeting, Pete and his colleagues of BankCorp understood that they would require support from Test Alpha for the conceptual design decisions and the guidance of the employees towards the new mode of work, namely internal crowdtesting. Therefore, Pete decided to extend the cooperation with Test Alpha. He would create an interdisciplinary team and be responsible for the overall organization of the project. In addition, two colleagues from BankCorp, Kate and Mike, would join the team to support Pete and Test Alpha by each assuming responsibility for a different work package. Kate had an extensive background in software testing and would be the future project management officer (PMO) of the crowdtesting system. As PMO, Kate would be responsible for the operational level of the crowdtesting system, organizing different test sets and the crowd. Mike was a service delivery specialist and supported the future system with technical solutions. Mike would be responsible for the technical level of the system, finding the necessary tools and making sure of the technical reliability of the system.

Finally, Pete agreed with Test Alpha on the next step. They would discuss the general workflow of internal crowdtesting in a kick-off meeting. The outcome of the meeting would enable the interdisciplinary team to design the process. Kate would focus on the workflow of the process. Mike would focus on the platform of the internal crowdtesting system. Test Alpha would provide feedback for the team based on their expertise in internal crowdtesting.

6.6 General Workflow of Internal Crowdtesting

In the preceding week, Test Alpha held a kick-off workshop at BankCorp to derive the concept knowledge of internal crowdtesting's general workflow. It should enable BankCorp to design a successful internal crowdtesting system and BankCorp managers to derive the outcome of their work packages.

The first step is that the system needs to define the crowd necessary for conducting the task. The PMO test must define the requirements for the crowd against the background

of the test object. The requirements could be demographics or expertise of the contributors.

The second step includes an open call that targets potential people in the crowd matching the requirements defined in step 1 and also some new people join the crowd.

The third step includes a crowdtesting manager who transfers the test cases to the crowdtesting platform. In addition, the PMO makes sure that the crowd has access to the test object and gets instructions on how to proceed during the test.

The fourth step includes the crowd that starts testing the test object according to the test cases and instructions. The crowd documents any software issues encountered during the process.

The fifth step includes the crowd that saves and stores the documented software issues as contributions on the crowdtesting platform.

The last step includes the test finishing and a crowdtesting manager evaluating the contributions of the crowd. If the test management cannot reproduce a software issue or has other problems with a certain contribution, the test manager may contact a tester and ask the contributors regarding clarifications (Leicht et al. 2016a).

The general workflow of internal crowdtesting is illustrated below in figure 10.

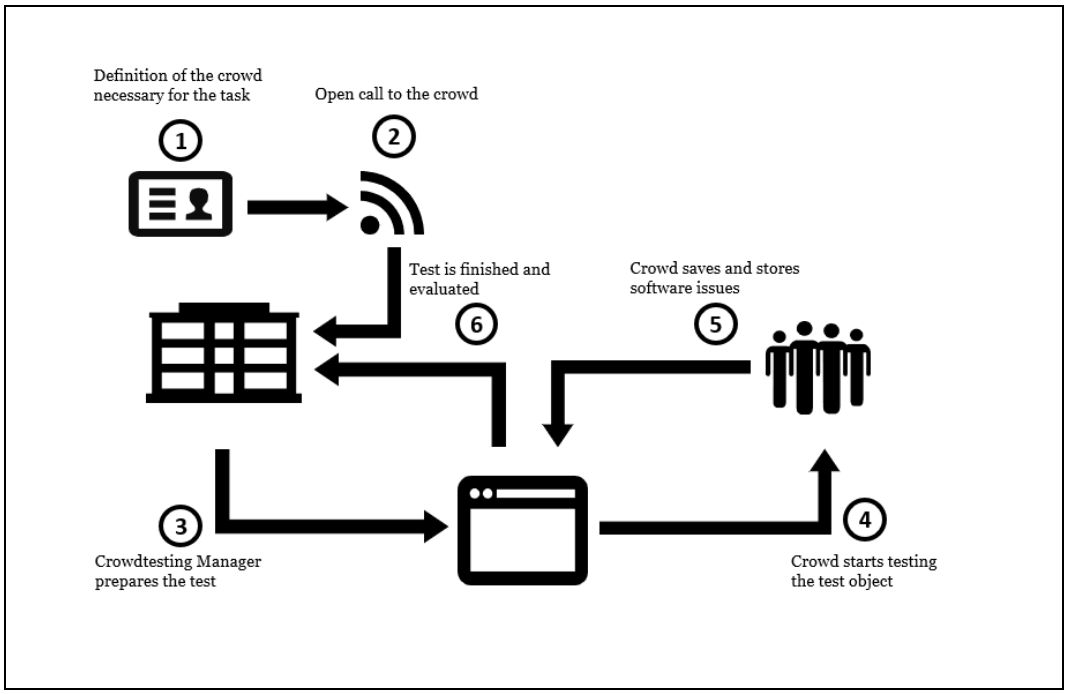

Figure 10. General Workflow of Internal Crowdtesting

6.7 Organizational Structure of Internal Crowdtesting

After going through the workflow, BankCorp managers were wondering how the organizational structure of the internal crowdtesting system that manages the single steps of the workflow could be structured. Test Alpha explained that an effective administration of crowdtesting would be central for the system, which includes all administrative tasks and a role model. The tasks would be structured according to four task clusters: “Definition of the Project”, “Planning of the Project”, “Execution of the Project” and “Evaluation of the Project”. Finally, the “General Role Model” structures the range of tasks among different roles in the system.

6.7.1 Definition of the Project

At the beginning of each project, the crowdtesting team must frame the crowdtesting project by, for example, defining specific project goals that would help the organization to comply with all regulations. This framing task includes four steps:

- *Analysis of Potential*: analyzes the potential of crowdtesting for a particular project. In the core banking project, Pete already assessed the problems, such as “*Lack of Expertise of Testers”* or “*Inadequate Quantity of Software Testers”*, and researched the potential of crowdtesting for solving them, such as fast access to specialized knowledge or higher quality of the task outcome.
- *Crowdtesting Goals*: if there is a reasonable potential for a project, the step defines the goals of a specific crowdtesting project. In the first meeting, the team defined the goals with the help of Test Alpha, such as Integration of Employees, Adequate Coverage and Fast Test Cycles.
- *Crowdtesting Setting*: based on the goals of the project, the step decided what type of crowdsourcing the project would require. Pete looked at the advantages of internal as well as external crowdtesting and found that the advantages of the internal setting outweighed the external one.
- *Compliance Assessment*: the last step was to examine the compliance of the project. In the core banking project, the compliance requirements were very high, due to high regulatory standards for banks regarding data. The project would comply with all regulatory standards because Pete conducted it with employees internally. Therefore, no data would cross the boundaries of the bank.

6.7.2 Planning of the Project

After the framing of the project, the planning begins, which prepares the execution of the project and contains two steps:

- *General Project and Test Scoping*: each test requires an operational definition of test cases for the crowd, which are specific guidelines directing the crowd towards the test scope. The team would have to specify which part of the core banking was in the scope for each test iteration and which part was outside of the scope.
- *Platform Assessment*: before each crowd test, the team would have to prepare the platform for the execution of a testing initiative. The team supporting Pete would have to make sure that the platform is operational, the communication tools are functioning and the test cases for the crowd test are uploaded as well as accessible to the crowd.

6.7.3 Execution of the Project

During the execution of a crowd test, the crowd would test the core banking system and document software issues. The crowd test management supports the crowd and supervises the crowd test iteration. The execution contains three steps:

- *Communication and Incentivization*: at the beginning of a crowd test iteration, the management must communicate to the crowd that the test started and provide access to the test. Pete will have to derive a concept on how to incentivize the crowd to participate in a crowd test. If the single employee in the crowd reacts to different incentives, an incentive concept should include a range of different incentives, like giving opportunities to learn or social incentives, where the employees enjoy the group dynamic.
- *Technology Management*: during the test, the crowdtesting management must ensure the stable performance of the platform and its communication tools. The team should ensure that the crowd can access the test cases and document software issues constantly. In addition, Pete must provide a context in which the core banking system is online and avoid any offline times.
- *Test Support*: Pete and his team must support the crowd with any issues that may occur, such as questions on how tools work or how to find the test cases.

6.7.4 Evaluation of the Project

Finally, the organizational structure must evaluate the documented software issues. Pete's team will have to filter all results according to the scope of the project, potential duplicates and classify them in terms of severity.

- *Out of Scope:* some software issues might be out of the project scope and, therefore, not of interest for the test team.
- *Duplicates:* some employees in the crowd may have found the same issue, which requires the elimination of the duplicates.
- *Severity:* Some software issues have a different severity and the team must assess which one applies for each issue. Many differentiate the severity classes "Trivial", "Minor", "Major", "Critical" and "Blocker".

6.7.5 General Role Model

Test Alpha presented the role model for internal crowdtesting to illustrate, as seen in table 24, how the tasks would be distributed among different roles, which is necessary to manage a crowd test:

Role	**Description**
Crowd Project Management Officer (PMO)	Coordinates the crowd activities through all crowdtesting iterations. Plans the crowd test iterations Defines and selects the crowd needed Provides support during the crowd activities Writes a summary of the crowd activities and results
Contributor in the Crowd	Reacts to the crowd tests invitations Conducts crowd tests Submits results as specified Answers questions concerning submissions
Crowd Manager	Provides operative supervision of crowd during crowd activities Creates and supplies general information about crowd iterations Conducts a briefing with the crowd PMO for each crowd iteration

	Supports the crowd Creates a status of the test for the PMO
Crowd Result Manager	Evaluates the submissions of the contributors

Table 24. General Role Model of an Internal Crowdtesting System

6.8 Building an Internal Crowdtesting System

Until this point, the interdisciplinary team of BankCorp employees and Test Alpha defined and framed the crowdtesting project and internal crowdtesting platform. They discussed the general steps of the workflow, and the organizational structure of the system. With this conceptual knowledge, the project team could start designing the internal crowdtesting system for BankCorp.

In the next phase, the team would design building blocks of the system that would be the foundation of the system. For this purpose, Pete organized some new sets of workshops to hold a week later. Based on the basic workflow and the general role model of the internal crowdtesting system, the interdisciplinary team would gather and derive requirements for the system. Kate, the future crowd PMO of the system, focused on developing a detailed workflow and the definition of the crowd criteria. In addition, Mike started to assess what tools support the workflow and what requirements they have.

According to Test Alpha, an internal crowdtesting system is based on seven building blocks. Three of them were already designed:

- *Crowd Segmentation*: the system had to form employee groups who signed up for the crowd according to predefined criteria with the purpose of allocating an appropriate crowd group to a task, conducting it effectively. Each BankCorp department had different levels of expertise regarding the core banking system necessary to conduct tasks in their daily business. In this perspective, an employee from the department “A” could not operate the core banking part from department “B” and the other way around. Therefore, Kate segmented the crowd according to their affiliation to departments, reflecting their expertise. This way she could ensure that the whole core banking system was covered by finding contributors from all departments. Consequently, during the crowd building

process, among other information such as name or age, Kate would also ask employees in which department of BankCorp they worked.

- *Crowd Testing Workflow*: After Test Alpha illustrated the general workflow depicted in figure 10 and the organizational structure, Kate decided to follow the general workflow of the internal crowdtesting and designed BankCorp's crowdtesting system accordingly.
- *Role Model*: As the interdisciplinary team agreed to follow the general role model of Test Alpha, depicted in table 25, they would not design a new role model.

Therefore, the team would focus on designing the 4 building blocks left. They had to think of different possibilities to conceptualize the remaining blocks:

- *Crowd Building*: Pete's team had to identify potential employees for the crowd and find a way to reach them. Test Alpha compared the design of Crowd Building with designing a marketing campaign for the crowdtesting project. Therefore, one should wonder how long the campaign should go and where to reach potential employees that fit within the definition of the crowd criteria.
- *Crowd Tester Incentivization*: the crowd needs to become motivated to join the crowd, participate in an internal crowdtesting initiative and provide contributions. Test Alpha was asking Pete and his colleagues what would motivate bankers of BankCorp, what could be effective.
- *Crowdtesting Platform*: Mike was aware of the workflow and the organizational structure. Therefore, he already started reflecting and brainstorming what tools could be used for the platform. He asked himself, what tools would he or his banker colleagues use in everyday work situations and how could one use them to build this platform.
- *Crowd Communication Tools*: Mike thought the same about the communication tools. He asked himself what kind of communication a crowd test would require and what tools could one use to ensure an effective communication between the crowd and the crowdtesting management but also among the crowd.

6.9 Management Challenges of Internal Crowdtesting Systems

After conceptualizing the building blocks, the internal system was set up and went live. The first several iterations were successful. The crowd tested the core banking system and submitted several software issues. After a couple of weeks running the internal

crowdtesting system, five problems occurred, which will be elaborated upon below. The new work mode of internal crowdtesting was too different compared to the traditional work mode and the employees in the crowd as well as the bank had trouble to adapt in certain situations.

6.9.1 Supervisors reluctant of employee's participation

BankCorp built up a crowd of more than 200 employees to work on crowdtesting initiatives. These employees also work in the traditional working environment of BankCorp, where they are usually situated within clear as well as well-organized hierarchical structures that were directly associated with a given business unit, department and/or team. A direct supervisor is in charge and can directly steer and instruct the working activities of individual employees. In the internal crowdsourcing setting, however, the crowdtesting management had to attract many employees directly participating on a voluntary basis. Building up such a crowd that serves as flexible resource pools that can be used in an on-demand fashion created various tensions. While the top management was more open to such approaches, the direct supervisors of the employees were reluctant to internal crowdtesting. Some regarded it as loss of resources and power and, in particular, because internal crowdsourcing initiatives were conducted during regular working hours. Thus, some of them rejected the idea of their staff joining the crowd and did not allow them to participate in crowd initiatives. In addition, the work council was sensitive regarding concerns of potential exploitation of employees as well as a possible deterioration of working conditions. Consequently, Pete's team had to make sure to get both parties on board; otherwise, many tensions would hamper the introduction of internal crowdtesting.

6.9.2 Inadequate IT competences of employees in the crowd

Inadequate IT competences and new workflows for the crowd were an adaptation barrier in the internal crowdtesting system. Pete's team faced a crowd with a high diversity of personal and educational backgrounds as well as socio-demographic backgrounds. While most of these were unproblematic for the introduction of internal crowdtesting and contributed to the success of the core banking project, highly diverging IT competences had a big impact on the successful usage of the internal crowdtesting system. This was particularly the case with respect to some employees who originated from jobs that did not require high IT competences. For instance, some employees did not possess basic IT competences and workflow understanding of an internal

crowdtesting system. Some employees brought high IT competences, mastering the IT tools and the new workflow quickly. The interdisciplinary team would have to conceptualize a training process to elevate the IT level and workflow competences of employees in the crowd to a minimum level, enabling them to use crowdtesting tools and workflow. Otherwise, some employees were not able to conduct internal crowdtesting tasks and could not submit software issues.

6.9.3 Parallelism of work modes

Internal crowdtesting is a new work mode for most employees of BankCorp. They are only partly active in the crowd and its new work mode while performing their regular everyday job for the rest of their working time. A parallelism of work settings is the consequence. Switching between the everyday work mode and the completely digitally mediated work mode of internal crowdtesting added complexity and increased the stress level. Therefore, the interdisciplinary team of Pete would have to prepare the employees to work in the new internal crowdtesting work mode, which facilitated the constant switching between both modes if participation in internal crowdtesting became a regular task. As opposed to the employee's regular job, in which they directly interact with clients or colleagues, internal crowdtesting was a challenging work mode. They needed to integrate themselves into an emerging community of the crowd, building new digitally mediated working relationships and to internalize the frequent implicit code of conduct and directives within internal crowdtesting initiatives.

6.9.4 Developing new incentivization structures

Internal crowdtesting replaced the traditional hierarchy and authority with a new, a more democratic and egalitarian way of working. Due to the lack of traditional authority as well as the voluntary nature of the crowd's participation in initiatives, the challenge was to develop a new incentivization structure that would be capable of motivating employees in the new work mode. Pete's team had to learn a new way of incentivizing the employees, which required time to master it. A prominent challenge was the interdisciplinary team that did not have many possibilities to test different incentive structures, because in an internal crowd the potential pool of crowd workers is limited to the employees only. If an employee lost interest in participating in the crowd, it became increasingly difficult to replace the employee because the number of potential replacements was limited.

6.9.5 Find a new way of delegating work

The origin of the internal crowdtesting initiative was a project from the business functions of the bank, developing the new core banking system. Thus, the interdisciplinary team had to master the difficult challenge of delegating tasks from the business to the crowd according to the new mode of work. This includes how to decompose heavier tasks such as certain parts of the core banking system from the core system into smaller ones that are applicable for single employees in the crowd. In addition, the team had to explore what language would be comprehensible for the crowd. Kate delegated some internal crowdtesting initiatives incomprehensibly for employees in the crowd, which led to the crowd not understanding all testing terms Kate was used to applying. As a result, the employees in the crowd could not – or only poorly – conduct some of the crowdtesting initiatives.

6.10 Outlook

After 6 months, Pete had to report to his boss and summarize the results of the project. Pete was happy to report that the internal crowdtesting system ran successfully. They were able to integrate more than 200 employees into the crowd who subsequently were actively testing the new core banking system. As a result, the project could meet the goals of integrating sufficient employees and access expert knowledge across department boundaries. In addition, the crowd submitted more than 2,000 software issues providing an adequate coverage. Finally, Kate was able to set crowdtesting initiatives quickly and flexibly, due to the decentral and dynamic nature of crowdtesting.

In contrast, Pete had to admit that he initially did not think that an internal crowdtesting system would be such a complex endeavor leading to a change management because of the fundamental difference of the new work mode, compared to the traditional one. Pete and Kate were still in the process of optimizing the system with respect to the challenges that arose from the change in management which occurred after the internal crowdtesting system went live. Overall, Pete was optimistic that they could manage the cultural change successfully and further capture the benefits and advantages crowdtesting offered BankCorp.

After Pete's summary, his boss was very pleased with the outcome of the project and congratulated him on finding this innovative solution for this high priority project. He had introduced another solution to overcome challenges of the digital transformation

that would affect the competitive environment of BankCorp. Based on this success, his boss asked Pete to develop a list of additional application areas of internal crowdtesting, external crowdtesting and crowdsourcing in general for the organization to find more opportunities to exploit the potential of crowdsourcing. Pete was happy that his idea was well appreciated by his boss and gladly took the task to his team.

The teaching case presented the basic principle of the dissertation "crowdsourcing" to the students and guided them through the narrative of the case along the design and management challenges of internal crowdsourcing systems. The students reflected these challenges and connected them with the greater picture of digital transformation.

7 TEACHING NOTE

The teaching note is at hand of the potential instructor helping to gain insight into the case. The increased knowledge of the case topic guides the instructor through the case, by depicting important details and explaining the challenges. Finally, the teaching note demonstrates the teaching objective, proposes potential assignment questions and how to position it in the course to maximize the learning values of the case.

7.1 Synopsis

"Leveraging the internal work force through crowdtesting – Crowdsourcing in Banking" presented the teaching case of *BankCorp*. The Bank reorganized the internal workforce using internal crowdsourcing to face two challenges of an IT department in the financial service industry within the process of digital transformation. Firstly, digitalization presents the challenge of a more dynamic environment, shorter product life cycles and customers expecting a higher quality standard, such as intuitive usability. In addition, the fast-growing hardware market and segmentation of devices, such as smart phones, laptops or tablets, increase the complexity of software testing, increasing the need for quality assurance tremendously. Secondly, the dynamic process of digitalization confronts employees of banks with an increasing amount of software introduced to their everyday work because internal processes are being increasingly digitized. For instance, employees face digital platforms, such as intelligent enterprise systems (e.g., Enterprise Resource Planning) or social collaboration platforms, such as instant messaging (e.g., Slack), social networking (e.g., IBM Connections) and group collaboration tools (e.g., Microsoft SharePoint). In this context, the IT department faced the responsibility of introducing new IT to the employees and achieving a successful workflow as well as

acceptance among the employees. Consequently, the IT department received greater responsibilities regarding digitalization challenges, such as an increased quality assurance and introduction of IT tools to employees, leading to a widening gap between tasks and available resources (Engelbrecht et al. 2017; Liang et al. 2007).

The teaching case illustrates a potential solution for the challenges by presenting "Internal Crowdsourcing". The fundamental idea of internal crowdsourcing is that a company invites a group of employees to solve a task voluntarily via an IT-based platform (Blohm et al. 2013). A company could launch an internal crowdsourcing platform, inviting its employees to join the crowd to conduct a task. This way a company can integrate employees in solving problems, adding their expertise and work force dynamically from all over the globe. An example for internal crowdsourcing that finds increasing application in practice is internal crowdsourced software testing or internal crowdtesting. The focus of internal crowdtesting lies on employees forming a crowd to test software. The case shows the potentials and challenges of crowdsourcing in general, what is special about internal crowdsourcing and how organizations should go about designing as well as introducing such systems in order to guide the employees to the new mode of work (Zuchowski et al. 2016a).

The case presented Pete's perspective, the head of software development at BankCorp's IT department. He had to handle a high priority project, namely developing a new core banking system but could not expect a major increase of resources. Therefore, he had to manage specific problems such as an inadequate quantity of software testers and a lack of expertise of testers because professional testers do not have in-depth knowledge of the core banking system. Pete decided to introduce crowdtesting as a solution for these problems, which was essentially a new principle of organizing the internal workforce. Firstly, internal crowdsourcing enabled the IT department to form a crowd with employees from outside the IT department, which integrated additional workforce to testing efforts on the one hand. On the other hand, the employees added their expertise to the talent pool and increased the level of testing quality. Secondly, the employees were the end users of the tested IT tools. In the process of testing the IT tools, the employees became acquainted with the new IT tools early on and this improved the introduction of new IT tools into the organization. In addition, the employees would be involved in the development, increasing their acceptance of the new tools.

Throughout the case, Pete and his team faced challenges in designing and introducing crowdtesting to the organization. On the one hand, they illustrated the fact that the design of internal crowdtesting requires several technical and organizational elements because internal crowdtesting turns out to be a complex socio-technical system. On the other hand, the team realized that crowdtesting is a different way of organizing work, which is new to the employees, making the transition from the traditional to the new work mode difficult. For many employees, internal crowdsourcing is a new experience that requires a change in their everyday work routines as well as an acquisition of new competencies and, therefore, guidance in the introduction. The case illustrates how the team overcomes challenges in designing and introducing internal crowdtesting, addressing problems of the IT department due to digital transformation and specific project problems.

7.2 Teaching Objectives and Position in Course

The overarching teaching objective of the case is to confront students with the possibilities and challenges of internal crowdsourcing as a potential solution for challenges in the digital transformation process. Most industries are facing increased competition, faster innovation cycles and new digital products through digital transformation. In particular, the financial service industry encounters great changes, for instance, transferring or investing money through new fintech companies, providing new financial services. Thus, organizations in the financial industry are forced to change their organizational structure, processes and working modes to meet the challenges of new competition and requirements of digital transformation appropriately. However, most organizations are not prepared for competing in the digital arena. Thus, internal crowdsourcing as a new mode of work may reflect an important opportunity to integrate additional resources and conduct tasks swiftly. The example of internal crowdtesting is relevant in illustrating the advantages, which are increasingly important and are realized through collaborations between traditional software testing departments and the broader organization that extends the software testing abilities of the IT department. Thus, the case will introduce the students to the difficulties of IT Management with a focus on designing internal crowdsourcing as a new work mode and guiding employees from the traditional work mode to the new mode in order to cope with challenges in the digital transformation process (Knop et al. 2017; Leicht et al. 2016a).

7.2.1 Teaching Objectives

- Describing the digital transformation in organizations and critically evaluating its implications using the example of the financial industry.
- Understanding the basic principles of crowdsourcing for orchestrating digital work.
- Describing the characteristics of internal crowdsourcing and critically evaluating how it can support internal business initiatives such as software testing within the IT department.
- Designing options for the technical and organizational building blocks of internal crowdtesting.
- Outlining the management challenges of organizations that derive from the transition of the traditional work mode to the new work mode internal crowdsourcing and find solutions to overcome them.

7.2.2 Position in Course

The case was originally written for a class that covers topics such as digital innovation & transformation as well as the Internet economy. However, the case might also be used for classes that engage in IT management as well as change management through IT and present typical challenges companies may encounter with such topics. The teaching case should be handed out to the students to read and prepare them before class. During class, the students can discuss the case and compare ideas as well as suggestions for the assignments. The students' preparation should be supported by assignment questions and supplementary readings. The case can be taught in a 90 minutes session.

7.2.3 Assignment Questions

The students should answer the questions of the case by considering what actions Pete's interdisciplinary team could take. The student should derive recommendations for actions regarding the design and the introduction of internal crowdtesting to exploit its potential. As preparation of the discussion in class, we recommend that the students prepare the following assignments:

- *Assignment 1*: Please design potential solutions for 1-2 building blocks presented in the case. How should one design the building blocks of the crowdtesting system?

- *Assignment 2*: Please discuss the differences between the traditional and new work mode. What problems occurred during the transition and how should one counter these? Discuss 2-3 problems and potential solutions. Why would the solutions be effective?
- *Assignment 3*: Please discuss potential applications of internal crowdtesting outside the core banking project/ of external crowdtesting/ of crowdsourcing in general.

7.2.4 Supplementary Reading

Leicht, N., Blohm, I., and Leimeister, J. M. (2017). "Leveraging the Power of the Crowd for Software Testing," *IEEE Software* (34:2), pp. 62-69.

Malhotra, A., Majchrzak, A., Kesebi, L., and Looram, S. (2017). "Developing Innovative Solutions through Internal Crowdsourcing," *MIT Sloan Management Review* (58:4), p. 73.

Zuchowski, O., Posegga, O., Schlagwein, D., and Fischbach, K. 2016. "Internal Crowdsourcing: Conceptual Framework, Structured Review, and Research Agenda," *Journal of Information Technology* (31:2), pp. 166-184.

7.3 Teaching Plan

Before starting to address the assignment question, the class could discuss the digital transformation presented in the teaching case.

Q: How does the digital transformation affect the competition for organizations in the financial industry as well as its software development and quality assurance efforts?

Firstly, the students should describe the changes in the competition for banks due to digitalization-enabled fintech's:

- The financial industry is facing increased competition, faster innovation cycles and new digital products through the digital transformation.
- In particular, new fintech companies with new financial services, for instance transferring or investing money, place the financial industry under great pressure, leading to great changes.
- Thus, organizations within the financial industry are forced to change their organizational structure, processes and working modes to meet the challenges of new competition and requirements of digital transformation appropriately.

Secondly, the students should describe the increased complexity of software development due to digitalization and discuss the implications for the IT department:

- Software development and quality assurance are encountering a more dynamic environment and shorter product life cycles.
- The number of users who expect a higher quality standard such as intuitive usability is increasing.
- The fast-growing hardware market and segmentation of devices, such as smart phones, laptops or tablets increase the complexity of software development and testing additionally.

Assignment 1: Please design potential solutions for 2-3 building blocks presented in the case. How should one design the building blocks of the crowdtesting system?

The students should design 1-2 building blocks before class. The students will probably bring different building blocks with different views and details, covering most of them. During class, the students should discuss ideas on how to design the building blocks illustrated below in table 26. At the building block *Crowd Role Model,* the class should come up with different roles and their responsibilities, rights as well as duties. Moreover, the building block *crowd communication tools* could be designed by tools like Skype, Outlook or WhatsApp. In order to improve the moderation of the discussion the Socio-Technical System theory could be introduced to structure the design propositions of the students. The different building blocks of an internal crowdsourcing system are depicted in table 25 and structured according to the STS theory:

Building Block	**Description**
Crowd Tester Incentivization *Actor*	The crowd needs to be motivated to provide contributions. Different aspects can motivate the crowd. Firstly, compensation, for instance money or other things that the crowd considers as valuable. Secondly, some contributors get motivated by simply being curious about the test object. They want to learn more about it or just want to become better acquainted with it. Thirdly, some contributors like to have a chance to increase/better their reputation in relation to their peers or superiors. Some might see crowdtesting as an opportunity for visibility in the perspective of their boss. Fourthly, social motives are also a reason why some contributors join the crowd. Crowdtesting provides them with an opportunity to communicate with people and

	enjoy it as a team effort or event. The concept should contain a range of different incentives.
Crowd Tester Enablement *Actor*	The crowd testers have different levels of IT skills. Even the contributors with the lowest IT skills need to be enabled to handle the IT tools and process to participate in crowdtesting projects. Therefore, the crowd requires an onboarding program that ensures a minimum level of IT competences and knowledge of the crowdtesting workflow, such as trainings, one pagers or videos.
Crowd Processing Platform *Structure*	Grants access to the test instructions, test cases of the test iterations and enables the work processing. It provides possibilities for documenting defects as well as evaluating the input of the crowd. Solutions could include for instance the use of Dropbox, Google Docs, JIRA, Visual Studio.
Crowd Communication Tools *Technology*	The internal crowdtesting platform requires communication among the crowd as well as between the crowd and the test management. Communication tools send invitations for tests to potential contributors that match the specific definition for a test and provide an overview of who accepted the invitation or not. In addition, e-mails, chat messaging and video calls should be possible during the tests and afterwards. Tools could include Outlook, WhatsApp, Skype.

Table 25. Building Blocks of the System

Assignment 2: Please discuss the differences between the traditional and new work mode. What problems might occur during the transition and how should one counter these? Discuss 2-3 problems and potential solutions. Why would the solutions be effective?

Firstly, the class should reflect and discuss the differences between the traditional work mode and the new work mode of internal crowdsourcing, as illustrated below in table 26:

Characteristics	**Traditional Work Mode**	**Internal Crowdsourcing Mode**
Environment	Colleagues know each other and their	Colleagues are available remotely in digital communication channels. Learn

(Blohm et al. 2013)	supervisors. Face to face communication in an analogue environment.	how to communicate and give feedback in new environment.
Task Diversity (Leicht et al. 2016a)	Well specified and stable set of tasks.	Diverse task range that changes often because of the dynamic and decentralized mode of work overcoming department boundaries.
Hierarchy (Zuchowski et al. 2016a)	Vertical hierarchy with direct supervisors that provide clear defined tasks.	Horizontal hierarchy with voluntary participation and no direct supervision of superiors.
Motivation (Zhao and Zhu 2014b)	Enforcement based mainly on extrinsic motivation and authority.	Motivation based more on intrinsic motivation in a voluntary environment.

Table 26. Characteristics between traditional and new Mode

Secondly, the students should reflect 2-3 problems that might occur during the transition phase from the traditional to the new work mode. In order to support the discussion of the students the Technochange theory could be presented. Picturing the transition from traditional to new work mode as a Technochange process can facilitate and structure the discussion. The sum of all students illustrates a range of problems. The problems are depicted below in table 27 and structured according to the Technochange theory:

Transformation Problems	**Description**
1. Supervisors reluctant about employee's participation in internal crowdsourcing *Chartering*	The crowdsourcing management must ensure that the supervisors of the crowd workers, the high management, and the work council approve of internal crowdsourcing.

2. Inadequate IT competences of crowd workers *Shakedown*	The management must lift the IT and workflow competences of crowd workers to a minimum level, enabling the use of crowdsourcing IT tools and workflow.
3. Parallelism of work settings *Shakedown*	A common transformation problem of employees is switching between the analog everyday work and the digitally mediated work setting of the internal crowd, which can increase the stress level and may be exhausting.
4. Developing new incentivization structures *Benefit*	The challenge is to develop a new incentivization structure that can motivate employees in the new work mode, due to the lack of traditional authority as well as the voluntary nature of the crowd's participation in initiatives.
5. Find a new way of delegating work *Benefit*	The crowdsourcing management must master the difficult challenge of delegating business tasks to the crowd according to the new mode of work. Some managers delegate to the crowd incomprehensibly for crowd workers because they were not aligned with the needs and competences of the crowd.

Table 27. Transformation Problems

Finally, the class should discuss the different problems and their solutions with the focus on the effectiveness of the solutions illustrated below in table 28. The applicable solutions proposed by the students should be discussed. For instance, the students could design a motivational concept to overcome the fourth problem *Developing new incentivization structures*. This concept could include different options, such as financial compensation or reputational aspects, which includes for example awarding the best crowd tester of the month.

Solutions to Problems	**Description**
1. Receive approval for internal crowdsourcing *Chartering*	The crowdsourcing management finds arguments to convince direct supervisors to let employees join the crowd and conduct internal crowdsourcing tasks during the working hours, such as an appropriate period of time.

2. Enable the crowd through training and support *Shakedown*	The management needs to ensure the minimum level of IT competences through adequate training and support, especially because some crowd workers may not originate from IT related occupations. The training should include the usage of the internal crowdsourcing tools as well as the understanding of the workflow of the system.
3. Support the crowd to switch between crowdsourcing and traditional work settings *Shakedown*	Some crowd workers experience the constant switch between the crowdsourcing and traditional setting as being stressful and exhausting. As counter measurements this article provides proper training and relocation of crowd workers.
4. Design a concept to keep the crowd motivated *Benefit*	To address decreasing motivation of the crowd, the management should design an incentivization concept with many different incentive measures.
5. Apply a new way of delegating work *Benefit*	Managers must learn a new way of delegating tasks to a crowd and determine how to translate business needs to crowdsourcing tasks.

Table 28. Solutions to Problems

Assignment 3: Please discuss potential applications of internal crowdtesting outside the core banking project/ of external crowdtesting/ of crowdsourcing in general.

This is a final brainstorm assignment, where students should think of new applications. The students could lastly discuss how the new ideas would address the general problems of BankCorp regarding the digital transformation.

- *Internal crowdtesting*: other software, such as intranet or room bookings
- *External crowdtesting*: Client related software such as website, e-banking or apps
- *Crowdsourcing in general*: Other business tasks such as innovation jams or forecasts, idea competitions or new services such as a BankCorp crowdfunding platform

The teaching note gave the potential instructor an overview of the case by depicting important details and explaining the challenges. It supported the instructor by providing potential teaching objectives, assignment questions and how to position it in the course.

8 CONCLUSION AND CONTRIBUTION

Despite the growing interest, internal crowdsourcing still bears the overarching research gap of more precise and mature design knowledge, for instance within the allocation processes regarding interrelations of internal crowd qualifications and crowdsourced tasks (Zuchowski et al. 2016a). Current literature illustrates the lack of design knowledge in academia and practice, leaving organizations with difficulties or left unable to capture the benefits of internal crowdsourcing (Benbya and Leidner 2016; Hu and Schlagwein 2013). The lack of design principles of internal crowdsourcing overarches the lack of research regarding adaptation barriers of internal crowdsourcing as well. Designing a system is only the first step. In order to close the overarching research gap and capture the benefits of internal crowdsourcing, a company has to learn how to overcome adaptation barriers too (Knop and Blohm 2018a; Leicht et al. 2016b; Zuchowski et al. 2016a).

The dissertation addressed the overarching research gap by conceptualizing internal crowdsourcing in chapter two, as socio-technical systems (STS), designing and implementing a successful version of such a system by means of an action design research approach (ADR) and formalizing these findings as five generalizable design principles in chapter four. The design principles are considered comprehensive due to the robust and extensive application of ADR (Sein et al. 2011), which were derived from a successful internal crowdsourcing system, comprehensively evaluated during 18 test iterations. Consequently, the design principles increase quality, quantity and time-to-market of the internal crowdsourcing system's outcome by integrating end users successfully.

The next objective was to identify adaptation barriers in chapter five, adapting internal crowdsourcing systems. Hitherto, the dissertation has identified a set of adaptation

barriers, broadening the understanding in our cases. Compared to existing literature (Erickson et al. 2012), the technochange perspective was applied to assess comprehensively and structured the results of internal crowdsourcing, identifying eight adaptation barriers. In addition, these adaptation barriers were assessed in the context of the other two cases. The dissertation investigated the measures of the companies for overcoming the challenges imposed by the adaptation barriers. Furthermore, a comparative examination was carried out between the three cases in order to understand the learning process of removing barriers, explain differences and similarities that drive the intended change in the organization. The results were consolidated in chapter 5.4 that illustrates what measures a company should apply. In addition to the measures aimed at overcoming adaptation barriers, the dissertation summarized overall recommendations regarding the standardization of adaptation barriers, presenting further means aimed at improving the internal crowdsourcing system in a more mature stadium (Knop and Blohm 2018a). Finally, the dissertation included a teaching case to summarize and present the findings from a more practical and educational perspective, combining the design and barrier challenge of the research questions, emphasizing the contribution to closing the overarching gap. In this perspective, the dissertation at hand addresses practitioners as well as the IS research community (Knop and Blohm 2018b).

8.1 Contributions to Literature

The first contribution to literature is the reflection of the real world problem (Hevner et al. 2004), i.e., transforming intentional design decisions into design principles for the successful design of internal crowdsourcing systems, which represents more mature design knowledge (Heinrich and Schwabe 2014). Following Gregor (2006), our design principles represent a theoretical contribution type “design and action”, as they give explicit prescriptions for constructing an artefact and answer various calls for design research, filling the research gap of the first research question regarding lacking design knowledge as described in 1.1. For instance, the STS *actor* component required further examination of relevant design decisions when initiating sustainable commitment of the internal crowd (Zogaj and Bretschneider 2014). Hence, the dissertation derived the

"Social Sustainability" design principle, because design decisions were found in the system that assisted in increasing the long-term commitment of contributors, such as variety of incentives and expectation management of the crowd. Another example of the dissertation addressing the research gap constitutes the development of the overarching design knowledge for the STS *technology* component, which remained unclear (Zuchowski et al. 2016a). The dissertation provides firstly overarching design knowledge through the "Intuitive Technology" design principle, which prescribes how to design tools that support a successful introduction and prescribes the usage of the technology in the internal crowdsourcing system to the crowd through simple tools that are favorably already known to the crowd. Thus, the research conducted by the dissertation develops nascent principles found in existing internal crowdsourcing research further to more mature meta-design knowledge, a nascent design theory with more mature design principles (Heinrich and Schwabe 2014). The design principles constitute the nascent design theory, because they provide generalizable insights applicable in various settings of internal crowdsourcing (Gregor and Hevner 2013). More precisely, it fulfils two components of a design theory, *Principles of form and function* as well as *Justificatory knowledge* (Gregor and Jones 2007). *Principles of form and function*, because the design principles define the structure, organization and functioning of the design product, such as internal crowdsourcing as an integrative system. *Justificatory knowledge*, due to linking goals, shape and processes to judge the capabilities for the design, like the capability of social sustainability, creating a longitudinal interest of the crowd (Gregor and Jones 2007).

Secondly, the results of the dissertation fill the research gap of the second research question regarding lacking adaptation barrier knowledge as described in 1.1. The current research contained only a few adaptation barriers derived without theoretical frameworks. Malhotra et al. (2017) research focused mainly on the operational phase, therefore the outcome of this dissertation expands the work by focusing on the adaptation phase and deriving eight barriers. The dissertation also expands the work of Erickson et al. (2012) by analyzing this research gap with a comprehensive theoretical lens improving the outcome of the assessment. Against this background, the dissertation

contributes to the research area of crowdsourcing by using the technochange lens, conceptualizing the adaptation of internal crowdsourcing systems as a technochange project and depicting the generative learning process of removing barriers that initiates the organizational change. The knowledge of the eight adaptation barriers enables companies to overcome these and reach a stable operation. This contribution to literature is a type of explaining by expanding the scientific body of knowledge with empirical results of three case studies, which will support the management of crowdtesting initiatives. The case study research approach supports the process of forming a rigor management approach, identifying a greater range of adaptation barriers and overcoming them, since companies are currently struggling in adapting internal crowdtesting initiatives and have room for improvement (Gregor 2006).

Thirdly, combining the outcome of the two research gaps, the design and the adaptation of internal crowdsourcing systems leads to a better understanding with respect to internal crowdsourcing as a new mode of work organization (Blohm et al. 2013). In addition, the combination of the two research questions emphasizes internal crowdsourcing as a socio-technical system, creating a more comprehensive knowledge of the new work mode overcoming its lack of design principles and adaptation barriers. Internal crowdsourcing must be better understood before designing socio-technical components of the system, because the design of internal crowdsourcing systems differentiates from the external crowdsourcing mode, i.e. conducting an internal cultural change or maintaining a longitudinal motivation among the employees (Zuchowski et al. 2016a). In an external setting the crowdsourcing principle remains outside the organizational boundaries and does not have a major effect on the internal culture (Di Gangi et al. 2010; Simula and Vuori 2012). On the contrary, during the design process of internal crowdsourcing, it was realized that the roll out in a company requires a cultural change, which for instance constitutes a potential adaptation barrier (6. Parallelism of work settings), but also needs to be addressed on the design level by a design principle (3. Culture Change). On the one hand, the employees need to be integrated to the new work mode, for example, work in a digitized environment with only remote contact to peers and superiors. On the other hand, the managers must learn

to work with a hybrid hierarchy, which combines traditional authority and an egalitarian work mode form crowdsourcing. They must respect a new level of freedom of the employees but also be aware that sometimes direct superior of the employees can use the authority for a more efficient allocation mechanism than in the external setting (Deng et al. 2016). In addition, the external setting is based on rather short term commitments, whereas in internal crowdsourcing, it is crucial to maintain a longitudinal motivation (Zuchowski et al. 2016a). It was learned that in the internal setting, a diversity of incentives supports long-term interests of the employees. By providing deeper understanding of internal crowdsourcing as a new socio-technical mode through the combination of the research questions, one can go beyond initial conceptualizations of external crowdsourcing or internal crowdsourcing as input-output-process (Leicht et al. 2017) and highlight the complex interrelations of the involved building blocks. A successful internal crowdsourcing system differs with respect to important aspects from the external setting (Dissanayake et al. 2015; Zuchowski et al. 2016a) and is not just about an IT-Platform (Rohrbeck et al. 2015); rather, it is about the intelligent interaction of the required socio-technical components and their proper adaptation in the organization. The research community has still a rather rudimentary understanding of internal crowdsourcing as a socio-technical system, which leads to difficult design processes and problematic adaptations of the systems decreasing the benefits of internal crowdsourcing (Benbya and Leidner 2016). The design principles, the knowledge of adaptation barriers and solutions to overcome them support a deeper understanding of internal crowdsourcing as socio-technical systems, because they were derived comprehensively through the socio-technical system theory lens and its components: *structure, actor, technology* and *task*. Furthermore, the design principles are the result of a rigorous ADR design process and the knowledge regarding the adaptation barriers of a comprehensive multiple case study through the technochange lens providing new insights to an internal crowdsourcing system, which creates a high-quality outcome with respect to appropriate and timely quantities as well as allowing for high employee acceptance in the crowd. Therefore, they are enabled to cope successfully with complex tasks in such systems, such as software testing. Finally, the teaching case reduces the

complexity of the research questions and clarifies the important aspects. This summarizing effect enables the teaching case to connect the two research questions with the greater context and drives students to discuss this topic against the background of digital transformation. It supports students to identify internal problems in companies and to reflect how internal crowdsourcing could solve them.

8.2 Contributions to Practice

The first practical contribution of this dissertation is a rich account of a novel application to internal crowdsourcing tasks. Companies expressed their limitations of design knowledge as described in the first research question of chapter 1.1, which led to the difficulties of organizations in terms of designing an internal crowdsourcing system that captures the benefits (Benbya and Leidner 2016). Practitioners must understand how they can embed a crowdsourcing system internally (Zuchowski et al. 2016a) to use the potential of internal crowdsourcing successfully, such as increased productivity (Erickson et al. 2012) or idea generation and selection (Soukhoroukova et al. 2012). The five design principles of this dissertation fill the research gap and will guide practitioners to design a system that allocates tasks to appropriate contributors, provides them with tools that fulfill their needs and adapts to the culture of the new work mode (Zuchowski et al. 2016a). Hence, our design principles help practitioners to design an internal crowdsourcing system that captures the benefits, such as fast access to specialized skills (Prpić et al. 2015) and increased flexibility (Kuek et al. 2015).

Secondly, combining the design knowledge with insights regarding adaptation barriers, practitioners have now an increased understanding of adaptation barriers in internal crowdtesting. It helps organizations to reorchestrate their employees using the principles of crowdsourcing increasing the agility, productivity and effectiveness of their business operations in an increasingly digital environment (Kuek et al. 2015). Internal crowdsourcing in which the collective workforce, creativity and intelligence of employees is harnessed, reflects an innovative form of work organization and, thus, the outcome of the dissertation regarding eight adaptation barriers supports practitioners in a major organizational transformation process beyond setting up a crowdsourcing platform for employees (Knop and Blohm 2018a; Zuchowski et al. 2016a). Against this

background, practitioners will be enabled to meet the management challenges from the new mode of work, facilitate contributors to engage productively in internal crowdsourcing initiatives for mid- and long-term periods and foster an environment in the organization that captures the benefits. This provides practitioners with sufficient knowledge on how to rollout internal crowdsourcing systems and guide the system to stable operations, as described in the research gap of the second research question in chapter 1.1. Consequently, they have information at disposal, which will enable them to overcome them and take advantage of the benefits. Therefore, the outcome of the dissertation supports an informed decision of choosing internal crowdtesting systems as a form of problem solving (Malhotra et al. 2017; Zogaj 2016).

Finally, the dissertation provides a teaching case with the overarching teaching objective to confront students with the benefits and barriers of internal crowdsourcing against the background of digital transformation. The case presents internal crowdsourcing as a potential solution for challenges in the digital transformation process. On one hand, the teacher can discuss the digital transformation with a real-life example. The internal crowdtesting scenario is relevant in illustrating the advantages, which are increasingly important and are realized in this specific scenario through collaborations between traditional software testing departments and the broader organization that extends the software testing abilities of the IT department. On the other hand, the case introduces the students to the challenges of IT management with a focus on designing internal crowdsourcing systems as a new work mode and guiding employees from the traditional to the new mode in order to cope with challenges in the digital transformation process (Knop and Blohm 2018b; Knop et al. 2017; Leicht et al. 2016a). In addition, the teaching case encourages students to look beyond crowdtesting and crowdsourced innovation in order to identify other potential areas of application as solution with high potential.

8.3 Limitations and Implications for Further Research

The dissertation ensured high quality research by applying the robust approach of action design research and a comprehensive multiple case study. Despite all efforts to maximize the quality of the results, the dissertation also has some limitations leading to implications for further research.

Firstly, a robust ADR method deriving five design principles for internal crowdsourcing systems was conducted. Nevertheless, it can be assumed that other design principles could arise in the future, given that Zuchowski et al. (2016a) suggests to analyze design

parameters and their specific context (Pedersen et al. 2013). Therefore, the dissertation encourages other scholars to delve further into the design knowledge. The research in the dissertation was mostly in the application area of internal crowdsourced software testing (Leicht et al. 2016b). The dissertation started by assessing the design principles in the other application area of internal crowdsourced innovation management, but further research would be necessary in order to verify the results of the dissertation in hand. It is possible that other application areas might alter, add to or reduce the design principles of this dissertation according to the requirements of the other application area. Moreover, internal crowdsourced software testing is an application that could be allocated to the crowdsourcing archetype "crowd solving" (Geiger et al. 2012). For further research, it would be beneficial to assess other application areas of internal crowdsourcing that follow the definition of the other archetypes of crowdsourcing, such as crowdsourced innovation management, which can be described as an application area that follows the definition of the "crowd creation" archetype. Future research in a different context should compare the different settings and clarify the impact on design. The dissertation agrees with Zuchowski et al. (2016a) and Pedersen et al. (2013) that the contextual features on the system design of internal crowdsourcing is not sufficiently understood. The work in hand increased the knowledge of the basic or inter-contextual design features, which appear in different internal crowdsourcing settings, such as crowdtesting and crowdsourced innovation management. Therefore, it is important that future research develops the design principles of the dissertation further, assesses and differentiates between inter-contextual design principles, which are less affected by different settings and contextual design principles that are highly affected by specific settings. The research outcome would enhance the design in particular settings and increase capturing the benefits of internal crowdsourcing (Kuek et al. 2015; Prpić et al. 2015). Some contextual design principles might work in certain settings but not in others. Clarifying what design principle works in what setting would further stabilize the design success of internal crowdsourcing and improve an informed decision process regarding internal crowdsourcing being a means to solve a problem or not (Leicht et al. 2016b). Finally, further research could apply different research methods in order to provide a different perspective on the research outcome. The dissertation applied rather qualitative methods in order to follow an explorative approach with novel research questions. Therefore, a more quantitative assessment and verification could lead to interesting research outcomes.

Secondly, the list of adaptation barriers identified by the dissertation is probably not final. Therefore, following Zhao and Zhu (2014a) as well as Malhotra et al. (2017), the dissertation encourages future research to extend the assessment of adaptation barriers regarding the interaction of adaptation barriers with other barriers, potential solutions and avoiding the occurrence of barriers. The relative effect between barriers but also solutions are not well understood (Ghezzi et al. 2018). On one hand, some adaptation barriers might occur in groups, because they have similar origins. Others might prevent or signal that other specific barriers will not occur, excluding each other. On the other hand, overcoming a barrier with a certain solution might provoke the occurrence of a specific new barrier. Assessing and understanding these patterns and dependencies are highly relevant for overcoming management challenges while adapting internal crowdsourcing systems and guiding them to stable operations (Correia et al. 2018). The dissertation increased the basic understanding of adaptation barriers of internal crowdsourcing and how to overcome them. This proposition of future research would deepen this knowledge by not just overcome barriers but also avoid them through understanding the patterns and interdependencies. The knowledge of avoiding barriers would increase the potential of saving resources substantially and enhance the capabilities of guiding an internal crowdsourcing system to stable operations. Such a research goal might require more than a comprehensive theoretical lens, as presented in this dissertation but combining it with a more specific perspective. A procedure to achieve this might be combining a focus on either internal or external parameters with an appropriate theory (Pedersen et al. 2013). In the internal perspective, new studies could focus on adaptation barriers related to qualifications in the crowd (Zogaj and Bretschneider 2014) or to behavior of the crowd managers as solutions aiming to increase the success of the initiatives (Simula and Vuori 2012). In addition, new studies addressing company cultures and their impact on adaptation of internal crowdsourcing would provide important outcomes (Zuchowski et al. 2016a). Similarly, focusing on external factors might deliver interesting insights that could be important for the research community. For instance, analyzing economic factors or social effects on internal crowdsourcing initiatives in relation to longitudinal studies. The outcome of this future research would support practitioners and the academic community to understand better adaptation barriers of internal crowdsourcing and their solutions. It would increase the potential of internal crowdsourcing initiatives and enhance capturing their

benefits, such as fast access to increased productivity (Jette et al. 2015) and internal knowledge (Gaspoz 2011).

Thirdly, the current understanding of internal crowdsourcing design and adaptation in an organization as a transformation process is insufficient. Companies still struggle to adapt to the fast-changing environment due to digitization, either missing to capture the benefits or losing advantages to the competition (Kuek et al. 2015). The dissertation encourages future research to develop a specific process theory for designing and adapting internal crowdsourcing, serving practitioners as a guideline how to initiate and manage a transformational change in a new digitized environment (Correia et al. 2018; Ghezzi et al. 2018). For the research community it would serve as a lens supporting the understanding and forecasts of these organizational transformations. The dissertation applied the socio-technical system and technochange theory for answering the two research questions regarding designs gaps and management challenges. Future research should use this outcome as a starting point to further explore and assess closer the interrelations between the triangle of the two theories and the current state of research in the area of internal crowdsourcing, as described by Zuchowski et al. (2016a), Malhotra et al. (2017) and Knop and Blohm (2018a). The dissertation assessed and depicted how internal crowdsourcing interrelates to each of the theories. Scholars should deepen the knowledge of the interrelations and sharpen the focus by combining the theories more closely against the background of internal crowdsourcing. The technochange theory is a robust perspective necessary to depict the process of transformation towards a new form of work (Markus 2004). The socio-technical theory is necessary in order to add the required components and systematic nature of internal crowdsourcing systems (Baxter and Sommerville 2011; Lyytinen and Newman 2008). The dissertation suggests applying the ADR research method, which derives solutions for classes of problems, such as the transformational change of digitization through internal crowdsourcing. This method enables a systematic specification of a theory addressing a real life problem (Gregor and Jones 2007; Von Alan et al. 2004). ADR combines the practical with the theoretical perspective leading to a deep understanding of the theoretical research goal, a new process theory for internal crowdsourcing systems (Sein et al. 2011). The combination of the socio-technical and technochange theory would provide a more precise perspective than current theories. This new process theory would be a specific internal crowdsourcing perspective which could deepen the knowledge regarding the design and adaptation of a new form of work distribution

guiding the transformational change in an organization due to digitization. Internal crowdsourcing specific events could be analyzed on a deeper level, such as the parallelism of work modes, both the traditional and the new internal crowdsourcing mode. An improved understanding of these steps in the transformation process would enable the design of internal crowdsourcing systems and the adaptation to organizations, to ensure the benefit capture of internal crowdsourcing, initiating and managing a transformational change in a new digitized environment (Kuek et al. 2015; Zuchowski et al. 2016a).

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CURRICULUM VITAE

Education

09.2015 – 02.2020	University of St. Gallen, Switzerland: PhD in Business Innovation
02.2012 - 10.2014	University of St. Gallen, Switzerland: Master in Business Innovation
02.2013 - 06.2013	University Ca' Foscari of Venice, Italy: Exchange Semester
09.2008 - 02.2012	University St. Gallen, Switzerland: Bachelor in Business Administration
01.2008 - 03.2008	International House Sydney, Australia
08.1997 - 06.2006	Anna-Schmidt-Schule, Germany: Major in Biology, Politics & Economics

Practical Experience

Since 11.2018	PricewaterhouseCoopers, Zurich, Switzerland Position: Senior Consultant Task: Consulting in Cyber Security with a specialization in Cyber Security processes and role models in financial as well as other industries. Introducing cyber security solutions to the client's organization and acting as intermediary between IT and Business for compliance aspects.
03.2015 – 08.2018	Competence Center Crowdsourcing, St. Gallen, Switzerland Position: Consultant Task: Consulting in Crowdsourcing with a specialization in conceptualization of Crowdsourced Software Testing processes with clients in banking, insurance and other industries. Conducting workshops concerning Crowdtesting processes with consideration of Data Security concepts.
10.2014 - 12.2014	Goodgame Studios, Hamburg, Germany Position: Sales Associate Task: The Sales Talents Program provided workshops for sales techniques and the possibility to get first-hand experience as a Sales Associate. Expanding the business, establishing independently sustainable partnerships with websites and negotiate contracts.
09.2013 - 02.2014	Audi AG, Ingolstadt, Germany Position: Strategist in the Technology Department Task: Development and Operationalization of the department strategy through creating benchmarking analyses of OEM's, defining KPI's for the R&D process, restructuring the development process of vehicle projects and setting up a trend forecast concerning the automobile industry.