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Essays on Innovation and Knowledge Management

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Abstract

The articles in this thesis cover three different units of analysis of the open innovation landscape – (1) the innovation process, (2) a specific innovation and knowledge management tool, and (3) the individual participants and their motivation to engage in innovation and knowledge management.

Building on an in-depth qualitative case study analysis of three innovation processes within incumbent companies, the *first empirical chapter* sheds light on the rationale and methods of incumbents that successfully integrated external stakeholders along the entire innovation and product development process. Companies utilized users as valuable co-developers in a dynamic manner based on the stage of the innovation process. In the cases highlighted, this thesis showcases that the feedback and ideas provided by external stakeholders were crucial for the innovation processes. Another striking aspect found was the method of field trials performed by all three case companies. In contrast with traditional pilot testing, the field trials under review also served to investigate (changing) user behavior in relation to a novel green product or service and therefore generated additional valuable knowledge with respect to business model innovation.

The second empirical chapter concerns the development of a knowledge management platform employing gamification and highlights the system requirements to consider when such a platform should be implemented into a company context. In particular, the gamification element of quests was the preferred element to translate different knowledge management processes and methods (in this context knowledge management within Cost Engineering) to an

IT platform. The system framework presented in this chapter builds on a social network with four pillars (= concepts), namely, a task, evaluation, game, and organizational concept.

Analyzing the phenomenon of gamification further, the *last empirical chapter* analyzes the effect of gamification as a non-monetary incentive on the motivation and output of participants on an ideation platform. The field experiment shows that the common game elements used in practice as well as in the previous chapter are perceived by participants as extrinsic rewards and therefore may not provide a compelling experience that generates intrinsic motivation and needs satisfaction. This chapter shows that there is an effect on participants' quantitative performance but not on their intrinsic motivation or qualitative performance.

In summary, this thesis contributes to the understanding of recent trends in innovation and knowledge management. The goal of this thesis is to generate knowledge that supports innovation managers, especially in incumbent companies, in their efforts to integrate external (i.e., non-R&D personnel) stakeholders into the innovation process.

Kurzfassung (German abstract)

Die Artikel dieser Dissertation beschäftigen sich mit drei verschiedenen Analyseeinheiten von Open Innovation Ansätzen innerhalb etablierter Firmen: (1) dem Innovationsprozess, (2) einem spezifischen Innovations- und Wissensmanagement Tool und (3) dem Individuum und dessen Motivation, sich für Innovation und Wissensmanagement zu engagieren.

Das *erste empirische Kapitel* beleuchtet, aufbauend auf einer detaillierten qualitativen Fallstudienanalyse von drei Innovationsprozessen innerhalb etablierter Unternehmen, die Grundlagen und Methoden etablierter Unternehmen, externe Stakeholder erfolgreich in den gesamten Innovations- und Produktentwicklungsprozess einzubinden. Die Analyse zeigt, wie und mit welchen Rational Unternehmen externe Stakeholder dynamisch, in Abhängigkeit des Fortschritts im Innovationsprozess, einbinden. Die Fallstudien zeigen auf, dass das Feedback und die Ideen externer Stakeholder den Innovationsprozess entscheidend geprägt und bereichert haben. Hervorzuheben ist besonders der Einsatz von weitreichenden Feldstudien als dominierende Open Innovation Methode bei allen drei Firmen. Im Gegensatz zu traditionellen Pilotphasen im Produktentwicklungsprozess, waren die untersuchten Feldstudien derart komplex und geartet, dass Sie speziell das Nutzerverhalten und den Umgang mit dem innovativen nachhaltigen Produkt im Lebensalltag analysieren konnten. Dadurch konnte wertvolles Wissen, nicht nur für die technische Produktentwicklung generiert werden, sondern auch zur Schärfung des gesamten Geschäftsmodels.

Im *zweiten empirischen Kapitel* wird eine Wissensmanagementplattform, welche Gamification Elemente einsetzt, entwickelt und analysiert. Neben dem entwickelten Plattformkonzept und den Plattformausrüstungen, werden speziell organisatorische und Infrastruktur Aspekte

analysiert und bewertet, welche zu beachten sind, um eine solche Plattform in einem Unternehmenskontext zu implementieren. Die Ergebnisse zeigen, dass insbesondere Missionen (Quests) als Gamification Element für den Einsatz im Unternehmenskontext als am geeignetsten erachtet wurden, um verschiedene Schritte und Methoden des Wissensmanagements (in diesem Kontext Wissensmanagement im Cost Engineering) auf einer IT-Plattform abzubilden. Der in diesem Kapitel vorgestellte Ansatz baut auf einem sozialen Netzwerk mit vier Säulen (Konzepten) auf. Es wurden ein Aufgaben-, Bewertungs-, Spiel- und Organisationskonzept entwickelt, welche jeweils als Leitfaden zur Implementierung herangezogen werden können.

Um das Phänomen Gamification weiter zu beleuchten, analysiert das *letzte empirische Kapitel* den Effekt von Gamification, als nicht-monetären Anreiz, auf die Motivation und Leistung von Teilnehmern, auf einer Ideenplattform. Das Feldexperiment zeigt, dass die Spielelemente, welche primär in der Praxis eingesetzt werden, von den Teilnehmern als extrinsische Belohnung wahrgenommen werden. Somit, kann gezeigt werden, dass Gamification Auswirkungen auf die quantitative Leistung der Teilnehmer hat, jedoch nicht auf ihre intrinsische Motivation oder qualitative Leistung.

Zusammenfassend trägt diese Dissertation zum Verständnis aktueller Trends im Innovations- und Wissensmanagement bei. Die aufgezeigten Ergebnisse unterstützen Innovationsmanager, insbesondere in etablierten Unternehmen, dabei, externe Akteure in den Innovationsprozess einzubinden.

1 Introduction¹

1.1 Motivation

With the advent of digitization, the nature and structure of new products and services has changed significantly (Nambisan, Lyytinen, Majchrzak, & Song, 2017) and has led to a paradigm shift in the way companies innovate (Saldanha, Mithas, & Krishnan, 2017). This increasing pressure to innovate has led to the advent and ongoing development of new forms of innovation and knowledge management practices, for example, crowdsourcing (Boudreau & Lakhani, 2013). The continued opening-up of companies to integrate the knowledge and resources of various external stakeholders (external as in non-R&D personnel) into the innovation and new product development process can no longer be neglected (Enkel, Gassmann, & Chesbrough, 2009; Chesbrough, 2003). Open innovation (Chesbrough, 2003) or, recently, even open business models (Weiblen, 2014) are the new norms for companies that want continuously innovative, sustain their market position or disrupt whole industries. Thus, companies increasingly draw from external and internal stakeholders to enrich traditional product development teams (Gassmann, 2006, p. 778; Sousa & González-Loureiro 2016, p. 826), which leads to a myriad of organizational setups, methods and tools to facilitate the inclusion of external sources and the companies journey away from relying on internal innovation capabilities only (Majchrzak & Malhotra, 2013; Piller, & Walcher, 2006). Additionally, during the last decade, innovation has increasingly been put forward as a means

¹ This chapter is partly based on Zimmerling, Purтик, & Welpе (2016), Zimmerling, Höflinger, Sandner, & Welpе (2016), Zimmerling, Höllig, Sandner, & Welpе (2018) ;see Appendix for full references

of addressing the challenges of the 21st century and fostering sustainable development (Carrillo-Hermosilla, del Rio, & Konnola, 2010; De Medeiros, Ribeiro, & Cortimiglia, 2014). Furthermore, there is widespread agreement that so-called green or environmental innovation requires the integration of external and internal knowledge due to its systemic character and related technological uncertainties (De Marchi, 2012; Driessen & Hillebrand, 2013). This thesis will, therefore, utilize the institutional and industry characteristics of green or environmental innovations and mostly stay within this context throughout its empirical chapters (see also Appendix-A) and supplements (see Appendix-B).

Successful enrichment of traditional product development teams with external and internal stakeholders is dependent on the overall ecosystem a company is acting in (Salter, Criscuolo, & Wal, 2014) down to the individual actor, leading to a possible bandwidth of units of analysis, which Bogers et al. (2016) subdivided as follows: industrial, regional innovation systems, society specific systems, inter-organizational, extra-organizational, organizational, and intra-organizational. This thesis follows this division, and the chapters of this thesis only focus on organizational as well as intra-organizational aspects (see Figure 1.1 for clarification).

At the organizational level, one can further distinguish between *organizational design and the strategies of the company* and *methods, tools, and practices utilized*. At the level of organizational design and strategies, previous studies collected evidence that showed that companies' innovativeness can be improved using a strategy of collaborating with non-R&D personnel (West & Bogers, 2014; Alexy, Criscuolo, & Salter 2012), and studies investigated how firms can best utilize external resources (Fjeldstad, Snow, Miles, & Lettl, 2012). In that research stream, Alexy, Criscuolo, and Salter (2012), for example, found that certain firms implemented special units and even dedicated "agents for ideas" to match external ideas with

interested internal customers to better structure coordination and overcome internal resistance to outside ideas. Furthermore, Lakhani Lifshitz-Assaf, and Tushman (2013) investigated the productivity side of open innovation and different forms of interaction. In this vein, a recent study by Seidel, Langner, and Sims (2016) investigates the effectiveness of different forms of community-based innovation in the technology life cycle. They conclude that innovation contests and crowdsourcing, for example, are most beneficial in the last phase of the technology lifecycle (i.e., *sensing the next discontinuity*) (Seidel, Langner, & Sims, 2016).

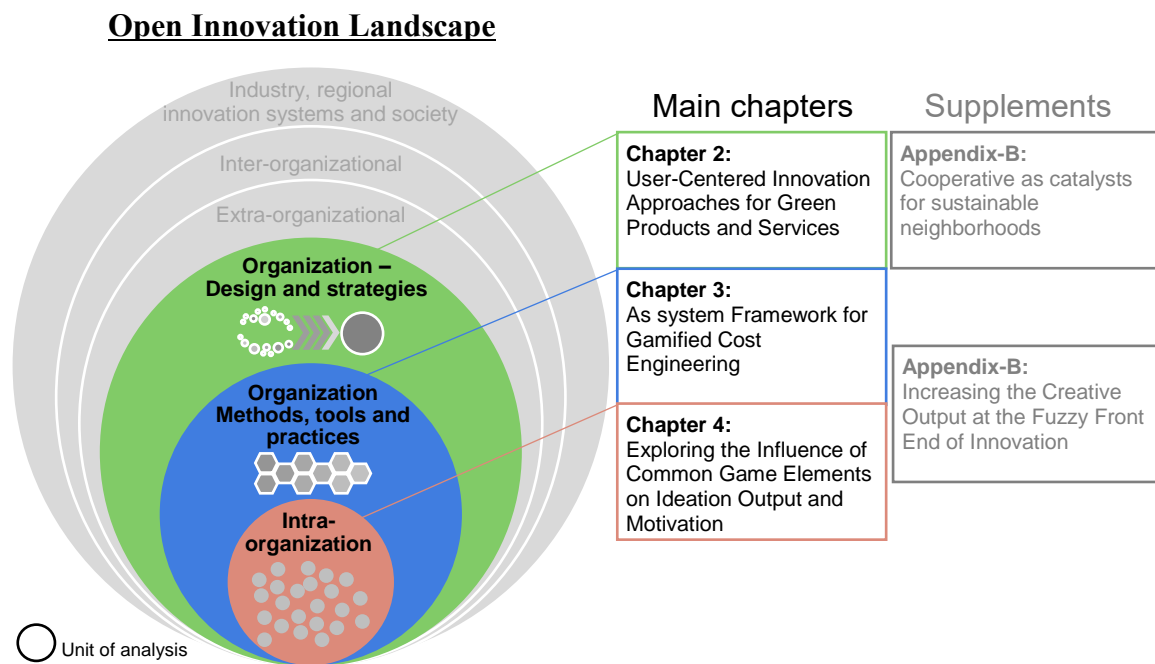


Figure 1.1 Thesis overview and orientation within the research landscape.

At the level of individual methods and tools used for innovation and knowledge management, a rich body of literature has shown that users can not only give important feedback for improving existing products (Hult, Morgenson, Morgan, Mithas, & Fornell, 2017) but firms

should also value the knowledge of users' needs (Nambisan, 2002); additionally, firms can directly tap into users' solution knowledge to innovate (Priem, Li, & Carr, 2011; Von Hippel, 1986). Various tools and methods were developed and investigated for those purposes. Among other methods are lead user workshops, idea contests, user toolkits, innovation labs and online communities, which are meant to assist firms to not only discover users' needs and expectations but also to tap into stakeholders' creativity and solution knowledge (Franke & Piller, 2004; Füller, Hutter, Hautz, & Matzler, 2014; Von Hippel, 1986). Similarly, scholars agree that IT tools and methods for knowledge management and sharing positively influence a firms' innovativeness (Hildrum, 2009; Joshi, Chi, Datta, & Han, 2010). Studies have not only demonstrated a positive effect of IT on product innovation (Majchrzak & Malhotra 2013), but a recent study also found "*how IT enables process innovation by allowing manufacturing firms to more effectively absorb knowledge*" (Trantopoulos, von Krogh, Wallin, & Woerter, 2017). Lastly, there is a growing body of literature investigating various characteristics and dynamics at the level of individual actors in the innovation and knowledge management process. In particular, regarding what motivates external participants to initially consider offering their resources (Füller et al., 2014) and what drives participation in the process (Leimeister, Huber, Bretschneider, & Krcmar, 2009). In particular, studies at that level found that many tools and methods, whether with firm internal stakeholders (Björk, Di Vincenzo, Magnusson, & Mascia, 2011; Björk & Magnusson, 2009; Fairbank & Williams, 2001) or firm external stakeholders (Blohm, Bretschneider, Leimeister, & Krcmar, 2011; Füller et al., 2014; Hutter, Hautz, Füller, Mueller, & Matzler, 2011), benefited from a mix between competition and co-operation among participants.

Despite the myriad of research conducted within that field, there are still several themes open for investigation (for a detailed overview see Bogers et al., 2016). This thesis builds on the literature of innovation management and information systems science to contribute to the field, especially to previous research in open innovation and knowledge management. At the level of the organizational design and strategies outlined above, more research is necessary to “*explore the respective roles of different stakeholders and their heterogeneous contributions to corporate innovation processes*” (Bogers et al., 2016, pp. 25–26). In Chapter 2, this thesis, therefore, contributes to the literature by analyzing how companies have utilized various open innovation methods to enrich their product development process with external stakeholders along their overall innovation process. Furthermore, additional research is necessary to increase the efficiency of tools and methods to integrate stakeholders, especially how to develop tools that are motivating and engaging for external stakeholders who are not incentivized by the internal incentive measures deployed by the R&D teams. Bogers et al. (2016) therefore call for more research to understand the factors that motivate employees to embrace open innovation and open knowledge sharing and determine which novel tools and methods can “*accommodate innovative suggestions from sources both internal and external to the firm*” (Bogers et al., 2016, p. 14). Against this background, Chapter 3 builds on the literature of information system science and utilizes a design science research approach to ingrain the motivation aspects of gamification, a non-monetary incentive system, in a software tool for knowledge sharing. Lastly, at an individual level, this thesis adds to previous studies at the individual level and contributes to the growing body of literature that investigates how to motivate participants in crowdsourcing processes and thus increase its efficiency (Majchrzak & Malhotra, 2013; Leimeister et al., 2009). Using a large-scale field study, Chapter 4 analyzes the effects that gamification elements have on intrinsic motivation as well as quantitative and qualitative

ideation performance. Thus, this chapter adds to the findings of the open innovation literature as well as information systems sciences, in particular, the growing field of gamification. By answering how different elements of gamification affect the motivation and performance of participants in an ideation task, this chapter sheds more light on the performance of gamification in this context.

In the following chapters, this thesis provides an overarching conceptual framework and derives distinct research questions. Section 1.3 provides an overview of the different methodologies utilized to contribute to the open questions on the different units of analysis. Lastly, an overview of the chapters and how they relate to the field is found in Section 1.4 of the introduction.

1.1.1 Conceptual Framework and Research Questions

Innovation has a long history as a driver of the growth of companies and countries and can be seen to be a part of the “overarching concept of knowledge management” (Brockhoff, 2017, p. 466). The management of innovation starts with the advent of specialized R&D departments and, more precisely, with the management of those departments by defining objectives and establishing long-term planning of innovation activities (Brockhoff, 2017). Since Schumpeter's seminal work on creative destruction and the need for continuous innovation, innovation currently has the highest priority for top management (Wagner, Taylor, Zablit, & Foo, 2014). Studies have shown, and it is accepted, that product innovation activities lead to a company's renewal (Dougherty, 1992); these activities also draw on and serve the firm's competencies and knowledge, such as the knowledge of customer needs (Danneels, 2002). It is not surprising that the organization and management of innovation developed in ever more formal structures and that the new product development process serves as the main driver of generating a competitive

advantage among firms (Lengnick-Hall, 1992). Methodologies such as the innovation funnel or stage gate process enjoy high popularity among practitioners and researchers alike (Vanhaverbeke & Cloudt, 2014, pp. 256–257). These methodologies serve as tools for managers to organize innovation in a more rigorous manner and coordinate the interplay of firm's marketers, engineers and/or designers, who are responsible for the creativity and product development process (Poetz & Schreier, 2012). Chesbrough (2003) defines this innovation strategy, in which firms primarily utilize their internal R&D departments, in a closed innovation model (p. xx). In this context, companies protect their intellectual property (IP) aggressively to prevent competitors from utilizing it rather than sharing insights with them (Gassmann, 2006). In that sense, technology management, for example, patent management, evolved as a sub-stream of innovation management, which this thesis does not focus on.

Due to the ubiquity of knowledge, the high pace of innovation and the accelerated digitization of recent years, the management of innovation underwent a paradigm shift (Saldanha, Mithas, & Krishnan, 2017). The next section describes this paradigm shift from closed to open innovation as well as green innovation as a particular context to study open innovation.

1.1.2 Open Innovation and Green Innovation

Building on the emerging opportunities enabled by digitization, firms developed new ways to organize innovation, in particular, by opening up their innovation process and, in so doing, by leveraging resources from external stakeholders along their internal innovation process (West & Bogers, 2012). This opening has received increased attention from scholars, who have conducted a myriad of studies since Chesbrough (2003) defined the term Open Innovation in comparison to closed innovation (Bogers et al. 2016). Open innovation is characterized by three distinct processes: outside-in, inside-out and coupled (Enkel, Gassmann, & Chesbrough,

2009; Enkel, Perez-Freije, & Gassmann, 2005). Outside-in describes the process of absorbing knowledge and know-how from an external stakeholder. The opposite process is the inside-out process, which describes the outflow of information and could, for example, be performed by out-licensing existing know-how (e.g., patented technologies) to create revenue streams or alternative markets for their innovation to accelerate diffusion on the market. The coupled process is probably the most well-known form of open innovation and describes the process of integrating external stakeholders by sharing internal knowledge and thereby jointly developing new products. One method is the well-known concept of crowdsourcing, as first defined by Howe (2006), which requires the company to take the first step and initiate the innovation activity in cooperation with external actors. Crowdsourcing comes in various forms and varying complexities, starting from idea challenges, which can attract a large heterogeneous crowd of often non-experts (Füller et al., 2014), all the way to highly complex computational challenges that require expert knowledge (Boudreau, Lakhani, & Menietti, 2016). Idea contests have made the coupled process particularly prominent as companies also utilize it for marketing purposes (Belz, Silvertant, Füller, & Pobisch, 2009). A full spectrum of the “open innovation research landscape” can be found in a recent structured overview of Bogers et al. (2016), who additionally further highlight areas to investigate.

Over the last decade, innovation has also been the main driver for sustainable development (Carrillo-Hermosilla, del Rio, & Konnola, 2010; De Medeiros Ribeiro, & Cortimiglia, 2014). Additionally, green or environmental innovations are seen to specifically require the integration of external and internal knowledge due to their systemic character and related technological uncertainties (De Marchi, 2012; Driessen & Hillebrand, 2013). “Green innovation” (Olson, 2013) or “sustainability innovation” (Schaltegger & Wagner, 2011) and “eco-innovation”

(Carrillo-Hermosilla, del Río, & Könnölä, 2010) are newly developed technologies that add value across the economic, ecological and/or social dimensions of products and services. The transition to electric mobility, for example, requires sustainable technologies that are systemic in nature since the technologies cannot be anchored onto existing systems and break with original market barriers (Abdelkafi et al., 2013; Johnson & Suskewicz, 2009). For those innovations, collaboration with external actors is the main driver for successful development and commercialization (Dangelico, Pontrandolfo, & Pujari, 2013; Driessen & Hillebrand, 2013; Laperche & Picard, 2013). Green innovations require higher levels of involvement of an external stakeholder than conventional innovations (De Marchi, 2012). Chapter 2, therefore, uses the institutional and industry characteristics of green innovations to answer Research Question 1.

As mentioned above, the field of open innovation is still maturing, and despite the research already conducted, there are still several themes open for investigation (for a detailed overview, see Bogers et al., 2016). From an innovation process perspective within the realm of open innovation, more research is necessary to “explore the respective roles of different stakeholders and their heterogeneous contributions to corporate innovation processes” (Bogers et al., 2016, pp. 25–26). Not only but especially within the field of green innovations, only a few studies have investigated the entire product development process and the distinct open innovation methods and tools companies apply at each phase, in particular, to integrate users. Some articles, for example, focus on user integration; however, the majority of articles have focused on rather incremental innovation processes with end-users (Heiskanen, Kasanen, & Timonen., 2005; Liedtke, Baedeker, Hasselkuß, Rohn, & Grinewitschus, 2015) or analyzed a particular method, such as innovation workshops (Brown & Vergragt, 2008; Hoffmann, 2007).

Furthermore, cases were investigated as to how government organizations or NGOs promote and facilitate the integration of external stakeholders into green innovation processes (Fam & Mitchell, 2013; Jerneck & Olson, 2013). Thus, an investigation of the impact of the integration of stakeholders, such as users, on a company's innovation has rarely been a subject of research (De Marchi, 2012; Laperche & Picard, 2013; Wagner, 2009). This thesis, therefore, combines the literature on green innovation and open innovation to answer the following research question:

Research Question 1: How does company-driven user integration affect green innovation in incumbent firms?

1.1.3 Incentives and motivations in internal and external Open Innovation

Within a company's boundaries, incentive systems and motivation have been widely studied, and financial rewards are still the main motivation for work (Levačić 2009). The main theory applied is the principal-agent theory, which solely relies on extrinsic incentives and does not focus on intrinsic motivation (Van Herpen, Van Praag, & Cools, 2005). However, the motivation of the agent in this context is also decisive (Levačić 2009). One main vehicle is a performance-based payment rate to increase motivation and performance, for which various studies conclude mixed success rates (Shaw, Duffy, Mitra, Lockhart, & Bowler, 2003; Beer et al., 2004). Generally, humans are seen to be motivated when they perform a certain task in pursuit of a certain purpose, and in principle, every activity can be motivating. Here, one primarily distinguishes between two types of motivation, namely, extrinsic and intrinsic motivation (Deci, 1972). In the realm of open innovation, internal knowledge management or company internal open innovation efforts, traditional motivation and incentive structures for everyday work mostly do not apply. These factors are even more different for participants from

outside the boundaries of a company compared to participants in internal open innovation initiatives (Wendelken, Danzinger, Rau, & Moeslein, 2014).

As mentioned above, companies incentivize and motivate employees using various incentive systems, such as salaries, promotions, rewards, profit sharing or holiday bonuses (Baker, Jensen, & Murphy, 1988). However, rewarding employees with non-monetary rewards for creating new ideas was found to be more effective than high-powered incentives (Baumann & Stieglitz, 2014). Furthermore, Holmstrom and Milgrom (1994) found that low-powered incentive systems within firms sparked cooperation and coordination. The results are similar for open innovation activities with external partners, in which financial rewards are also prevalent but the motives are also of an intrinsic nature (Wendelken et al., 2014). Generally, there is a vast body of literature regarding different user types and user groups (Wendelken et al., 2014) as well as how externalities, such as a participant's network position or company process, for the internal open innovation context (Björk & Magnusson, 2009), influence participant performance. The essays presented in Chapter 3 and 4, however, primarily build on past findings regarding the relationship between participant's initial motives and design or incentive elements, which are directly incorporated into the open innovation method or tool, as well as how they influence performance.

These motivational factors include, among others, having fun (Antikainen, Mäkipää, & Ahonen, 2010), community identification (Hars & Ou, 2001), perceived organizational/management support and trust (Paroutis & Al Saleh, 2009), interesting and challenging questions (Muhdi & Boutellier, 2011), curiosity (Witt, Scheiner, & Robra-Bissantz, 2011), monetary rewards, a mixture of cash and non-monetary rewards (Ebner, Leimeister, & Kremer, 2009), and feedback (Chen, Zhang, & Latimer, 2014). The latter are primarily of extrinsic

nature, which, in certain contexts, can undermine the prevalent intrinsic motivation (for an overview, see Deci et al., 1999). In a recent meta/analysis from Cerasoli, Nicklin, and Ford (2014), however, the authors demonstrated that incentives “boosted the intrinsic motivation-performance link”, suggesting that incentives and especially those that are indirectly performance salient have a positive effect on performance (Cerasoli, Nicklin, & Ford, 2014, p. 17). A finding that speaks especially for incentive supporting components of information systems, such as those described by Leimeister et al. (2009), supports open innovation tools and knowledge management platforms.

In idea contests or knowledge management systems, a stimulating environment that motivates participants has been shown to result in an increased quantity and quality of contributions (Blohm, Bretschneider, Leimeister, & Krcmar, 2011; Füller et al., 2011). The experience provided, for example, by an idea contest should be enhanced to intrinsically motivate its participants (Adamczyk, Bullinger, & Möslein, 2010; Leimeister et al., 2009; Piller & Walcher, 2006).

Those studies showed that ideation platforms, regardless of whether they included employees (Björk, Di Vincenzo, Magnusson, & Mascia, 2011; Björk & Magnusson, 2009; Fairbank & Williams, 2001) or users (Blohm, Bretschneider, Leimeister, & Krcmar, 2011; Füller, Hutter, Hautz, & Matzler, 2014), benefited from a solid mix of competition and cooperation among participants. The overall notion is that the means to facilitate the interaction, feedback and knowledge transfer to strengthen the feeling of community among participants (Abu El-Ella, Stoetzel, Bessant, & Pinkwart, 2013; Gressgård et al., 2014), as well as designing certain incentive and reward structures (Chen, Williamson, & Zhou, 2012; Füller, Hutter, Hautz, & Matzler, 2014; Toubia, 2006), are driving the efficiency of ideation processes, crowdsourcing

and knowledge management platforms. Furthermore, studies investigating drivers that increase the output of idea contests showed that monetary rewards (Morgan & Wang, 2010) or firm recognition (Leimeister et al., 2009) are common approaches for establishing motivation and fostering output within idea contests.

However, as shown by Cerasoli, Nicklin, and Ford, 2014. (2014), non-performance contingent rewards, in particular, speak to one's intrinsic motivation. Thus, creating a stimulating environment and motivating participants can result in an increased likelihood of participation, for example, an idea or knowledge management platform resulting in higher numbers and quality of contributed ideas (Füller et al., 2011). The experience provided by those platforms or within open innovation methods should, therefore, be enhanced to intrinsically motivate its participants (Adamczyk, Bullinger, & Möslin, 2012; Leimeister et al., 2009). Chapters 2 and 3 of this thesis specifically focus on information systems tools and how design elements can be utilized to increase the participation and performance of those platforms as tools of open innovation. These chapters therefore additionally draw from previous findings from the Information Systems (IS) literature.

For information systems, perceived usefulness and ease of use are seen as essential to success (van der Heijden, 2004). In particular, the utilitarian aspects of the IS are assumed to affect intrinsic motivation positively. Hedonic attributes describe aesthetic, experiential, and enjoyment-related benefits (Chitturi, Raghunathan, & Mahajan, 2008; Hamari, Koivisto, & Sarsa, 2015). The objective of hedonic components in an IS is to provide a self-fulfilling value to the user. Moreover, the value of a hedonic system is a function of the degree to which the individual experiences fun when using the system (van der Heijden, 2004). Reeve (1989) found that performance satisfaction leading to feelings of mastery, efficacy, and competence relates

enjoyment to intrinsic motivation. As hedonic IS aims to enhance self-fulfillment (van der Heijden, 2004), the central concept of intrinsic motivation, it is assumed that the hedonic attributes have a connection to the intrinsic motivation to engage in activities on the platforms. Social aspects also represent an important determinant of the motivational affordance of design elements. In that sense, a subjective norm of an environment (i.e., the perceived social pressure, has an influence on use intention and behavioral outcomes) (Ajzen, 1991). The motivational affordance of design elements concerning the enhancement of recognition originates from the inherent longing of human beings for relatedness and acceptance from their peers (Ryan & Deci, 2000). Zhang (2008) emphasizes that the social interaction facilitated within a service has the potential to fulfill these social needs. Recognition refers to the social interactions encouraged by a service, e.g., the feedback users obtain concerning their behavior (Hernandez, Montaner, Sese, & Urquizu, 2011). However, when motivations are driven by extrinsic rewards (e.g., incentives), they are assumed to be related to gaining acceptance and approval from peers or instructors (Hernandez et al., 2011). Furthermore, if a sense of relatedness between peers (interpersonal relationship) is established, the development of intrinsic motivation can be anticipated since the need relatedness may be fulfilled (Preece, 2001).

1.1.4 Design Elements and Gamification as incentives on OI platforms

Building on the open innovation literature above and on additional findings within the IS literature, this chapter outlines the current state of research with respect to incentive-enhancing design elements, in particular, outlining the results from previous studies that are most relevant for the context of tools and methods of open innovation. The focus is on quantitative studies to obtain an overview of which platform elements were found to drive participation on OI platforms.

Introduction

In line with the literature described in the previous section, Jung, Schneider, and Valacich (2010) demonstrated that feedback (i.e., evaluating each other's real-time performance within a group by a ranking system) and goal setting (i.e., having a goal to create a certain amount of ideas) had a positive influence on performance both in terms of quantity and quality. A result found within longitudinal data from Dell's IdeaStorm platform. Chen, Zhang, and Latimer (2014) was used to measure the positive influences of peer feedback (in the form of comments) and sponsor company feedback (in the form of status tags) on the contribution levels and lengths of engagement with the platform. In another ideation experiment, Gressgård et al. (2014) found that systems with high synchronicity (i.e., the possibility of real-time interaction) and parallelism (i.e., the number of dialogues possible) had a positive impact on idea quality, whereas the latter also influenced idea quantity. Furthermore, system variations with respect to anonymity had no impact. This finding is in line with F. Chen et al. (2014), who found that anonymity had no effect on group performance in an idea generation task. In general, one can say that different design elements as an incentive structure have the power to improve idea generation regarding site visits and a number of ideas (Toubia, 2006). Interestingly, however, when rewarding the impact of ideas (as a proxy for quality), quality could not significantly be influenced, which is also in line with the findings from the psychology literature that indicate that external incentives have little to no direct impact on quality performance (Cerasol, Nicklin, & Ford, 2014).

Another aspect of platform or method design in open innovation is the "appreciation by the organizer", which can be given through certain design elements, such as votes or comments, to stand out from the competition. The findings from Leimeister et al. (2009) suggest that participants are particularly incentivized when they receive direct feedback and appreciation

from the crowdsourcing company. As outlined above, there is a consensus that crowdsourcing leads to innovation benefits from both competitive and cooperative processes (Hutter et al., 2011). In this context, Scheiner (2015) emphasizes the heterogeneous nature inherent to incentives. In a crowdsourcing context, in this case an idea contest, he found that monetary rewards seemed to be rather insignificant at motivating participants. However, the creation and design of a joyful milieu in which people can gain positive experiences appear to be particularly important. Therefore, ideation and knowledge management platforms should be organized in a manner that encourages individuals to participate and co-create continuously (Majchrzak & Malhotra, 2013). According, Leimeister et al. (2009) designed their study on the model that the outcome is highly dependent on the activation of a participant through motives and incentives to foster the desired behavior (i.e., number and quality of comments and ideas). The overall concept is that incentive-enhancing design elements should facilitate the interaction. A recent approach to meet these requirements is to provide this experience by using gamification theory, arguing that the use of design elements typical to games e.g., reward points (Majchrzak & Malhotra, 2013), enables behavioral changes by catering to the intrinsic values of the end-users (Seaborn & Fels, 2015). According to Seaborn and Fels (2015, p. 28) “the most commonly stated objective behind using a gamified approach is to encourage behavior change in end-users, whether that behavior change involves increased participation, improved performance, or greater compliance”. This leads to the assumption that game mechanics influence motivation by addressing triggers of motivation (Scheiner, 2015). This thesis, therefore, conceptualizes that gamification elements as incentive supporting components in the sense of the model from Leimeister et al. (2009) will, in the first place, increase participation intensity (quantity) in open innovation tools and methods. Additionally, by increasing the motivational affordance of the context and feedback mechanisms in place, gamification can lead to a higher qualitative

performance in cases in which it speaks to participants' intrinsic need satisfaction. This thesis, therefore, follows the call from Majchrzak and Malhotra (2013), who identified that the topic has not yet been researched in great detail and called for a better understanding of appropriate allocation and aggregation of incentives for competition and cooperation.

Decoupling game elements from their characteristics of external incentives adds another layer to IS systems, which can, as outlined above, be related to the concepts of utilitarian and hedonic IS systems (Bui, Veit, & Webster, 2015) and thus foster the needs for competence, autonomy, and relatedness. Additionally, incorporating recent findings from the psychology literature, Cerasoli, Nicklin, and Ford (2014) found that incentives, despite being external, such as game elements, increase the importance of intrinsic motivation rather than mitigate it.

Gamification is a recent trend term and is used in various applications (see, for example, Nike+, Miles & More and Foursquare). The term gamification was first defined by Deterding et al. (2011) as the "use of game design elements in non-game contexts." A recent systematic survey on the usage of gamification in various disciplines found that an aggregated definition was emerging and defined gamification as "the intentional use of game elements for a gameful experience of non-game tasks and contexts" (Seaborn & Fels, 2015). The underlying assumption is that non-game digital applications, through gameful design, will grow into more engaging and motivating applications (Deterding et al. 2011). For tools and methods within the company boundaries, the approach is called "enterprise gamification" (Werbach & Hunter, 2012). In a company setting, gamification can be seen as a new multidimensional low-powered incentive system that acts across hierarchies and through which company goals can be differentiated.

Gamification can further be distinguished from serious games, which are full games without the purpose to entertain but rather to educate and train subjects or study customers (Abt, 1987). Similar to the abovementioned applications, different aspects of gamification were intentionally implemented in various innovation and knowledge management platforms. Those studies focus on the performance of the overall tool or method (Gray, Parise, & Iyer, 2011) or on single game elements within a tool or method (Jung, Schneider, & Valacich, 2010). Research in information system science, which translates, implements and ingrains gamification holistically for a specific tool or method of innovation or knowledge management, is, however, scarce - despite its potential to increase the efficiency of innovation and knowledge management tools by increasing the participation rate of external and internal stakeholders. Chapter 2, therefore, answers the following research questions:

RQ2: How and why does gamification help to introduce and maintain Cost Engineering ²in companies? Which game mechanism and game elements are most suitable for Cost Engineering methods? What needs to be considered in the framework to implement gamification in an enterprise process?

At a further level of analysis, surveys revealed that users of crowdsourcing and social networks preferred a gamified version that have game points that could be collected (Goh & Lee, 2011; Mekler, Brühlmann, Opwis, & Tuch, 2013). In the broad context of social networks, studies

² Most knowledge is task-specific and requires a proper structure based on internal processes and external influences with a dynamic interaction (Yang 2010; Zangiski et al. 2013). Cost Engineering is highly dependent on vital information sharing and data availability (Rajkumar and Jose 2005), and employee experience and knowledge are key, particularly for projects with high uncertainty (Lauven et al. 2010; Xu et al. 2012). Thus, Cost Engineering is closely related to knowledge as well as competence and serves as an ideal context to study knowledge management. The results of a study in this field can therefore be directly translated to knowledge management platforms in general.

showed that points have a similar positive effect with respect to user engagement and participation as financial rewards or the possibility to win prizes (Bista, Nepal, & Paris, 2012; Eickhoff, Harris, de Vries, & Srinivasan, 2012; Liu, Alexandrova, & Nakajima, 2011). However, in terms of open innovation tools and knowledge management platforms, the effects, in particular of the motivational effects of gamification, were thus far only partially investigated. Scheiner (2015) evaluated game mechanics in a gamified idea competition using an independent panel study. As indicated above, his findings point toward the existence of differences regarding the motivational effects of different game elements. Game mechanics with references to social aspects, such as social game points (or votes), in particular, are more highly appreciated by participants (see also Füller, 2006; Füller, 2010). However, evaluation of the effects of different game elements in comparison and in the context of open innovation or knowledge management platforms lacks empirical insights. Scheiner (2015), therefore, suggested that further studies should investigate the extent to which game mechanics determine the overall motivation of participants.

Against this background, Chapter 3 investigates the effect of game elements on intrinsic motivation and whether game elements act like the external incentives that were previously found to positively moderate the relationship between intrinsic motivation and performance (quality) (Cerasoli, Nicklin, & Ford, 2014). Using an experimental setup, Chapter 3 answers the following research question:

RQ3: Does gamification increase the motivational affordance and hence the number of ideas and comments and do they differ in the quality?

1.2 Methodology

Due to the differences in the research questions, this thesis utilizes quantitative and qualitative research methods to adequately answer the research questions.

The first study (Chapter 2) and *Supplement 1* (see Appendix-B-1) address the understanding of the role of users and other stakeholders in green innovation processes of established companies and a cooperative. Due to their explorative nature, the first study and Supplement 1 are based on a qualitative case study analysis (Eisenhardt, 1989; Yin, 2008). Selection of the cases followed the principle that they had to demonstrate a large extent of external stakeholder integration in different phases of the innovation and development process. The research relied on two main sources of empirical data. First, semi-structured interviews were conducted with company representatives of all relevant departments, such as innovation management, product management, and market research, as well as with integrated users and third parties that had been involved in the development process. An interview guide with open-ended questions allowed the interviewees to elaborate their stories on the role of an external stakeholder in the development process. The overall selection of interviewees aimed to provide the researchers with a detailed understanding of the innovation process and related methods to enrich the process with different stakeholders. Second, for each case, an extensive document analysis enriched the dataset. The documents included those that were publicly available, such as annual reports, press releases, media articles and other publications, as well as in-house documents, such as project reports and presentations. The document analysis helped to better understand the organization and innovation process, as well as the context in which the interviewees worked, which was a vital component to corroborate the understandings gained via the interviews (Bowen, 2009). Interviews with three independent sources per case and the

consultation of secondary sources allowed for data triangulation to enhance the validity and reliability of each case.

Data analysis was a two-step process (Eisenhardt, 1989). First, each case was analyzed in isolation, and individual case reports were written to structure the data and understand the development process of each company. The second step included coding all of the interviews with software for qualitative data analysis (NVivo). Codes referred to the different methods applied by the companies to involve and collaborate with stakeholders as well as the underlying rationale, motivation, and strategy. The coding of the different phases of the innovation process and methods used to integrate users helped to structure the vast amount of data. Codes focusing on the motivation and benefits of user integration as well as its impact on product and service development only emerged during the coding process and guided the presentation of the findings.

The second research question addresses the development of a knowledge management tool that utilizes gamification as a novel incentive system to increase participation as well as idea and knowledge sharing. Chapter 3, as well as *Supplement 2* (see Appendix-B-2), answers that question. To this end, in collaboration with industry experts, Cost Engineering was identified as a focus area in which a novel knowledge management tool could have a significant impact on performance. A focus derived from collaboration with an industry partner guaranteed a sufficient interest in the topic to draw on the input from industry partners throughout the study. Chapter 2 aims to develop a framework, not to test it, and utilized a qualitative research approach based on the components of case study research (Eisenhardt & Graebner, 2007) and Design Science Research (Peppers, Tuunanen, Rothenberger, & Chatterjee, 2007). Chapter 2 is based on two rounds of interviews with 20 experts from 8 companies from the German and

Austrian high-tech industry as well as two rounds of workshops. The first round provided inputs for the framework and development of gamification elements in the given context. The second round validated specific functionalities and dynamics of the game elements to finalize the system framework. Based on the input from Chapter 3, *Supplement 2* developed a special functionality for ideation challenges on the platform, which are related to new innovation projects, a need that was discovered while conducting the interviews. To validate the design and final specifications of the gamification elements to be implemented as a way of increasing the motivation to share knowledge, an online-based conjoint analysis was performed. With 75 employees from two companies, the study gained insights into how certain platform elements work to increase the willingness to share knowledge based on the scale from Bock, Zmud, Kim, and Lee (2005).

The last section, Chapter 4 builds on the platform previously developed and examines how common game elements – in this case points for answering and commenting, social points in the form of points once other participants value a post, and virtual rewards for answering and commenting – influence the output (quantity and quality) of idea contests. Additionally, the effect of game elements on intrinsic motivation are investigated as was whether game elements act similarly as external incentives that were previously found to positively moderate the relationship between intrinsic motivation and performance (quality) (Cerasoli, Nicklin, & Ford, 2014). To test the proposed hypotheses, a randomized controlled online field experiment was performed, specifically, an idea contest that lasted for five days, in cooperation with Audi AG on the topic of Peer-to-Peer Carsharing. Participants were able to contribute by submitting posts and comments on five platform conditions. The field experiment ran for 5 days and was carried out within a bachelors-level course in strategic management, offering (as an initial incentive)

every participant a bonus for the final grade if they voluntarily decided to participate. Additionally, 2x2 Audi event tickets among all participants were raffled. To ensure task-non-contingency (Deci et al., 1999), the incentives initially offered were not linked to participation in the idea contest but linked to solely register for the contest and complete the survey plus an additional homework assignment given to fulfill the university's regulations. Students who showed their willingness to participate were randomized and allocated to the respective treatments. After the contest, participants completed a post-experimental survey. With this field experimental set-up, the study was able to determine the effects gamification has on intrinsic motivation and performance (quality and quantity) among participants in idea contests.

1.3 Structure of the Thesis

Table 1 provides an overview of the three main articles (Chapter 2-4) of this dissertation and indicates how the two supplementary articles (Appendix-B) enrich the three chapters. By qualitatively analyzing the open product and service development process in incumbent firms and one cooperative, Chapter 2 and *Supplement 1* (see Appendix-B-1) outline the different approaches utilized to involve stakeholders in the overall innovation and development process. These studies outline the companies' rational and success drivers to continuously integrate different stakeholders and utterly open up the development process during the entire development process of their new products and services. In doing so, these two studies advance the previous research on open innovation methods, which mainly focused on particular methods or stakeholders and did not investigate the overall development process and different methods used in different stages. The two studies, therefore, contribute to existing knowledge by analyzing the effect of user integration at various stages of the innovation process and its impact on the development process. Additionally, the rationale as to why firms integrated

external stakeholders at different development stages, as well as the firms' benefits, is highlighted.

Table 1: Overview of the main chapter of this dissertation

	<p align="center">Chapter 2 Process level: <i>Rationale, methods and driver for stakeholder integration</i></p>	<p align="center">Chapter 3 Method level: <i>Software framework for idea and knowledge management</i></p>	<p align="center">Chapter 4 Individual level <i>Motivation and output of participants in an idea contest</i></p>
Purpose	<p>Identify the role of users in the development of novel green products and services in incumbent firms</p> <p>Analyze the methods employed by the companies to integrate users into different innovation phases</p> <p>Understand the underlying company's motivations as well as the benefits associated with the approach</p>	<p>Develop a novel knowledge management approach for Cost Engineering</p> <p>Understand the obstacles for employing gamification in a German company</p> <p>Design a system framework to employ gamification for idea and knowledge management in Cost Engineering</p>	<p>Understanding how gamification influences intrinsic motivation in the context of idea contests</p> <p>Analyzing the effects on the qualitative and quantitative output of participants when employing gamification in idea contests</p>
Design	<p>In-depth case study analysis of three cases from incumbent companies</p>	<p>Qualitative-empirical expert interviews and design science research approach</p>	<p>Quantitative-empirical field study design (N=486)</p>
Theory	<p>Open innovation, green innovation</p>	<p>Knowledge management, gamification</p>	<p>Intrinsic motivation, idea contest, gamification</p>
Supplements	<p>Appendix-B-1 supplements the findings as the study addresses similar questions for a housing cooperative</p>	<p>Appendix-B-2 supplements both chapters as it builds on the work of Chapter 3 by utilizing a conjoint analysis regarding the intention to share knowledge on the platform. The results were used to characterize the game elements utilized in the field study in Chapter 4.</p>	

Chapter 3 moves to the next unit of analysis and develops a novel tool to integrate external stakeholders in the knowledge management process outside of the respective department within the boundaries of a firm. This chapter highlights the potential of gamification as a non-monetary motivational stimulus in the knowledge management process in the context of a Cost Engineering. A system framework that is developed to implement Cost Engineering methods through a social network and knowledge management tool. In particular, the study highlights how a quest (i.e., a gamification element) can increase the intention to share knowledge. Building on the findings from this study, *Supplement 2* (see Appendix-B-2) builds a bridge to the last chapter by utilizing a conjoint analysis among employees to define specific peculiarities of game elements within a company set to further increase the intention to share knowledge.

Seamlessly, Chapter 4 investigates, at an individual level, the impact of different game elements on the participation intensity and quality. Using a field experiment, this Chapter sheds light on how gamification influences a user's intrinsic motivation as well as the quantitative and qualitative performances in an idea contest.

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2 End-users as co-developers for novel green products and services - an exploratory case study analysis of the innovation process in incumbent firms

Journal Publication:

Zimmerling, E., Purтик, H., & Welpе, I. M. (2016). End-users as co-developers for novel green products and services—an exploratory case study analysis of the innovation process in incumbent firms. *Journal of Cleaner Production*, 162, S51-S58. doi: 10.1016/j.jclepro.2016.05.160.

Keywords: Green innovation; User-centered development; Field trials; Co-developer

Abstract

Studies focusing on green innovation have shown that companies can gain a competitive advantage by collaborating with multiple stakeholders in the innovation process. Since novel green innovations are often systemic in nature and require changes in consumption behavior, end-user integration along the innovation process may be particularly relevant for the success of such products and services. The main aim of this paper is therefore to add to our understanding of the role of users in the green innovation processes of incumbent firms. The comparative case study in the context of e-mobility and smart housing outlines the methods used by three European incumbent firms to integrate users at different stages of the innovation process as well as their motivation and benefit. The findings show that users were basically co-developing the novel green product or service from the beginning. In the cases under review, early and constant end-user integration served as a risk management tool, since it uncovered behavioral changes induced by the innovations among potential future users. This helped companies to overcome risk aversion towards the development of genuinely new green products and services and to bring these to the market. Field trials similar to living labs proved to be of particular importance for gaining insight into the everyday lifestyle of users. Thereby, the paper stresses an approach to green innovation in incumbent firms, which has not been given much attention in literature before. In addition, our cases show that the benefits of user integration can not only be high for rather incremental green innovations but also for genuinely new innovation in highly technological industries. User integration helped the case companies to uncover behavioral changes in the consumption phase and strengthening market acceptance. We conclude that firms may profit from an extensive user input throughout all phases of the innovation process to develop novel green products and services, and call for further research on how firms can overcome entry barriers to user integration in green product development in the future.

3 A system framework for gamified Cost Engineering

Journal Publication:

Zimmerling, E., Höflinger, P. J., Sandner, P. G., & Welp, I. M. (2016). A system framework for gamified Cost Engineering. *Information Systems Frontiers*, 18, 1063-1084. doi.

10.1007/s10796-016-9624-3

Keywords: System framework. Cost Engineering, Gamification. Motivation. IT platform

Abstract

This study develops a system framework and an enterprise IT solution for integrating gamification elements to efficiently implement and continuously perform Cost Engineering. Cost Engineering is a systematic approach to manage knowledge and competencies regarding costs reduction measures throughout the life cycle of products and is technology, resource and time intensive. Gamification as a non-monetary multidimensional incentive system holds great potential to implement and establish Cost Engineering in a novel and less resource demanding manner and stipulate knowledge sharing and dissemination. Building on a review of the relevant literature we conducted 20 interviews with experts from eight companies of the German and Austrian high-tech manufacturing industry to examine the system requirements from an organizational perspective. Analyzing the interviews, we found that companies need a flexible platform where the game elements help to align management objectives with concrete tasks, meet legislative regulations and have different evaluation methods. Our proposed system framework combines the organizational and IT requirements with gamification elements to efficiently steer Cost Engineering methods and best manage knowledge and competencies.

4 Exploring the Influence of Common Game Elements on Ideation Output and Motivation

Current Status:

Zimmerling, E., Höllig, C. E., Sandner, P. G., & Welppe, I. M. (2018). Exploring the influence of common game elements on ideation output and motivation. *Journal of Business Research*, 94, 302-312. doi: <https://doi.org/10.1016/j.jbusres.2018.02.030>

Keywords: Open innovation, Online idea contests, Gamification, Intrinsic motivation, Idea quality

Abstract

Despite the widespread and increased usage of idea contests and, within these, gamification elements, to date, there is little data on the effects of utilizing gamification elements to increase performance and motivation in online idea contests. We therefore investigate the incentive effect of gamification elements on the output of online idea contests in a field experiment with 446 individuals across five treatment groups. Our results show that game elements can increase quantitative performance but not the motivation of participants or the quality of ideas. Additionally, we do not report a crowding out effect. We therefore conclude that gamification is more suitable to increasing the performance of effortless tasks such as commenting but should not be the main driver for increased idea quantity and quality. The results are in line with recent meta-analytical findings in the psychology literature suggesting that external incentives positively influence quantity but have less influence on the quality of performance.

5 Conclusion³

This thesis advances the literature and generates new knowledge regarding recent trends in innovation and knowledge management. In a narrower sense, the articles in this thesis contribute to the literature on open innovation. The goal of this thesis was to generate knowledge that supports innovation managers, especially in incumbent companies, in their efforts to integrate external (i.e., as in non-R&D personnel) stakeholders into the innovation process. The articles cover three different units of analysis – (1) the innovation process, (2) a specific innovation and knowledge management tool, and (3) the individual participants and their motivation to engage in innovation and knowledge management. These three articles, as well as the additional articles in the appendix, provide a well-rounded overview of relevant topics for firms that seek to integrate external stakeholders into their innovation efforts. The first article sheds light on the rational and methods of incumbents that successfully integrated external stakeholder along the entire innovation and product development process. The second article addresses the development of a knowledge management platform employing gamification and highlights the system requirements to consider when to implement such a platform into a company context. Analyzing the phenomenon of gamification further, the last article analyzes the effect of gamification, a non-monetary incentive, on the motivation and output of participants on an ideation platform. In the following sections, I summarize the main

³ This chapter is partly based on Zimmerling, Purтик, & Welpе (2016), Zimmerling, Höflinger, Sandner, & Welpе (2016), Zimmerling, Höllig, Sandner, & Welpе (2018) ;see Appendix for full references

Conclusion

findings as well as the main contributions of the studies comprising this thesis. Additionally, I provide an overview of the general implications and possible avenues for future research.

5.1 Summary of findings

Chapter 2 investigates stakeholder integration and, in particular, user integration into the innovation process of incumbent companies, focusing on green innovations as the context. Utilizing an in-depth case study analysis of the innovation process of three incumbent firms in the automotive and energy sector, this chapter highlights how those companies profited from stakeholder integration along the entire innovation process. It sheds light on the rationale of integrating stakeholders – *the why* – and the approach and organizational setting to integrate stakeholders into the respective innovation process – *the how*.

With respect to *the why*, this chapter showcases, that companies change their rationale for integrating external stakeholders throughout the innovation process so that they best benefit from doing so. First, they integrate stakeholders or users mostly to validate internal ideas and explore future needs. A rationale that changes as the process moves from an ideation to a development and prototyping stage in which user collaboration mainly served the refinement of product/service under development, thereby increasing the chances of market success. Users as stakeholders are therefore utilized in a dynamic manner according to the stage of the innovation process and this thesis characterizes them as valuable co-developers. This chapter further showcases that the feedback and ideas provided by external stakeholders were crucial for the innovation processes. This finding contrasts with the literature, which found a rather limited benefit or no benefit at all of user integration in green innovation (De Marchi, 2012).

With respect to *the how* striking in all three cases is that the companies utilized field trials. An approach with great similarities can be found at LivingLabs, which gave users the chance to actively co-develop the product through their feedback and suggestions but also the opportunity to learn about the product, exposing ways of using it in everyday life and

Conclusion

changing behavioral patterns. Thus, in contrast to traditional pilot testing, the field trials under review also served to investigate (changing) user behavior in relation to a novel green product or service. In doing so, companies were able to gain insight into changes induced by their novel sustainable products. Those insights are particularly crucial for the development of the overall business model that is necessary for a successful commercialization. Furthermore, companies' set ups involved innovation teams acting independently with a strong cross-functional character. Those teams enjoyed a strong backing by top management and had access to sufficient funding. There are indications that these innovation teams represent a new form of innovation advocates that share similarities with traditional R&D teams and intrapreneurs at the same time.

Additionally, the findings suggest that all three companies experienced a learning process during user integration. The findings indicate that by experiencing the innovative potential of users, companies broke down prejudices and triggered further user integration.

Chapter 3 addresses *the how* level of external stakeholder integration and the development of a novel approach –a system framework for knowledge management in an internal company setting. The chapter is set in the context of knowledge management for Cost Engineering and aimed to find a solution and approach tailored to SMEs to implement and perform various Cost Engineering methods in a flexible and resource-friendly manner. In particular, with the use of gamification to motivate participants on the platform, the chapter showcases how Gamified Cost Engineering has the potential to revolutionize companies by building on non-monetary motivational stimuli and thereby optimizing the Cost Engineering processes across teams and divisions. One important finding is that the gamification element of quests was the preferred element to translate different Cost Engineering methods into a knowledge management

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platform. The system framework presented in the chapter builds on a social network with four pillars (= concepts), namely a task, evaluation, game, and organizational concept. Through these concepts, the peculiarities of the quests for Cost Engineering are defined. Those quests are collected in game environments for specific Cost Engineering methods or can be sorted by-products. The Cost Engineer can then invite specific employees according to their competencies and draw upon their knowledge, which is then stored and searchable by topic and cost engineering method. Participants are additionally motivated to participate through a point and badge system. The proposed game concept based on quests, points, and topic-specific badges aims to increase the intention to share knowledge within the IT enterprise solution. The solution provides a framework that makes the knowledge management and management of Cost Engineering more flexible and less resource intense.

The last chapter - Chapter 3 – again ties in with the previous chapters and focuses on the last remaining unit of analysis in the process of integrating external stakeholders into the innovation process – the individual participant. This chapter utilizes a field experiment to systematically test whether game elements affect intrinsic motivation, need satisfaction, participation intensity and idea quality in an online idea contest platform. The chapter's findings indicate that common game elements used in practice as well as in the previous chapter are perceived by participants as extrinsic rewards and therefore may not provide a compelling experience that generates intrinsic motivation and need satisfaction. As extrinsic rewards the employed game elements were able to influence the participants' quantitative performance but did not result in increased intrinsic motivation and thus lacked the associated positive effects, namely, enhancing the extent and quality of effort invested in a specified task (Cerasoli, Nicklin, & Ford, 2014).

5.2 Implications for theory and practice

With the rise of digitization and with it a changing landscape for product and service offerings (Nambisan, Lyytinen, Majchrzak, & Song, 2017) the way companies innovate has changed dramatically in recent years (Saldanha, Mithas, & Krishnan, 2017). In particular, companies continue to open up and integrate external stakeholders (external as in non-R&D personnel) into the innovation and new product development process (Chesbrough, 2003; Enkel, Gassmann, & Chesbrough, 2009). This thesis, therefore, contributes to the understanding of this paradigm shift on three levels.

On the first level, the innovation process, this thesis shows that a close collaboration with external stakeholders from the very beginning of the development process can help companies leave their more traditional innovation processes. An early integration may also serve companies looking to overcome risk aversion towards very novel innovations. Integrating stakeholders throughout the entire innovation process can function as risk management by minimizing the chances of market failure of green products and strengthening a company's willingness to invest in green product/service development. Additionally, the findings indicate that by experiencing the innovative potential of users, companies broke down prejudices and triggered further user integration. A similar process NASA experienced when opening up to the crowd, not just during one project but the organization itself (Gustetic, Crusan, Rader, & Ortega, 2015). This is a finding that corresponds to the literature on the "not invented here" syndrome, which describes a company's initial rejection of external input and ideas due to the perception that the company itself is the most qualified actor in the particular area of the innovation (Katz & Allen, 1982).

Conclusion

Furthermore, with respect to the innovation process and outcome, this thesis can show a positive impact on the development of novel green products and services. This finding adds to the literature by contrasting the literature which attests user integration in green innovation in highly technological industries provides a rather limited benefit or no benefit at all (De Marchi, 2012). In particular, the integration of users through field trials and the importance of those is a result that has not been highlighted in the literature before and therefore adds valuable insight into that method for practitioners and researchers alike. Chapter 2, therefore, adds to the understanding of the firms' rationale to integrate users in different phases of the innovation process as well as the firms' benefits from user integration by employing different methods in different stages of the innovation process.

On the level of innovation and knowledge management methods, tools and practices, this thesis adds to the understanding of how to employ gamification in an online based knowledge management tool to share and document knowledge within a company. The proposed system framework gives companies an approach to preserve knowledge for the organization by setting the right non-monetary incentives as outlined by North (2005). In addition, the evolution of gamification is still ongoing, and many companies will tap into this trend, trying to utilize its potential as a non-monetary incentive system in the future (Nacke & Deterding, 2017). In that sense, this thesis adds to the increasing literature (e.g. Witt, 2017) on organizational and managerial aspects, which practitioners have to consider when implementing gamification in a company setting in general. In particular, the results in *Chapter 3* can help to reduce complexity for employees and managers through the employment of gamification methods in knowledge management for Cost Engineering. By following the design of the system framework this thesis provides a solution to implement Cost Engineering as a knowledge management discipline

more flexible and less resource intense in the organization. By doing so, the approach counteracts the general issue that valuable information, especially estimations, from cost experts might be lost when employees leave their company (Alroomi et al. 2012). Furthermore, the employment of the proposed artifacts of game environments and quest-based data and information gathering is not limited to knowledge management in Cost Engineering. They serve as a foundation that can be tailored to various company-specific peculiarities to improve task efficiency, especially for cross-functional teams.

In addition to the practical implications above, the findings of Chapter 4 shed further light on the employment of gamification and can, therefore, help organizers to establish idea contest platforms that appropriately and successfully foster the motivational needs of users. The chapter contributes to the literature by highlighting the potential of game elements on online idea and knowledge management platforms and provides evidence that gamification can lead to increased quantitative performance of knowledge-related tasks. However, game elements in this context should be treated with caution, particularly to avoid mitigating the utilitarian aspects of applications (van der Heijden, 2004). The chapter adds to theory and practice as it highlights that simply employing individual game elements – as is currently common practice - might not be sufficient to create a compelling gameful experience in idea contests and knowledge management systems. The findings underline the context specificity of gamification, as contrasting results were found in other contexts, such as sports (e.g. Hamari, 2017) or education (e.g. Sailer, Hense, Mayr, & Mandl, 2017). Generally, to create an intrinsic motivation environment one must consider systematically altering the activity towards a more game-like experience as proposed by Deterding, Björk, Nacke, Dixon, and Lawley (2013) or through the game environments proposed in Chapter 3.

Conclusion

This thesis further adds to the literature as it could demonstrate how the implementation of a simple leaderboard or a badge system providing feedback to users in the context of an online idea contest platform can significantly enhance the contribution of participants. Additionally, game elements do not show negative effects on autonomy or motivation (i.e., have shown no effects on motivation) and can, therefore, be employed without the fear of a crowding-out effect. Based on the presented results, this chapter sees no harm in the short-term usage of game elements in idea contest platforms. For different periods (shorter or longer), managers should, however, treat the implementation of game elements in that context with caution as it remains uncertain whether different periods result in another outcome of the effects.

5.3 Directions for future research

As Chapter 2 solely included cases with a very high degree of stakeholder integration and in particular user integration, future research could compare the results with varying degrees of stakeholder or user integration. Chapter 2 also focuses its investigation on the company perspective. In a similar sense, it would be interesting to understand users better in terms of the impact on their life after being part of a company's innovation process. To make the process of integration more efficient, another aspect that needs further investigation on the user side is to better understand the participants' motives and motivation, especially for methods such as field trials. Here, past research heavily focused on crowdsourcing platforms (Wendelken et al., 2013), but it would be interesting to investigate the differences between methods of user integration.

From a company perspective, the long-term market success of innovative products and services, which relied on user integration, still needs further investigation. Field experiments

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could show first that the sheer indication that users were part of the development process could lead to increased sales numbers (Nishikawa, Hidehiko, Schreier, Fuchs, & Ogawa, 2017).

With respect to the innovation and knowledge management methods and tools, further research is needed to better understand cultural differences when employing the proposed system framework, especially cultural differences in the acceptance of gamification in a workplace setting such as research for traditional incentive systems. In particular, within company boundaries, more research is necessary to better employ gamification for knowledge management in a flexible and context-specific manner. Similar to research focusing on the effects of status incentives (Besley & Ghatak 2008; Gubler et al., 2013), additionally, research could focus on the spillover effects of gamification on the motivation and performance of employees in general. In addition, future research should investigate with an economic perspective how employing game elements ties in with the existing mix of monetary and non-monetary incentives at the workplace.

With respect to gamification to motivate participation in online idea and knowledge management system, further research should design a system that makes the target behavior—contributing a response to the challenge—as simple as possible in all aspects. For example, with artificial intelligence and voice recognition research should develop a system that intelligently guides participants to post short answers to questions that build upon each other or which gives intelligent guidance while posting an idea via keyboard or voice recording.

In addition, more research is necessary to investigate the long-term effects of employing gamification on company-wide knowledge management platforms. Thus, the effects of facilitating game elements in idea contests over longer or shorter periods should be examined in the future. In particular, it would be an interesting avenue for future research to investigate

timeframes to determine how long it takes for game elements to become internalized and salient as an external reward structure in the midterm and how long this effect lasts in the long term. Similarly, it would be beneficial to study how d continuous gamification schemes compare to those of one-off rewards with respect to motivating participants and increase the efficiency of innovation and knowledge management methods and tools.

5.4 Concluding remarks

In conclusion, this thesis demonstrates, using different empirical approaches and units of analysis, that the field of innovation and knowledge management is highly dynamic and ever-changing. With the recent advent of artificial intelligence, voice recognition, and virtual reality, in particular, the way in which we innovate and manage knowledge will further change dramatically. Companies therefore not only need to innovate within the ecosystem of these technologies but also to adapt the way that they innovate, especially in collaboration with external stakeholders. The results give managers an overview to start their innovation endeavors at a process, method, and individual level. This thesis further highlights multiple directions for future research and intends to spur the discussion with respect to finding the right mix of methods for each innovation process as well as suitable incentive structures and systems to tap into the innovative potential of the companies in the ecosystem.

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