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Customer Integration 4.0: Leveraging Customer Knowledge in Innovation Processes by Using Digital Technologies

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Abstract

Motivation: Companies increasingly embrace the open innovation paradigm to develop products and services that delight customers and meet customers' needs. Research has brought forward numerous methods and tools to help companies in gathering and leveraging customers' knowledge and creative ideas in innovation processes. However, despite the ongoing research on customer integration, many customer integration initiatives still fail to deliver the desired benefits, which are an improved customer relationship, cost-to-market, time-to-market, or a better fit of products to customers' needs. We identify the following three major challenges of successful customer integration: 1) selecting the customer integration method(s) and digital technologies most appropriate to generate the required or desired customer input within time, budget, and other resource constraints; 2) many customer integration methods fail to attract customer participation and engagement. There is only little guidance for companies on how to design IT-based customer integration methods that keep customers attracted and engaged during the process of providing their input; 3) managing customer knowledge and turning it into innovation. Administrative information systems to support knowledge management in customer integration are scarce. This doctoral thesis intends to address these issues by building up a theoretically grounded understanding of how digital technologies and information systems can be used in innovation processes to gather and manage customer knowledge more effectively and efficiently.

Research Design: We take a mixed-methods approach to address the above mentioned challenges and the research questions that follow from them. In a mixed-methods approach, quantitative and qualitative methods are combined in a single study or across a series of closely related research to generate rich insights into a research topic. In this doctoral thesis, literature reviews, design science research, experiments, and focus groups were conducted to answer the three research questions that guided this research endeavor.

Results: As a result of this doctoral thesis, we found that practitioners frequently apply Microsoft office tools like PowerPoint, SharePoint, and Excel, or tweaked solutions for special purposes to manage knowledge in their innovation processes. This knowledge management approach is rather immature and hinders formal documentation, interoperability, knowledge sharing, and reuse across departments and companies in innovation networks. In this thesis, we develop and evaluate digital artifacts (a decision support system, an ontology, and a customer knowledge management system) to support knowledge management as well as the selection of appropriate IT-based customer integration methods. Further, this thesis provides guidelines for the design of digital customer integration methods that can generate positive user experience for customers that participate in customer integration initiatives.

Contribution: This thesis contributes to theory and practice. The contributions to theory include decision criteria for the selection of customer integration methods as well as a structured overview and evaluation of customer integration methods with regards to the identified decision criteria. Additionally, we draw on previous marketing and human-computer interaction research to identify customers' experience as an important determinant

of the success of the customer integration initiative. However, the notion of experience has rarely been applied in the context of customer integration. This thesis provides an overview of multi-disciplinary literature on human experience and its relevance for customer integration research. By applying a user experience perspective to customer integration research, we advance the general understanding of how to design IT-based customer integration methods that positively influence customers' emotions, perceptions, and behavioral intentions.

The contributions to practice include a decision support system, which helps practitioners in selecting suitable customer integration methods. Further, we provide guidelines for practitioners on how to design for positive customer integration experience, resulting in task enjoyment and a high quality and quantity of customer contributions to the innovation process. As for managing customer knowledge and turning it into innovation, we contribute an ontology and a customer knowledge management system.

Limitations: The publications presented within this doctoral thesis are subject to several limitations which follow from the selected research methods. The provided guidelines for the design of customer integration methods creating a positive customer integration experience have been derived by reviewing existing multi-disciplinary literature. These research findings are limited by the scope of our literature review (i.e., selected databases, journals, keywords, inclusion/ exclusion criteria). For the design, implementation, and evaluation of the proposed prototypes (decision support system, knowledge management system), we followed the design science research paradigm. We conducted interviews and surveys with a small sample of experts to identify requirements and evaluate the developed prototypes, which limits generalizability and transferability of our research findings.

Future Research: Given the results and limitations of this doctoral thesis, there are several possibilities for future research. Additional empirical research is required to test the proposed research framework on influencing factors and implications of customer integration experience, and their interrelatedness. We particularly looked into toolkits for user innovation and design as a case study to derive design guidelines for positive customer integration experience. Our analysis of toolkit interface design can be replicated in the field, with other products, and other sample populations. Concerning the selection of customer integration methods and knowledge management in customer integration, we provide prototypes that can be improved and evaluated with larger samples and longitudinal applications across different companies and industries. For instance, the knowledge base of the decision support system can be extended by success factors for customer integration identified by a case survey of published customer integration case studies.

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List of Abbreviations

CAIS	Communications of the Association for Information Systems
CIM	Customer Integration Method
CIMS	Customer Input Management System
CRM	Customer Relationship Management
DSS	Decision Support Systems
ECIS	European Conference on Information Systems
e.g.	for example
HICSS	Hawaii International Conference on Systems Sciences
ICED	International Conference on Engineering Design
i.e.	that is
IS	Information Systems
IT	Information Technology
M	Method
MKWI	Multikonferenz Wirtschaftsinformatik
No	Number
O	Outcome
P	Publication
POMS	Production and Operations Management Society
RQ	Research Question
T	Title
TAM	Technology Acceptance Model
UML	Unified Modeling Language
WI	Wirtschaftsinformatik
WKWI	Wissenschaftliche Kommission für Wirtschaftsinformatik

Part A: Introduction to the Doctoral Thesis and the Embedded Publications

1 Introduction

This doctoral thesis aims to provide an in-depth understanding of how Information Technology (IT) can enable companies to successfully integrate customers into innovation processes. By proposing a decision support system, a customer knowledge management system, and design guidelines, this thesis fills various gaps in customer integration research (see chapter 1.2). The following chapter motivates this doctoral thesis with a detailed description of problems in practice and research gaps in literature.

1.1 Motivation

Innovation is key to organizational growth and competitiveness (Nonaka 1994). Traditionally, innovation has emerged from in-house research and development. Due to increasing competitive and innovation pressures, companies increasingly rethink this closed innovation approach to manage their innovation activities and open up their innovation processes for external stakeholders such as customers (Riedl et al. 2010). The open innovation approach was coined by Chesbrough (2006b), who defined it as *"a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology"* (Chesbrough 2006b, 1).

In the open innovation paradigm, customers are considered as a key resource for innovation (Chesbrough 2006a; Chesbrough/Crowther 2006; von Hippel 1988, 2005). Through consuming and using products and services, customers possess great product and service related knowledge. This customer knowledge is required iteratively at many stages in the innovation process (Dahan/Hauser 2002). Customers can provide information on their needs and preferences, can create and evaluate ideas for new products and services, and provide feedback on product concepts and prototypes (Enkel et al. 2005a). There is a variety of customer integration methods including surveys, focus groups, lead user workshops, or prototype testing that provide means for companies to gather customer knowledge (Dahan/Hauser 2002; Zogaj/Bretschneider 2012).

The process of integrating customers into the innovation process can be separated in three distinct steps (Fähling et al. 2011): 1) Selection of (non IT or IT-based) customer integration method(s); 2) design and implementation of selected (non IT or IT-based) customer integration method(s); 3) knowledge management in terms of documenting and analyzing the obtained customer input, and lessons learned from conducting customer integration initiatives.

In the digital era, companies strive to manage their business processes more efficiently by harnessing emerging technologies (Müller et al. 2016; Fichman et al. 2014). In this context, the development of innovation networks with external stakeholders and the use of digital technologies are becoming more and more important in company's (open) innovation processes (Müller et al. 2016; Fichman et al. 2014). Though the use of internet and software applications, IT-based customer integration methods make customer integration faster and more affordable (Dahan/Hauser 2002; Leimeister et al. 2009). Technological advances support the customer integration process by providing new possibilities for companies to

integrate customers and to manage customer knowledge. For instance, idea competitions invite customers from all over the world or a geographically distributed selected sample of customers to virtually create and submit ideas on a certain topic of interest to the company (Ebner et al. 2009; Leimeister et al. 2009). Another example for an IT-based customer integration method are toolkits for user innovation and design. Toolkits are standalone software or web applications that allow customers to virtually design and explore products (von Hippel/Katz 2002). Leading companies including Dell, IKEA, Nike, and Adidas provide toolkits on their websites that enable customers to design their individual laptops, kitchens, and running shoes (Franke/Hader 2014; Franke et al. 2008). Virtual and augmented reality technologies allow customers to virtually experience products in virtual worlds (Matzler et al. 2011), and game elements help companies in attracting customers and keeping them engaged during the co-creation activity (Füller et al. 2014b; Hamari 2013; Hamari/Eranti 2011; Hamari et al. 2014).

Whether companies use face-to-face or IT-based methods, customer integration is of importance for companies to develop new products and services that are much closer to customers' needs than standard products (Cui et al. 2011; Franke/Schreier 2010), resulting in higher levels of customer satisfaction and user acceptance (Butler 2003; Merisalo-Rantanen et al. 2009). Further, previous research found that customer integration can help companies to build stronger customer relationships (Enkel et al. 2005a). Literature also revealed that customer integration has a positive effect on technical quality and innovation speed, and thereby can positively influence competitive superiority and sales performance of a company (Carbonell et al. 2009).

Despite the ongoing research on customer integration and the emergence of new technologies (e.g., Internet, mobile, social media, data analytics, virtual and augmented reality) that can be applied to gather and analyze customer knowledge more effectively and interactively, many customer integration initiatives fail to bring the potential benefits of customer integration. For instance, they fail to deliver the required customer input (Enkel et al. 2005b), to attract ongoing and sufficient customer participation and customer engagement (Ebner et al. 2009; Füller et al. 2011; Kohler et al. 2011; Kohler et al. 2010), and to generate an atmosphere of mutual trust and transparency necessary for customers to reveal and share their knowledge (Gallivan/Keil 2003; Westergren 2010). Further, companies struggle in filtering relevant customer input from the huge amount of customer input they receive through online customer integration initiatives (Riedl et al. 2010). Table 1 provides an overview of some customer integration initiatives that failed. Additionally, Table 1 shows the reasons for their failure and the consequences.

Case	Customer integration method(s)	Reason(s) for failure and consequences	Source
Swiss Engineering	Survey of international customers	The company selected a survey to integrate international customers. This customer integration method failed to generate the needed customer input but confirmed obvious market trends. Reasons for the failure are the integration of customers at a very late stage in the innovation process, and the selection of a survey. Surveys are not appropriate tools to obtain customer ideas in respect of discontinuous innovation.	(Enkel et al. 2005b)
CompuSys, CONFIG project	User design group meetings, online bug reporting system, annual telephone surveys	In an ineffective communication between users and developers, the users withheld negative feedback. The company failed to create an atmosphere where the users felt free to share their concerns regardless of how critical they might be. From previous collaborations between the users and the company, the users had the feeling that such negative feedback will be ignored.	(Gallivan/ Keil 2003)
SAP Idea Competition	Idea competition	The SAP idea competition failed to attract sufficient and ongoing customer participation. 68 per cent of registered participants did not submit any idea. The online customer integration initiative struggled in identifying and activating promising community members.	(Ebner et al. 2009)
PowerDrive	Field-test and customer feedback	The collaboration between the company and three business customers lacked trust, transparency, and mutual understanding of value creation resulting in unclear roles, expectations, and dissatisfaction.	(Westergren 2010)
SPAR Bag Design Contest	Design contest	The company experienced a shit storm after announcing the winning design in their design contest. Some participants did not agree with the decision and posted negative and accusing comments. In this customer integration initiative, perceived unfairness and dissatisfaction with the outcome caused negative word-of-mouth.	(Gebauer et al. 2013)
IBM Innovation Jam	Online brainstorming, idea community	With its Innovation Jam, IBM targeted at obtaining creative ideas and identifying new market opportunities. 150.000 IBM employees, business partners, clients, and academic researchers submitted 46.000 ideas. IBM faced difficulties in filtering relevant posts and ideas from gigabytes of often aimless conversations between participants commenting on each other's' ideas.	(Bjelland/ Wood 2008)

Table 1: Cases of Customer Integration Failure

To sum up, there are three main challenges in customer integration (Enkel et al. 2005a):

Challenge 1 refers to the first phase of the customer integration process, the **selection** of customer integration methods suitable to obtain the required customer input in sufficient quality and quantity, within time, budget, and other resource constraints that the company faces.

Challenge 2 concerns the phase of properly **designing and implementing** the selected customer integration method with regard to a positive customer integration experience that attracts customer participation and engagement.

Challenge 3 relates to the challenging task of turning **customer input into innovation** and **managing knowledge in customer integration**. For this purpose, the generated customer knowledge need to be stored, analyzed, shared, and applied in the innovation process. Additionally, lessons learned from conducting customer integration initiatives need to be documented.

Thus, the potential benefits of customer integration including higher preference fit of products (Cui et al. 2011; Franke/Schreier 2010), higher innovation potential (Leimeister et al. 2009), stronger customer relationships (Enkel et al. 2005a), or improved time-to-market and cost-to-market (Reichwald et al. 2007) cannot be taken as granted by companies (Gallivan/Keil 2003). To realize these benefits, companies need to be aware of the different challenges and risks. This doctoral thesis provides approaches and tools for companies to consciously manage their customer integration processes and initiatives.

The question that arises from the examples of customer integration failure above (see Table 1), is how companies can tackle these challenges of customer integration. In order to develop solutions, in the following section we derive three research questions that guide this doctoral thesis.

1.2 Research Questions

In the following, we raise three research questions that follow from the above mentioned challenges of successful customer integration. Each of the three research questions is motivated by a thorough description of the problem in practice and research gap in literature.

Challenge 1: *There is no structured overview of the different customer integration methods available, their benefits and prerequisites. Information systems to support the selection of appropriate customer integration methods are missing.*

Previous research presents, develops, and tests a variety of IT-based and face-to-face customer integration methods (Dahan/Hauser 2002; Hemetsberger/Godula 2007; Zogaj/Bretschneider 2012). Customer integration methods differ in the type of customer input they can deliver (Edvardsson et al. 2012; Olsen/Welo 2011; Zogaj/Bretschneider 2012), their applicability in the different phases of the innovation process (Bretschneider et al. 2009; Edvardsson et al. 2012), or their applicability to integrate certain types of customers (Edvardsson et al. 2012). Several factors such as available time, budget, or other resources in

the company determine the applicability of methods and tools for customer integration (Fähling et al. 2011; Reinicke 2004). Additionally, each customer integration method entails particular tasks for practitioners in terms of preparing in advance or post-processing afterwards. For these tasks, companies need to possess certain skills and tools (Fähling et al. 2011).

The case of Swiss Engineering (see Table 1) shows that a major challenge related to customer integration is the selection of appropriate customer integration methods (Enkel et al. 2005b). Existing literature provides in-depth information on only a few customer integration methods (Edvardsson et al. 2012; Olsen/Welo 2011). Especially, there are a lot of research articles focusing on the early phases of the innovation process, examining the design, execution, and related challenges of idea competitions and idea communities (Blohm et al. 2011a; Ebner et al. 2009; Gassmann et al. 2005; Leimeister et al. 2009). However, there is little research on the evaluation and comparison of customer integration methods with regard to their benefits and prerequisites, and in particular the expenses and efforts they entail. Without this in-depth understanding of the different possible approaches to interact with customers and to obtain customer knowledge, practitioners struggle with effectively integrating customers into their innovation processes.

Existing approaches to support companies in selecting suitable customer integration methods are limited to two or three-dimensional frameworks and matrixes. These two or three dimensional matrixes classify customer integration methods with regard to two or three factors such as phase in the innovation process, type of customer involvement (design for, design with, design by) (Kaulio 1998), applicability to transfer of tacit and explicit knowledge (Hemetsberger/Godula 2007), type of customer input, or customer type (Reichwald et al. 2004). These rather qualitative decision criteria are primarily related to the innovation process, the customer, and the transfer of knowledge between the company and the customer. However, companies often think in numbers and face various constraints such as time, budget, or the availability of other resources such as facilities, personnel, or skills (Fähling et al. 2011; Reinicke 2004). Besides time and existing skills in the company, costs pose one of the most determining constraint and decision criterion (Reinicke 2004). Therefore, an approach that considers multiple and also more quantitative decision criteria is required to effectively support companies in selecting appropriate customer integration methods.

Additionally, the manual approach of selecting customer integration methods by comparing methods in two or three-dimensional frameworks is very time-consuming. To our research and knowledge, there are no prevalent or accepted information systems implementations that support this selection process.

This discussion shows that IT solutions reducing the associated effort with selecting customer integration methods are required. All of the aforementioned observations lead to the following research question:

Research question 1: How can companies be supported in the selection of appropriate customer integration methods? (RQ1)

Challenge 2: *Many customer integration methods fail to attract customer participation and engagement. There is only little guidance for companies on how to design customer integration methods that keep customers attracted and engaged during the process of providing their input into the innovation process.*

The emergence and proliferation of new technologies offers new opportunities for companies to integrate customers. IT-based customer integration methods enable companies to alleviate some of the organizational and physical problems faced in customer integration (Parameswaran/Whinston 2007). For instance, with the method "virtual concept testing" customers are presented virtual product concepts. The customers are then asked to express their preferences by purchasing the most favored product concept at a certain price. Thus, virtual concept testing provides companies with a low-cost alternative of testing virtual prototypes instead of real physical prototypes (Dahan/Hauser 2002). As a consequence, IT-based customer integration methods can reduce the expenses and efforts that customer integration entails for companies. Further, the Internet enables companies to reach customers all over the world, to increase the speed, and flexibility of customer integration, and to gather continuous feedback from their customers (Erat et al. 2006).

However, as the case of the SAP idea competition shows (Ebner et al. 2009) (see Table 1), there are online customer integration initiatives that fail to attract customer contribution, or fail to keep the customers engaged during the process of providing input (Füller et al. 2011; Kohler et al. 2011; Kohler et al. 2010). Customers' participation in customer integration initiatives is voluntary and mostly customers do not receive compensation for the effort expended in providing their input. Some customer integration methods such as toolkits for user innovation and design assign customers with active co-creation tasks requiring more effort, time, and expertise from customers (Franke/Schreier 2010). This effort, cognitive thinking, and expertise demanded from customers can discourage customers from participating in customer integration initiatives. Hence, IT-based customer integration methods need to be designed in a way that supports customers in successfully accomplishing their co-creation task, and allows customers to experience a sense of mastery, mental stimulation, and enjoyment, which makes it an internally rewarding co-creation task (Füller et al. 2009).

Based on findings from marketing, consumer behavior, psychology, and human-computer interaction research, we identify human experience as an important determinant for individuals' engagement and enjoyment (Csikszentmihalyi 1977; Hassenzahl/Tractinsky 2006; Hirschman/Holbrook 1982). Customers' experienced empowerment and enjoyment depend to a large extend on the design of the interaction tool (Füller et al. 2009). Therefore, companies need to pay particular attention towards designing an appropriate IT-based customer integration method by focusing on the experience that the method is capable to provide to customers. As a consequence, customers may also be more creative and willing to contribute their knowledge (Füller et al. 2011; Füller et al. 2009).

This leads us to the following research question:

Research question 2: How can companies design IT-based customer integration methods with regard to a positive customer integration experience? (RQ2)

Challenge 3: *From the company's perspective, customer integration initiatives entail high efforts and expenses for companies to implement the customer integration initiative, and to screen and evaluate the obtained customer input. From the customer's perspective, customer integration tasks or crowdsourced tasks can be viewed as work that customers perform for the company. For customers, customer integration tasks can be cumbersome and effortful to execute. This calls for a reduction of companies' requests to obtain customer feedback and the reuse of obtained customer input. Therefore, companies need to implement a structured approach to document, share, and reuse customer knowledge across departments and innovation cycles. Common solutions and languages to manage knowledge in customer integration are scarce.*

The different customer integration methods, result in a huge amount of heterogeneous and unstructured customer input (Franke/Hader 2014; Franke et al. 2009), which raises the challenge of managing and transferring customer input into useful knowledge for innovation. For instance, an idea might be expressed by a customer though verbal descriptions, drawings, as a low fidelity prototype (e.g., paper, lego prototype), or in an audio or video file (Brown 2008; Lim et al. 2006). Additionally, there are different levels of detail in which customers may express their ideas (e.g., idea described in two sentences or two pages of text).

As the case of IBM's "Innovation Jam" illustrates (see Table 1), companies face the challenge of filtering the most promising idea(s) from a huge amount of unstructured and heterogeneous customer ideas (Riedl et al. 2010). Unstructured and heterogeneous customer input is often not machine-readable and automatically processable; instead customer input needs to be manually processed, which makes it an extremely time-consuming and exhausting task (Ziegler et al. 2008). To this end, common languages and interchange formats across departments and companies can be helpful.

Common languages and tools can enable the sharing, reuse, and integration of knowledge across departments in a company or stakeholders in innovation networks. Such languages, interchange formats, and tools are essential to reduce R&D costs, time-to-market, or market risks by reusing customer input (Franco et al. 2010). The reuse of existing customer ideas, requirements, or concepts has been found to be a key factor to quality and productivity in innovation processes (Lim 1994; Orawski et al. 2013).

However, in practice different departments frequently have their individual guidelines and software tools to manage specific types of customer input (Franco et al. 2010; Song et al. 2013). For instance, a requirements manager may use a requirements management software to manage customer requirements, the sales and marketing department uses customer relationship management software, while service employees employ feedback management systems to obtain and respond to customer feedback (e.g., complaints). This approach to knowledge management hinders the transparency of existing knowledge in a company, and the sharing and reuse of customer knowledge in a company (Alavi/Leidner 2001; KPMG 1998; Cranfield University 1998). Moreover, missing or deficient documentation of lessons learned from previous customer integration initiatives can result in repeatedly making the same mistakes instead of learning from previous mistakes (Reinicke 2004). Hence, companies

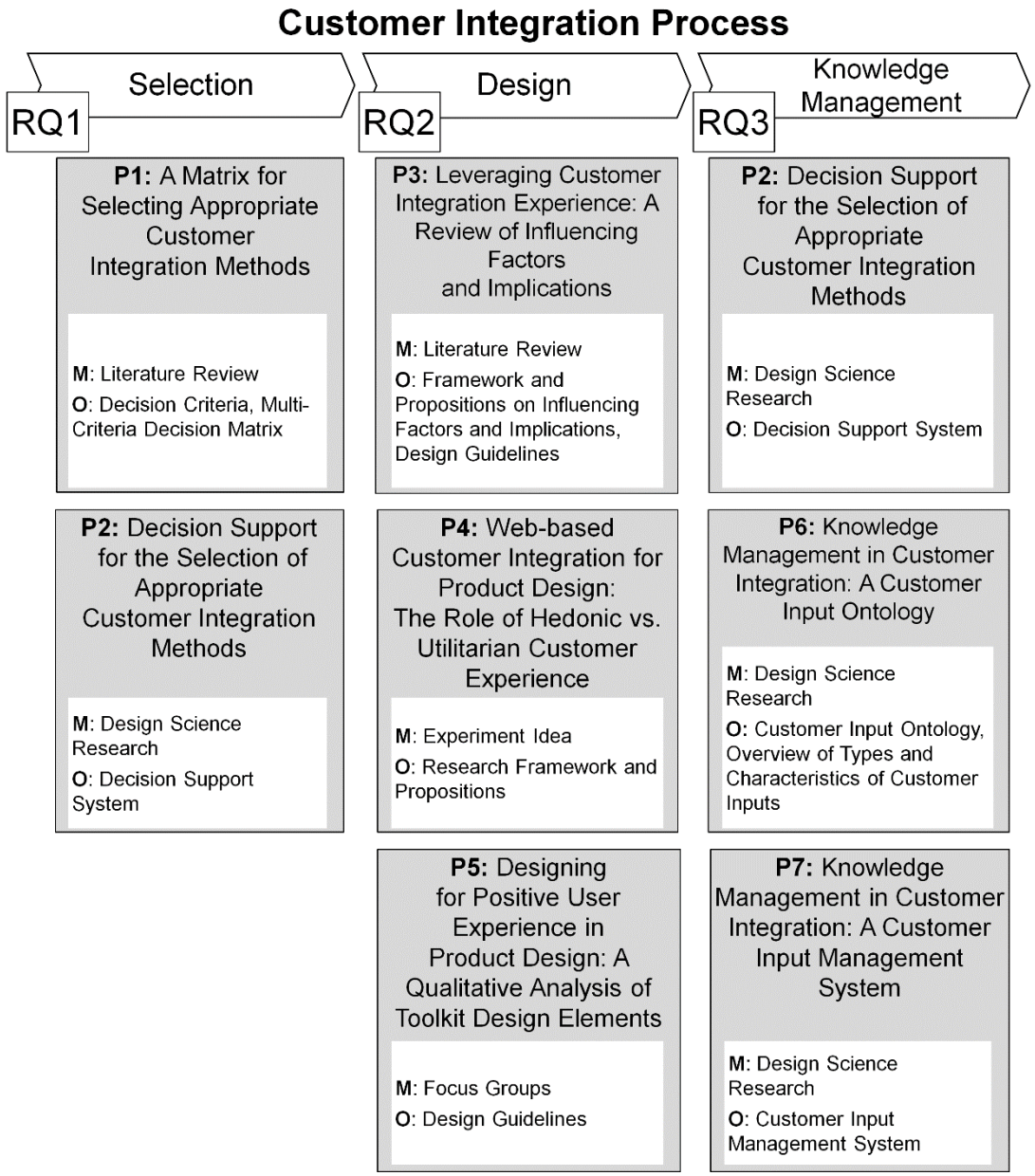
require a knowledge repository and organizational memory to support the collection, retention, and sharing of expertise related to customer integration, and therefore to enable organizational learning.

Besides the ongoing research on different face-to-face and IT-based methods to obtain customer input and to collaborate with customers, approaches and administrative information systems to enable the knowledge management processes of documenting, analyzing, and (re-)using customer input and knowledge are scarce (Hrastinski et al. 2010). This discussion leads us to the following research question:

Research question 3: How can companies manage knowledge in their innovation processes? (RQ3)

1.3 Structure

In order to answer the three research questions, our research endeavor resulted in seven publications. This cumulative doctoral thesis is divided into two main parts, part A and part B. Part A, consisting of five chapters, provides an introduction to the seven publications on which this doctoral thesis is based. The first chapter of part A provides a motivation of our research, three detailed descriptions of challenges in customer integration and corresponding research questions that this thesis aims to answer (chapter 1.2), and a brief summary of the seven publications (chapter 1.3). The second chapter provides theoretical background information on customer integration methods, decision support systems, customer integration experience, knowledge management, and ontologies. These concepts have been applied in our publications and therefore might be beneficial for readers of this doctoral thesis and the embedded seven publications. The third chapter provides an overview of the thesis' research design and briefly describes the applied research methods. Chapter 4 concludes part A by discussing the findings, implications, and limitations of our research as well as future research possibilities. Part B presents the seven publications which aim to answer the aforementioned research questions (see Figure 1).



RQ: Research question, **P**: Publication, **M**: Method, **O**: Outcome

Figure 1: Research Questions and Corresponding Publications

Regarding the publications included in part B, we need to make some remarks on formatting. The publications have been submitted to and published in different conference proceedings and journals. Each conference and journals has its own template and specifications concerning the reference style, or the formatting of texts, tables and figures. To achieve consistency throughout this doctoral thesis, the original research articles have been reformatted, applying a uniform formatting style. For instance, the tables and figures have been redesigned. This also concerns a sequential numbering of the tables, figures, and sections throughout this document. References in part A to the seven publications are presented as e.g. “see publication P1”.

In the following, the publications are briefly summarized. We highlight the research problems, the research methodology, and the main contributions of each publication.

- **P1 - A Matrix for Selecting Appropriate Customer Integration Methods:** Companies increasingly embrace the concept of open innovation in order to tackle problems of innovation and competitive market pressures. The integration of customers into innovation processes can be beneficial with regard to a company's innovation potential, customer relationship management, and customer satisfaction with new products and services. Despite the acknowledgment of the potential benefits of customer integration, companies lack a clear understanding of which customer integration method to apply when and how. Therefore, by conducting a structured literature review, this paper analyzes different customer integration methods. We identify seven decision criteria, which are key drivers for selecting an appropriate customer integration method: Costs, duration, required skills, number of customers, customer type, infrastructure, and phase in the innovation process. Active customer integration methods, which have been frequently examined in literature are focus groups, idea communities, idea competitions, lead user workshops, and toolkits for user innovation and design. This paper extends literature by evaluating and comparing these five active customer integration methods with regard to the identified seven decision criteria. A multi-dimensional decision matrix is proposed, which summarizes the evaluations and can help firms to make proper decisions when customers are about to being integrated into their innovation process. In P2, we extend the introduced decision matrix by taking it as a basis for the design and implementation of an IT-based tool for managing decisions and knowledge in customer integration.
- **P2 - Decision Support for the Selection of Appropriate Customer Integration Methods:** This paper builds on the research findings of P1. Which method to use in which situation depends on the firm, its organizational constraints, and the required customer input. To support companies in this rather complex decision, this paper introduces a decision support system. The decision support system has been developed following the three cycle perspective of the design science paradigm. By conducting a structured literature review and interviewing 14 experts working in the fields of innovation management, research and development, or marketing, we derived requirements for the design of the decision support system. Overall, 16 requirements including eight functional and eight non-functional requirements, have been identified. The prototype of the decision support system is based on a three-tier architecture and has been implemented using Java, HTML5, and MySQL. Finally, the prototype has been evaluated through a survey among 12 experts. The knowledge base of the decision support system provides an overview of different customer integration methods and accumulates information on their proper selection and implementation. The knowledge base is extendable. Further information and experiences on the proper selection, design, and implementation of particular customer integration methods can be captured and shared. By suggesting suitable customer integration methods based on the users' inputs (e.g., available budget and time, required customer input, phase in the innovation process), the decision support system can ease the burden of analyzing and selecting suitable customer integration methods in practice.
- **P3 – Leveraging Customer Integration Experience: A Review of Influencing Factors and Implications:** So far little research attempt has been made in analyzing

the experience customers' gain from participating in a customer integration initiative. Generally, customer or user experience is influenced by several factors and has an impact on an individual's engagement, task performance, perceptions, and feelings. This paper applies the concept of customer/ user experience to customer integration research and identifies influencing factors and implications of customer integration experience through a systematic review of multi-disciplinary literature. Based on 141 papers, we derive a classification of the most frequently investigated influencing factors and implications of the customer experience. In total, 22 different influencing factors and 15 implications of the customer experience have been identified.

Further, building on motivation-hygiene theory, the paper contributes a framework influencing factors and implications of customer integration experience, and their interrelationships. Practitioners can benefit from these research findings, helping in designing IT-based customer integration methods that can attract customer enjoyment and a high quantity and quality of customer contributions to the innovation process.

- **P4 - Web-based Customer Integration for Product Design: The Role of Hedonic vs. Utilitarian Customer Experience:** Based on the findings of P3 on influencing factors and implications of a positive customer integration experience, we analyze the appropriate design of toolkits for user innovation and design with regard to the experience they are able to provide to customers. With the analysis of toolkit interface design, this paper focuses on the rarely investigated design phase of the innovation process. Previous customer integration research particularly addressed the integration of customers into the early phases of idea generation and evaluation in the innovation process.

  In the field of marketing and consumer behavior, customer experience is frequently distinguished into hedonic or utilitarian experience. Similarly, products are categorized in hedonic or utilitarian products. The compatibility principle helps us to propose a match between the product design task in terms of the product type (hedonic vs. utilitarian) a customer has to customize and the experience (hedonic vs. utilitarian) generated by the toolkit interface in order to evoke appropriate response in terms of customer satisfaction, enjoyment, and willingness to contribute in the future. Applying the theory of hedonic/ utilitarian customer experience and the compatibility principle to the design of web-based toolkits for user innovation and design, we propose a corresponding research model as well as an experiment design to test the research model.
- **P5 - Designing for Positive User Experience in Product Design: A Qualitative Analysis of Toolkit Design Elements and their Implications on Emotional Reactions and Perceptions:** Customers are increasingly requesting unique products. To address this challenge companies can employ toolkits for user innovation and design. Compared to traditional shopping in a physical store, the online customization of an individual product requires higher efforts, time, and a lot of expertise from customers. To mitigate these design costs, practitioners need to acknowledge the user experience the toolkit is able to create for the toolkit user. Though the customization of products can be a challenging and exhausting task, the toolkit design needs to make the experience fun and engaging for customers. In order to gain an in-depth

understanding of how to design a compelling experience for toolkit users, the proposed experiment idea in P4 is conducted. After the experiment sessions, we conducted focus groups with 64 participants. We asked subjects about toolkit design elements that made the product customization task most/ least enjoyable and how the toolkit can be improved. Based on the focus groups, we identify different toolkit design elements and their implication on toolkit users' emotional reactions and perceptions. We found that visualization of the product configuration and detailed information on the options that can be selected both help the toolkit users to get a realistic understanding of the product. Additionally, particularly visualization stimulates a toolkit user's creativity and enjoyment while customizing a product.

- **P6 - Knowledge Management in Customer Integration: A Customer Input Ontology:** Customer integration methods can yield a flood of customer inputs including ideas, idea evaluations, or complaints across all phases of the innovation process. To effectively and efficiently manage this information flood and to turn customer input into innovation, appropriate knowledge management tools are required. To this end, ontologies can be helpful tools. Existing literature particularly provides ontology-based frameworks for the early innovation process phases. This paper aims to address the challenge of holistically managing customer input across all innovation process phases and innovation cycles by developing the Customer Input Ontology. Through a systematic literature review, we identify nine types of customer input and ten associated characteristics of customer input (e.g., quality, validity) that our ontology needs to cover. Additionally, we identify two existing ontologies of which ontology components could be reused. The Customer Input Ontology defines the core concept of customer input and therefore provides a shared and common understanding of customer input. Further, the Customer Input Ontology enables a more differentiated analysis of customer knowledge. Based on the Customer Input Ontology we design, implement, and evaluate the Customer Input Management System in P7.
- **P7 - Knowledge Management in Customer Integration: A Customer Input Management System:** In the open innovation paradigm, customers can actively take part in different stages of an innovation process of a company and communicate their input and knowledge in form of preferences, ideas, or complaints. However, the management of a huge amount of unstructured customer input poses a challenge for companies. The approaches employed by companies to manage customer input include standard office solutions or individual, self-designed software solutions, which raise problems of interoperability, transparency, and data redundancy. Further, available software solutions focus on idea management or the collection of customer feedback. Companies require inter-divisional tools that support, the collection, storage, sharing, and (re-) use of customer input across innovation cycles, departments, or companies in innovation networks. Building on the Customer Input Ontology (P7), we follow the design science approach to design, build, and evaluate a prototypical software platform, which we call the „Customer Input Management System". The Customer Input Ontology helped us to derive the data model and requirements for the Customer Input Management System.

Table 2 summarizes the seven publications and the research questions they address.

No	RQ	Title	Outlet	Status	Ranking
P1	RQ1	A Matrix for Selecting Appropriate Customer Integration Methods	Production and Operations Management Society (**POMS**) International Conference	Published	NR
P2	RQ1, RQ3	Decision Support for the Selection of Appropriate Customer Integration Methods	Proceedings of the 12th International Conference Wirtschafts-informatik (**WI**)	Published	A*
P3	RQ2	Leveraging Customer Integration Experience: A Review of Influencing Factors and Implications	Communications of the Association for Information Systems (**CAIS**)	Revise & Resubmit	B*
P4	RQ2	Web-based Customer Integration for Product Design: The Role of Hedonic vs. Utilitarian Customer Experience	Proceedings of the 22nd European Conference on Information Systems (**ECIS**)	Published	A*
P5	RQ2	Designing for Positive User Experience in Product Design: A Qualitative Analysis of Toolkit Design Elements and their Implications on Emotional Reactions and Perceptions	Proceedings of the 49th Hawaii International Conference on Systems Sciences (**HICSS**)	Published	B*
P6	RQ3	Knowledge Management in Customer Integration: A Customer Input Ontology	Proceedings of the 20th International Conference on Engineering Design (**ICED**)	Published	NR
P7	RQ3	Knowledge Management in Customer Integration: A Customer Input Management System	Proceedings of the Multikonferenz Wirtschafts-informatik (**MKWI**)	Published	C*

*WKWI, NR: Not Ranked

Table 2: Overview on Embedded Publications

2 Conceptual Background

The process of customer integration into innovation processes can be viewed as a sub-process of the innovation process. As Figure 2 shows, the customer integration process is triggered by the need for customer input in the innovation process (Fähling et al. 2011; Füller et al. 2014c). In the first stage of the customer integration process, the most appropriate customer integration method(s) is (are) selected to gather the required customer input, followed by the design and implementation of the selected customer integration method(s). The customer integration process is terminated by filtering relevant customer input from the flood of customer input that the company receives, and by delivering the relevant customer input to the innovation process.

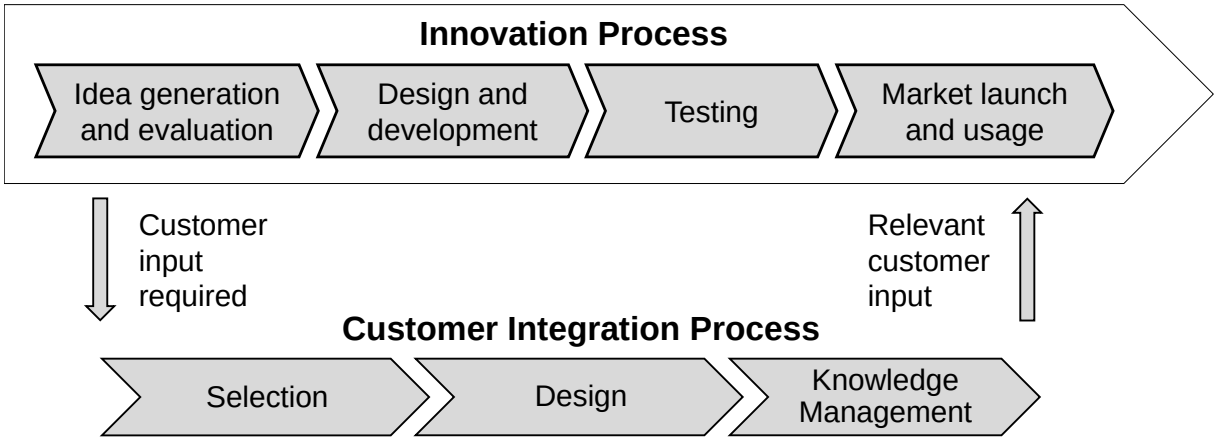


Figure 2: Customer Integration Process as a Sub-Process of the Innovation Process
Own illustration based on Fähling et al. (2011)

In the following we present theoretical background information relevant for the three different phases of the customer integration process.

Chapter 2.1 refers to the first phase of the customer integration process in which companies are faced with the challenge of selecting appropriate customer integration methods from a variety of existing customer integration methods. First, we present frequently researched methods in literature and frequently used methods in practice (chapter 2.1.1). Second, we introduce the concept of Decision Support Systems (DSS) – an interactive software-based computerized information system - that can help decision makers to solve problems and make decisions (chapter 2.1.2). Chapter 2.2 presents background information relevant for the design of IT-based customer integration methods. For the design of attracting and engaging customer integration methods, companies need to consider the concepts of customer, flow, and user experience (chapter 2.2.1) as well as hedonic and utilitarian design principles (chapter 2.2.2). Finally, in chapter 2.3 relevant theoretical background information on knowledge management (chapter 2.3.1) and ontologies as knowledge management tools (chapter 2.3.2) are provided.

2.1 Selection of Appropriate Customer Integration Methods

2.1.1 Customer Integration Methods

Research has brought forward a notable number of customer integration methods (Hemetsberger/Godula 2007). Depending on the customer integration method selected by the company, the degree and intensity of customer participation in the innovation process varies (Alam 2002). Based on the degree of customer participation and the respective roles and responsibilities assumed by customers in the innovation process (Cavaye 1995), the different customer integration methods are categorized into passive and active customer integrations (Alam 2002; Schultze et al. 2007).

Passive customer integration - as the least intense approach to customer integration - views customers as a resource of information and innovative ideas in the innovation process (Zogaj/Bretschneider 2012). Passive customer integration methods assign customers the role of passive participants in the innovation process. Examples for passive customer integration methods are surveys, ethnography, or complaint analysis (Zogaj/Bretschneider 2012). On the other hand, active customer integration methods such as lead user workshops, focus groups, toolkits for user innovation and design, or idea communities allow customers to actively contribute to the innovation process. Active customer integration methods enable customers to actively generate and evaluate ideas or design their own products. These tasks have traditionally been executed by internal R&D personnel (Zogaj/Bretschneider 2012).

As part of the publications P1 and P2, we have identified and analyzed different passive and active customer integration methods. Table 3 summarizes some customer integration methods and indicates their applicability to integrate customers into a certain phase in the innovation process, and to gather a certain type of customer input.

	Focus group	Lead user workshop	Idea competition	Idea community	Toolkit	Boundary Spanner	Complaint Analysis	Empathic design	Listening in	Information pump	Online reviews	Product testing	Quality function deployment	Security trading of concepts	Survey	Virtual concept testing
Innovation process phase																
Idea generation and evaluation	X	X	X	X		X		X	X	X			X			
Design and development					X									X	X	X
Testing												X				
Market launch and usage							X				X					
Customer input																
Needs, ideas, idea evaluations	X	X	X	X		X			X	X			X		X	
Preferences, solutions, concepts, product features	X	X	X	X	X	X		X						X	X	X
Prototype evaluations, design flaws												X				
Feedback, use information							X				X					
Degree/ intensity																
Active	X	X	X	X	X											
Passive						X	X	X	X	X	X	X	X	X	X	X

Table 3: Customer Integration Methods
Own illustration based on Bretschneider et al. (2009) and Zogaj/Bretschneider (2012)

In the following, we exemplarily describe five active and five passive customer integration methods that are frequently investigated in research and widespread in practice (Leimeister et al. 2009; Zogaj/Bretschneider 2012). Further descriptions of these customer integration methods can be found by using the web-based decision support system, developed and presented in P2.

Active customer integration methods

Focus group*:* In this active customer integration method a group of approximately six to ten customers is invited to discuss a certain topic with the company (Zogaj/Bretschneider 2012; Ozer 1999). The topic is defined by the company and may concern problems with existing products, or ideas for new products and services (Ozer 1999). Focus groups and lead user workshops are quite similar (Zogaj/Bretschneider 2012). The main difference between these two active customer integration methods is the type of customer that is integrated. While focus groups are applicable to co-create innovations with so-called “ordinary users” that do not have specific knowledge about certain markets and technologies, lead user workshops are applied to integrate “lead users” (Zogaj/Bretschneider 2012).

In general, focus groups can be conducted rather quickly and at low cost. Limitations of the method are the generation of in-depth, qualitative data with a small group that may not be representative. Further, focus groups and obtained opinions and knowledge may be dominated by some talkative persons (Jin et al. 2012b; Ozer 1999). Focus groups are frequently applied in practice. For instance, Volvo Cars conducted a focus group to gather knowledge on female customers since women were found to increasingly drive SUVs (Dahlsten 2004).

Lead user workshop: Lead users are defined as a group of customers that is ahead of market trends and experiencing needs which later will be experienced by many other users in the marketplace (Franke et al. 2006). The lead user method includes the systematic identification of lead users, and their integration into innovation processes through workshops, where ideas and concepts for new products or services are generated, discussed, and further elaborated (Leimeister et al. 2009; von Hippel 1986). For instance, Hilti employed the lead user approach to develop new product concepts for their product line "pipe hangers" which is a type of a fastening system often used in commercial and industrial buildings (Herstatt/Von Hippel 1992).

Idea community: A predominant approach to customer integration into the early phases of the innovation process are idea communities (Blohm et al. 2011b; Zogaj/Bretschneider 2012). These internet portals hosted by firms allow customers to share knowledge, discuss topics of common interest, or post, discuss and evaluate ideas. Prominent examples are the online community "Tschibo ideas", where customers were asked to post ideas as well as their problems of everyday life. These topics and ideas were answered by experts, discussed in the community, and jointly brought closer to a solution (Helfrich 2009). A further example is the Ducati Motor online community. Ducati developed a specific blog with the aim of integrating customers into their innovation process. The company received 2071 messages from 572 Ducati virtual community members (Marchi et al. 2011).

Idea competition: Another popular method for collecting ideas, are idea competitions (Yoo et al. 2013). Idea competitions (also called idea contests) seek customer ideas and solutions regarding a certain problem posted by a company (i.e., solution seeker). The submitted ideas, or solutions by customers get rated either by internal experts of the company or by the participating customers. Subsequently, the customers that generated the best solutions win a reward or prize (Ebner et al. 2009; Leimeister et al. 2009).

Companies including Dell, IBM, Motorola, Sony, Samsung, and Nokia organized a contest to gather customer ideas (Ebner et al. 2009; Leimeister et al. 2009; Yoo et al. 2013). Several companies complement these contests with community features allowing customers to create an account and a profile showing their activities in terms of ideas contributed, voted, and commented (Yoo et al. 2013). Further, some companies not only run contests to gather ideas but to also collect customers' creative designs. For instance, Swarowksi hosted a virtual platform which allowed customers to design and submit their own jewelry items (Füller et al. 2011). Similarly, SPAR initiated an international online design contest to gather designs for shopping bags (Gebauer et al. 2013).

Toolkit for user innovation and design: A possibility to integrate customers into the design phase of the innovation process is a toolkit for user innovation and design. Toolkits transfer need-related tasks of product and service development to customers (von Hippel/Katz 2002).

Companies including Dell, Nike, or IKEA increasingly equip their customers with toolkits to customize products such as laptops, running shoes, or kitchens to their individual preferences (Franke et al. 2008). Toolkits are frequently realized as web applications and provided on company websites. Advanced visualization techniques are used allowing users to zoom, rotate, and virtually experience their product configuration (Füller et al. 2016; Walcher/Piller 2012). The CYLEDGE configurator database (http://www.configurator-database.com/) provides an overview of the newest, most popular, and most exotic toolkits currently provided by companies.

Passive customer integration methods

Complaint analysis: Through this complaint and feedback systems, customers can submit their complaints, which are analyzed by the company to learn about customer problems, dissatisfaction, and needs. This information is important to improve existing products and services and to design new products and services (Merisalo-Rantanen et al. 2009; Park/Boland 2012). For instance, Siemens introduced a central customer complaint and feedback base to systematically collect complaints and customer needs. The result was an optimized support of complaint management and the strategic development of future-oriented know-how about customer needs (Salomann et al. 2005).

Analysis of online reviews: The systematic analysis of online reviews provided by people on the web (e.g. Amazon.com) can provide companies with positive and negative feedback information on their products and services. This information can help companies to improve their existing product and service portfolio (Dellarocas et al. 2010; Mudambi/Schuff 2010).

Product/ beta/ prototype testing: Before an invention is introduced into the market, customer integration methods called product, beta, or prototype testing allow companies to identify potential problems (Kaulio 1998; Park/Boland 2012; Dolan/Matthews 1993). A prototype is defined as a tangible artifact between the company and the customer. The prototype shows all implemented functions and represents the structure and behavior of the product/ service (Park/Boland 2012). With this method customers can test products or services and subsequently provide their assessments and feedback (Klein/Herskovitz 2007; Park/Boland 2012). Nowadays, companies such as AUDI take advantage of the Internet as well as augmented and virtual reality to let their customers virtually develop, test, and revise prototypes (Füller et al. 2004; Füller/Matzler 2007).

Survey: Another popular means of gathering customers' needs, opinions as well as more concrete information on product specifications and functions are surveys (Olsen/Welo 2011; Zogaj/Bretschneider 2012; Sawheny et al. 2005). This type of customer integration usually involves customers in written form. Surveys can include both, open-ended and closed questions to acquire customer knowledge. In comparison to workshops and observations that are capable of revealing more qualitative, in-depth information from a few customers, surveys

are more likely to yield surface information from a huge amount of customers (Olsen/Welo 2011). For instance, the company Swiss Engineering surveyed international customers to determine whether the developed product concept meets customers' needs, requirements, and expectations (Enkel et al. 2005b).

Virtual concept testing: The method "virtual concept testing" is rather similar to the method "conjoint analysis" and is employed by companies to gain insights into what features of a product customers value most. Customers are presented virtual product concepts with pictures and other multimedia representations. Further, customers are asked to buy the product concepts most favored at varying prices. This way, companies can decompose a product into its features and identify the most favored product features by different customers (Dahan/Hauser 2002). Compared to traditional testing of physical models of concept or prototypes, this customer integration method can reduce the time and costs required to gather concept evaluations from customers. Further, the number of tested concepts can be increased and can also be tested earlier in the innovation process (Dahan/Hauser 2002).

Dropbox employed virtual concept testing by creating a virtual representation of their software concept in the form of a video. After receiving positive feedback on their concept they further pursued their ideas. Based on the virtual concept testing, over 1.000 users volunteered as beta testers to test the prototype (Evers et al. 2014).

Figure 3 summarizes the five active and five passive customer integration methods as well as the customer input they are capable to deliver for the innovation process.

	Innovation process			
	Idea generation and evaluation	Design and development	Testing	Market launch and usage
Customer input	Need information, creative ideas idea evaluations	Information on preferences, product features and design tradeoffs, solution information	Feedback information on design flaws and product performance	Feedback and use information
Customer integration method	- Focus group - Idea competition - Idea community - Lead user workshop - Survey	- Survey - Toolkit - Virtual concept testing	Prototype testing	- Complaint analysis - Analysis of online reviews

Figure 3: Summary of the Described Active and Passive Customer Integration Methods
Own illustration based on Nambisan/Baron (2007) and Bretschneider et al. (2009)

The above described customer integration methods just present a few examples of how companies can integrate their current and potential customers into their innovation processes by using digital technologies including software and web applications, advanced visualization techniques, virtual and augmented reality. From a diverse range of IT-based or face-to-face customer integration methods, companies are faced with the challenge of selecting the most appropriate one(s). To enable this selection process, we analyze different customer integration methods in P1 and P2. We identify seven decision criteria for the selection of customer

integration methods such as the customer input or the phase in the innovation process. Further, we evaluate the five above described active customer integration methods with regard to the identified decision criteria.

2.1.2 Decision Support Systems

In daily business, decision makers have to make decisions in extremely complex, uncertain, risk-prone, and competitive environments (Vasilakos et al. 2012). To reduce risks in decision-making processes, decision support systems (DSS) are used. In the area of IS, the concept of DSS evolved in the mid-1960s and gathered up intensity in the 1980s. During the late 1980s, several types of DSS like Executive Information Systems, and Group Decision Support Systems evolved (Gachet 2001). In the 1990s, the development of data warehouses and Online Analytical Processing (OLAP)[1] widened the scope of DSS (Power 2013). Later, DSS were widely used in multidisciplinary research fields such as database research, artificial intelligence, human-computer interaction, simulation methods, and software engineering (Gachet 2001).

The forum guide to DSS (National Forum on Education Statistics 2006, 1) describes DSS as:

> *"An interactive software-based computerized information system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and business models to identify and solve problems and to make decisions".*

Thus, a DSS is a computer-based tool that aids the process of decision-making. The goal of these systems is to aid the human decision-making process, with the help of IT solutions. Computerized DSS allow companies to gather and provide relevant information to the decision at apt time (National Forum on Education Statistics 2006; Power 2013). Further, DSS are used in practice to mitigate prejudices and risks related to decision-making (Power 2013).

The different components of a DSS are a database management system, analysis models and reporting tools, a user interface, decision makers as users of the DSS as well as hardware, software, and networks (Gachet 2001). DSS can be categorized in:

- **Communication-driven DSS:** Allow two or more users to communicate, collaborate, and simultaneously share information (e.g., Microsoft's NetMeeting, Groove) (National Forum on Education Statistics 2006).
- **Data-driven DSS:** Emphasize on accessing and manipulating data internal or sometimes external to the company (Gachet 2001).
- **Document-driven DSS:** Provide access to and retrieve unstructured data in electronic formats (e.g., search engines) (Power 2013).
- **Knowledge-driven DSS:** Recommend actions to the decision maker (Gachet 2001).

[1] OLAP performs multidimensional analysis of business data.

- **Model-driven DSS:** Use data and parameters provided by the user to aid in analyzing a situation (Power 2013). This type of DSS emphasizes access and manipulation of e.g., statistical or financial models.

Considering these types of DSS in the context of our research, the introduced DSS in P2 can be categorized as a knowledge-driven DSS since it recommends the customer integration methods which best suit the organizational conditions (e.g., customer input needed, phase in innovation process, available budget, duration, skills).

As the conditions of decision-making and the user requirements change rapidly, DSS need to be designed as adaptive systems in an iterative design process (Sprague 1980). First, the manager and system developer decide on a small problem, for which the developer builds an initial system to support decision making. After a few weeks of use, the system is evaluated and incrementally expanded. This cycle is repeated several times until a *relatively* stable system is reached. The system will be subject to change as the environment and requirements change (Sprague 1980). Given this changing conditions and requirements, we designed the knowledge-driven DSS as an adaptive system (see P2). The knowledge base is extendable by further customer integration methods as well as information and expert knowledge on their proper design and implementation. Additionally, decision criteria can be added and weighted depending on the conditions of decision making.

2.2 Design and Implementation of IT-based Customer Integration Methods

2.2.1 Customer Integration Experience

Experiences can be defined as an internal state, assessment, and perception that result from being exposed to a marketing campaign, participating in or observing events, and interacting with a product or company personnel (Klaus/Maklan 2011; Nagasawa 2008). Human experiences are something very personal and unconscious, yet they are still accessible and memorable to the individual experiencing (Hassenzahl et al. 2010; Klaus/Maklan 2011). People especially memorize outstanding, rich, or touching experiences (Hassenzahl et al. 2010). Positive experiences are reflected by positive emotions such as fun and pleasure. In contrast, negative experiences evoke negative feelings of failure and frustration (Choi et al. 2006; Éthier et al. 2006; Hassenzahl et al. 2010). Therefore, researchers and practitioners alike are eager to identify the factors that determine or hinder a positive experience. The experience concept has been particularly researched in the fields of marketing, human-computer interaction, and psychology.

Customer experience

Under the concept of customer experience, *marketing researchers* investigate the experience that customers gain from the activity of purchasing or consuming products and services (Babin et al. 1994; Overby/Lee 2006). Customers always derive an experience – whether it is good, bad or indifferent (Berry et al. 2002).

Customer experience management has attracted companies' attention as means to provide value to customers and therefore to create competitive advantage, customer satisfaction, and loyalty (Berry et al. 2002; Sharma/Chaubey 2014). Customer experience management can be defined as the strategy of comprehensively managing the multiple touchpoints between the company and its customers including the company's marketing campaigns, service personnel, offline/ online stores, or products (Berry et al. 2002; Garrett 2006; Verhoef et al. 2009). Over a series of events, customers rationally recapitulate their evaluations and perceptions (Klaus/Maklan 2011). Therefore, the various touchpoints and stimuli (e.g., store atmosphere, product presentation, dressing and tones of voices of employees) need to be comprehensively managed and coordinated to generate a coherent picture and a holistic customer experience (Berry et al. 2002).

User experience

In the field of *human-computer interaction*, researchers study users' experience from interacting with a product, service, or system (Hassenzahl/Tractinsky 2006). In contrast, to marketing research the appropriate design of a single, often digital touchpoint (e.g., system, website) considering users' requirements and expectations is in the focus. The appropriately designed touchpoint results in increased perceived ease of use, usability, task performance, user acceptance, focused attention, and enjoyment (Law/Van Schaik 2010; Mahlke/Thüring 2007; Partala/Kallinen 2012).

The concept of user experience focuses on the interaction of users with a product or service, whereas the customer experience concepts comprises all interactions between a company and the customers. Thus, the relations between the concepts of user and customer experience can be visualized as shown in Figure 4.

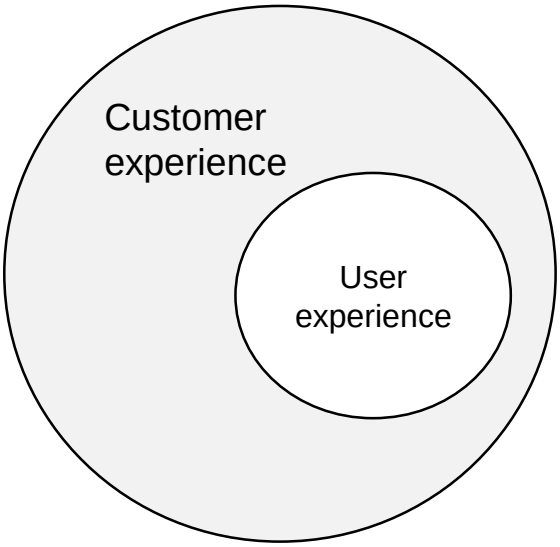


Figure 4: Customer Vs. User Experience

Flow experience

In the discipline of psychology, flow experience has been defined as a state of complete involvement in an activity, including deep enjoyment, concentration, focus, loss of self-consciousness, and transformation of time (Csikszentmihalyi 1975, 1990; Higgins 2006). This state can be reached by designing challenging but feasible tasks, clear goals of the task, and immediate feedback on task performance (Csikszentmihalyi 1975, 1990).

Customer integration experience

Acknowledging the positive effects of customer experience, user experience, or flow experience, first research endeavors have applied the experience concept to *customer integration research* (Füller et al. 2011; Kohler et al. 2011; Kohler et al. 2010; Matzler et al. 2011; Nambisan/Nambisan 2008). In this thesis, we apply the experience concept to study the adequate design of IT-based customer integration methods (P3, P4, and P5). For this doctoral thesis, we define the experience that customers gain from interacting with IT-based customer integration methods and participating in customer integration initiatives as the *customer integration experience* (see P3). In P3, we study the influencing factors and implications of a positive customer integration experience. Previous research found that, customer integration initiatives that generate a positive customer integration experience can lead to a higher quantity and quality of customer contributions to the innovation process. Additionally, a positive customer integration experience has been found to positively influence customers' task enjoyment and willingness to participate in future customer integration initiatives (Füller et al. 2011; Kohler et al. 2010; Matzler et al. 2011).

Figure 5 summarizes the concepts of customer, user, flow, and customer integration experience.

Customer Experience	User Experience	Flow Experience	Customer Integration Experience
• **Marketing research** • Customer experience management as the holistic management of touchpoints between the company and the customer • Customers‘ shopping and consumption experience • **Influencing factors:** Design of offline/ online store, retail environment (atmosphere, offering, personnel) • **Implications:** Customer loyalty, satisfaction, word-of-mouth, repurchase intentions	• **Human-computer interaction research** • Interaction of users with a product, service, or system, and the experience they receive • **Influencing factors:** Ease of use, usefulness, beauty, goodness • **Implications:** Task performance, user acceptance, enjoyment	• **Psychology research** • “Flow” describes a state of being completely involved in an activity for its own sake • **Influencing factors:** Challenging task that matches an individual’s skills, clear goals of the task, immediate feedback • **Implications:** Focused attention, loss of self-consciousness, transformation of time, enjoyment	• **Customer integration research, technology innovation management research** • Interaction of customers with IT-based customer integration methods • **Influencing factors:** Ease of use, usability, perceived autonomy, sense of community • **Implications:** High quality and higher amount of contributions, willingness to participate in the future

Figure 5: Summary of Customer, User, Flow, and Customer Integration Experience

2.2.2 Hedonic and Utilitarian Design Principles

To design for a positive experience, companies need to consider existing design principles and antecedents of a positive experience (Colombo/Pasch 2012; Garrett 2006, 2010).

In *marketing research*, customer experience is basically distinguished in *utilitarian and hedonic experience* (Babin et al. 1994; Hirschman/Holbrook 1982; Overby/Lee 2006). Utilitarian experience results from goal oriented shopping and consumption of products and services, associated with cognitive and economic evaluations of value for money, convenience, time savings, or purchasing all desired products on the shopping list (Babin et al. 1994; Noble et al. 2005; Overby/Lee 2006). In contrast, hedonic experiences are more personal and subjective reflections of shopping's potential entertainment and emotional worth (Babin et al. 1994). Analogous, existing marketing literature distinguishes between a utilitarian and hedonic design of (web) stores and marketing campaigns. A utilitarian design of stores and marketing strategies pursues a convincing format providing information on product performance and price. In contrast, hedonic formats are emotionally-appealing including high resolution images, graphics, or humorous product commentary (Childers et al. 2001; Eisend 2009; Tractinsky/Lowengart 2007).

Analogous to the differentiation in hedonic and utilitarian customer experience, marketing literature distinguishes in utilitarian and hedonic products and product attributes

(Addis/Holbrook 2001; Hirschman/Holbrook 1982). Products that are visually appealing, support self-expression, and evoke heightened levels of fantasies and emotions refer to as hedonic products. Examples for hedonic products are books, movies, designer clothes, or high heels. Hedonic product attributes are e.g. the interior and exterior design of a car. In contrast, functional products such as washing machines or dishwashers are so called utilitarian products (Addis/Holbrook 2001; Dhar/Wertenbroch 2000; Sen/Lerman 2007). Examples for utilitarian product attributes are functional aspects such as an engine of a car, or the sole and the damping effect of a running shoe.

In line with the two-dimensional view of hedonic and utilitarian customer experience in marketing research, *information systems* are classified in *utilitarian and hedonic information systems* (Van der Heijden 2004). The Technology Acceptance Model (TAM) is the most frequently applied theory to examine the design of information systems and their acceptance and adoption by users (Davis 1986; Davis et al. 1989). While the acceptance of utilitarian information systems is determined by perceived ease of use and perceived usefulness of systems, the adoption of hedonic information systems is related to the extent to which the user enjoys using a system (Davis et al. 1989; Deng et al. 2010; Van der Heijden 2004; Venkatesh 2000). Utilitarian systems are designed for the workplace and therefore aim at minimal distraction from the task, and enhanced task performance of employees. In contrast, hedonic systems such as game based information systems use game elements, animated pictures, colors, and sound to generate enjoyment and entertainment (Van der Heijden 2004). The TAM originally included rather utilitarian aspects such as perceived usefulness and perceived ease of use (Davis 1986; Davis et al. 1989). Some derivatives of the TAM also consider more hedonic aspects. For instance, TAM3 includes computer playfulness and perceived enjoyment (Venkatesh/Bala 2008). UTAUT2 encompasses hedonic motivation as a factor that influences behavioral intention (Venkatesh et al. 2012).

For the design of a positive user experience, researchers and practitioners in the field of *human-computer interaction* consider *instrumental* (i.e., utilitarian, pragmatic) and *non-instrumental* (i.e., hedonic) aspects of systems (Hassenzahl 2003; Hassenzahl/Tractinsky 2006). Non-instrumental design principles include the design of a visually appealing interface and mentally stimulating products, services, or systems. In contrast, ease of use, usefulness, or the fit to behavioral goals are instrumental qualities of a system that can create a positive user experience (Hassenzahl 2003; Hassenzahl/Tractinsky 2006).

Figure 6 provides an overview of the hedonic and utilitarian design principles.

Hedonic	Utilitarian
Characteristics • Entertainment • Enjoyment • Mental stimulation • Gamification • Multi-sensory **Design principles** • Visualization, high resolution images, graphics • Animations • Sounds • Humorous product commentary • Gamification • Visually appealing design	**Characteristics** • Cognitive and economic evaluations of value for money, convenience, time savings • Ease of use • Usefulness • Fit to behavioral goals, support to achieve goals **Design principles** • Convincing formats providing information on product performance and price • Ease of use • Usefulness • Minimal distraction from task

Figure 6: Hedonic Vs. Utilitarian Design Principles

In contrast to passive customer integration methods that rather refer to traditional market research methods, active customer integration methods directly relate to the context of open innovation by assuming customers active co-creation tasks (Zogaj/Bretschneider 2012). Further the design phase is less researched than the idea generation phase. Therefore, in this doctoral thesis, we take toolkits for user innovation and design as an example of an active customer integration method to analyze the appropriate design of customer integration methods with regard to a positive customer integration experience (see P4 and P5). Extending the hedonic and utilitarian design principles from marketing, information systems, and human-computer interaction research to the design of toolkits for user innovation and design, we design a utilitarian toolkit providing detailed information on the product and the options that can be selected, and a hedonic toolkit providing visual feedback of the product configuration (P4 and P5). We conduct focus groups with students after using a hedonic or utilitarian toolkit for designing a car (P5) to analyze the implications of the utilitarian and hedonic toolkit design elements on toolkit users' emotional reactions, and perceptions.

2.3 Knowledge Management in Customer Integration

2.3.1 Knowledge Management

In strategic management literature, the knowledge-based view of the firm emerged as an extension of the resource-based theory of the firm (Alavi/Leidner 2001; Grant 1996). Resources refer to as capabilities, processes, knowledge, trade contracts, capital, or machinery of a company (Priem/Butler 2001; Wernerfelt 1984). The resource-based view defines a company as a *"unique bundle of idiosyncratic resources and capabilities where the primary task of management is to maximize value through the optimal deployment of existing resources and capabilities, while developing the firm's resource base for the future*" (Grant 1996, 110). The knowledge-based theory of the firm treats knowledge as the most strategically important organizational resource that can create long-term sustainable competitive advantage (Alavi/Leidner 2001; Grant 1996; Nonaka 1994). Yet, not the existence of knowledge itself but rather the application of existing knowledge in order to create new knowledge and value particularly in the form of innovation generates competitive advantage (Alavi/Leidner 2001; Nonaka 1994; von Krogh 1998).

Studies report the loss of know how due to employees leaving the company, and problems with knowing what the company knows, identifying relevant existing knowledge, and leveraging it (Alavi/Leidner 2001; KPMG 1998; Cranfield University 1998). Therefore, to systematize, store, retrieve, share, create, and apply knowledge in a company, systematic knowledge management processes are required (Alavi/Leidner 2001). IT can support these knowledge management processes and can therefore act as an important enabler in knowledge management. For instance, employees can identify relevant knowledge by searching databases and online wikis, share knowledge and collaborate in virtual teams, or access information on experiences and lessons learned from past projects (Alavi/Leidner 2001).

Approaches and tools for knowledge management applied by companies are changing rapidly. While previous approaches included centrally managed, proprietary knowledge repositories such as structured and controlled search and access, new IT solutions are based on social software. Social software is open and more affordable. However, it also creates challenges of knowledge protection and firm boundaries (von Krogh 2012).

Knowledge can be created by interacting with customers. Through consuming and using products and services, customers possess knowledge that is of high relevance for companies to develop new, innovative products (Chesbrough 2006a; Chesbrough/Crowther 2006; von Hippel 1988, 2005). Customer knowledge can be defined as tacit knowledge. It is highly personal, hard to formalize and difficult to communicate to others. In contrast, explicit knowledge is formal and systematic. It can be easily communicated, documented, and shared (Nonaka 1994). Through social interactions with customers (e.g., brainstorming sessions or in communities), companies can try to externalize knowledge and transfer tacit knowledge into explicit knowledge (Leonard/Sensiper 1998).

To support knowledge management in customer integration, we develop a DSS in P2. The DSS stores information on different customer integration methods in its knowledge base.

Given that new IT solutions increasingly integrate social software and networks, we implemented a forum allowing the users of the DSS to post and discuss their experiences in customer integration (von Krogh 1998). Thus, the DSS constitutes an organizational memory on experiences and knowledge on customer integration methods and initiatives. While the introduced DSS in P2 supports knowledge documentation and sharing concerning customer integration methods, the introduced Customer Input Ontology and Customer Input Management System in P6 and P7 enable the knowledge management processes and activities of structuring, documenting, analyzing, retrieving, sharing, and (re-)using customer knowledge across innovation cycles.

2.3.2 Ontology

Concepts, methods, and tools supporting the management of knowledge are in the focus of knowledge management research (Jurisica et al. 2004). Ontologies pose tools to represent, retrieve, and reuse knowledge. An ontology formally and explicitly describes terms and concepts of a knowledge domain as well as their interrelations (Gruber 1993; Jurisica et al. 2004). For instance, an ontology for health care captures health care-related knowledge including the patient, disease, symptoms, diagnosis, and treatment (Jurisica et al. 2004). Another example is the Enterprise Ontology to capture and analyze key aspects of an enterprise including organizational units, strategies, activities, processes, customers, products, and vendors (Bullinger 2008).

Ontologies consist of a hierarchy of classes and sub-classes. Classes explicitly describe concepts in a knowledge domain. Classes may have super- and/ or sub-classes. Attributes are the characteristics that classes can have. Concrete individuals of a class are so-called instances that adopt all structural and behavioral properties of a class (Bullinger 2008; Noy/McGuinness 2001). For instance, the class “wine” has the more concrete sub-classes “red wines”, “white wines”, and “rosé wines”. A Bordeaux wine or a Merlot is an instance of the class “red wines” (Noy/McGuinness 2001). Attributes of the classes may be the wine producer, filling volume, description of flavor, or price. Attributes can take a set of allowed values. Possible values that the attribute filling volume can take are 0.25, 0.5, 0.75, or 1.0 liter.

Reasons for the use of ontologies is the 1) creation of a common understanding and fostering communication between people and organizations, 2) the facilitation of inter-operability between systems, 3) and the reuse of knowledge in companies (Uschold/Gruninger 1996).

Transferred to the context of customer integration, we develop the Customer Input Ontology in P6. The Customer Input Ontology formally describes concepts and terms in customer integration including customer integration methods, customer inputs in the form of ideas, or idea evaluations as well as their interrelations. The core of the Customer Input Ontology is the representation of customer inputs and their interrelationships to support knowledge management in customer integration including capturing, structuring unstructured customer input, searching for, rating, tracking, grouping, or reusing customer input across departments, customer integration initiatives, and innovation cycles.

Ontologies can be represented with formal notations and graphs. We visualized the Customer Input Ontology including the classes, attributes, and relations using Unified Modeling Language (UML) (Bullinger 2008) as illustrated in Figure 7.

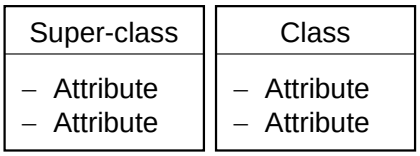
Visualization	Element
	**Classes** are visualized as **squares**. The **upper part** of the square shows the **name** of the class. In the **lower part**, the **bullet points** show the **attributes** of the class.
	**Relations** between classes are visualized with **arrows**. A short **notation** on the arrow indicates the **type of relationship** (e.g., evolves to class XY, has class XY, is a class XY). For instance, The class „Customer Input Type_Idea“ can evolve to the „Customer Input Type_Concept“.

Figure 7: Visualization of Elements used for the Customer Input Ontology
Own illustration based on Bullinger (2008)

3 Research Design

The research design defines the strategy for fulfilling the research objective and answering the research questions (Bhattacherjee 2012). One important aspect of the research design is the selection of research methods to collect data. Research methods are basically distinguished in qualitative and quantitative methods (Bhattacherjee 2012; Creswell 2003). Examples for quantitative methods are surveys or experiments; examples for qualitative methods are case study research, focus groups, expert interviews, and action research (Bhattacherjee 2012; Creswell 2003). This thesis follows a mixed-methods research strategy by combining qualitative and quantitative data to answer the aforementioned research questions. In the mixed-methods approach quantitative and qualitative methods are mixed in a single study or across a series of closely related research studies (Hanson et al. 2005; Creswell 2003). It has been found that combining qualitative and quantitative research methods can develop rich insights (Venkatesh et al. 2013).

For this doctoral thesis a mixed methods approach was particularly appropriate to answer research question 2. First, we followed a qualitative research strategy to explore the appropriate design of information systems, tasks, and marketing campaigns as well as the experience concept, and influencing factors and implications of a positive experience (P3). Based on these findings we collected and analyzed quantitative and qualitative data through experiments and focus groups in parallel to gain in-depth understanding of how to design for a positive user experience for customers using a toolkit for user innovation and design to customize a product (P4 and P5).

3.1 Research Methods

In this doctoral thesis, systematic analysis (literature review), design science research, experiments and focus groups are combined. The following sections (3.1.1 – 3.1.4) briefly introduce these methods. This includes a description of the characteristics and the steps of conducting each research method. We also describe the limitations of the research methods.

3.1.1 Literature Review

Reviewing past research is essential to any research endeavor (Webster/Watson 2002). A literature review aims at understanding and building on what already has been done (i.e., standing on the shoulders of giants), and identifying what still needs to be done (i.e., research gaps) (Baker 2000; Vom Brocke et al. 2009). Therefore, a literature review allows researchers to ensure rigor and relevance of their research. Relevance of research is improved by addressing a relevant problem and existing research gaps. Rigor of research is improved by using the existing knowledge base (Hevner et al. 2004; Vom Brocke et al. 2009).

A literature review is more than simply searching for papers, and subsequently collecting summaries of a number of papers (Levy/Ellis 2006). According to Webster/Watson (2002), "*an effective literature review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed"* (Webster/Watson 2002, xiii). From this definition, an

effective literature review needs to meet the following quality criteria: a) methodological analysis and synthesis of quality literature, b) provision of a firm foundation to a research topic, c) justification of the particular approach and methods taken to the research topic, and d) contribution of something new that advances general understanding of the research topic and adds to the existing knowledge base (Hart 1998; Levy/Ellis 2006). Additionally, a literature review needs to be of appropriate breadth, depth, consistency, clarity and brevity (Hart 1998).

In consequence, the process of identifying sources of relevant and high quality literature, searching for relevant literature, and subsequently analyzing and synthesizing the findings from the selected literature needs to be made as transparent as possible by researchers in order to proof credibility (Vom Brocke et al. 2009). Therefore, in the following we describe the main steps of a literature review process, which we applied in our publications P1 and P3.

Step 1 – Defining a search strategy: This first step includes the identification of key sources for relevant research articles, and the definition of a set of keywords to search the identified sources for relevant literature (Baker 2000). Leading journals and conferences of a research field are likely to include major, high quality contributions and should therefore be considered by researches when conducting a literature review. In case of a research topic of interdisciplinary nature, journals, conferences, textbooks, and online databases that provide access to other disciplines should also be included (Webster/Watson 2002). To systematically search these sources for relevant research articles, keywords that cover major themes and key issues related to the research topic should be defined (Baker 2000).

A thorough literature review should ensure that a relatively complete census of relevant literature is accumulated (Webster/Watson 2002). This can be achieved by reviewing the citations of identified research articles (i.e., backward search), and reviewing literature that cites the identified research articles (i.e., forward search).

Step 2 – Screening process in order to filter relevant literature: To narrow down the list of initially yielded research articles in step 1 to those that are relevant for the research topic (e.g., answering a specific research question), the identified research articles are assessed by analyzing the research articles' titles, abstracts, and full texts (Vom Brocke et al. 2009). In this context, researches should focus on research articles that address the core of the underlying research problem, rather than literature making a minor reference to the research topic (Levy/Ellis 2006).

Step 3 – Organizing and synthesizing literature: After collecting (step 1) and filtering relevant literature (step 2), the relevant research articles found need to be organized and synthesized (Vom Brocke et al. 2009). There are different approaches of organizing literature. Research articles can be organized according to their chronological order of publication, in an author-centric approach that lists and summarizes articles, in a concept-centric approach that groups research articles around similar ideas and concepts, or methodologically to group research articles that apply similar research methods (Cooper et al. 2009; Webster/Watson 2002).

According to Levy/Ellis (2006), the essence of synthesizing literature is *"to assemble the literature being reviewed for a given concept into a whole that exceeds the sum of its parts."* (Levy/Ellis 2006, 200). Thus, in the last step of the literature review, the main points of the research articles are extracted and reconstructed in a way that allows the advancement of general understanding of the research topic (Levy/Ellis 2006).

The findings of a literature review are limited by the defined search strategy and screening process including the selected databases, journals, keywords, and inclusion/ exclusion criteria to evaluate the relevance of identified papers.

3.1.2 Design Science Research

Information systems are implemented and used in organizations to improve the effectiveness and efficiency of the organization (Hevner et al. 2004). The design science research paradigm addresses the difficulties and wicked nature of designing useful information systems. It aims at ensuring the design of artifacts that enable productivity, meet business needs, and provide value to their users (Hevner/Chatterjee 2010).

Design science research can be defined as a research paradigm of creating innovative artifacts that solve relevant human problems, and thereby contribute new knowledge to the existing knowledge base. Therefore, artifacts need to be designed and implemented, and subsequently evaluated to check whether they actually address the problem (Hevner/Chatterjee 2010).

The term "artifact" describes something artificial, or constructed by humans rather than something natural (Simon 1996). An artifact can be a construct (vocabulary and symbols), model (abstractions and representations), method (algorithms and practices), or instantiation (implemented and prototype systems) (Hevner et al. 2004). In this doctoral thesis, we followed the design science paradigm, and in particular the three cycle view on information systems design as proposed by Hevner (2007) (*relevance cycle, design cycle, and rigor cycle*) to iteratively design, build, and evaluate IT artifacts that support companies in selecting appropriate customer integration methods (P2: DSS) and managing knowledge in customer integration (P2: DSS, P6: Customer Input Ontology, and P7: Customer Input Management System).

To ensure the *relevance* of an IT artifact to an existing problem, it is important to develop a sufficient understanding of the social, technical and organizational environment in which the artifact is intended to operate (March/Smith 1995). The organization as the application environment defines the design problem including people, organizations, their existing or planned technologies, goals, tasks, opportunities, and business requirements (Hevner 2007; Hevner et al. 2004). Therefore, in the *relevance cycle*, requirements which the design artifact needs to fulfill are identified in the specific application environment (Hevner 2007). These requirements can also serve as evaluation criteria in the *design cycle*.

The *rigor cycle* covers the iterative process of building on and adding to the knowledge base (Hevner 2007). The knowledge base accumulates previous research on foundational theories, methods, frameworks, instruments, constructs, and models that can be used to design and

evaluate artifacts. Further, fundamental to design science research is the generation of new knowledge by the design and application of the artifact (Hevner/Chatterjee 2010).

The two basic activities of the *design cycle* are building and evaluating an artifact (March/Smith 1995). In an iterative process of generating and evaluating (improved) versions of an artifact, finally a satisfactory artifact is achieved. The evaluation of design artifacts is usually conducted with regard to evaluation criteria such as functionality, completeness, performance, reliability, or usability (Peffers et al. 2006). Most of these attributes of an artifact are closely related to its application environment (*relevance cycle*). Approaches to rigorously evaluate artifacts are, amongst others, monitoring the use of the artifact in multiple projects (field study), in-depth study of the artifact in the business environment (case study), study of the artifact in controlled environments (experiment), execution of the artifact with artificial data (simulation), or execution of the artifact interface to identify failures (Hevner et al. 2004).

Figure 8 illustrates the three design science research cycles.

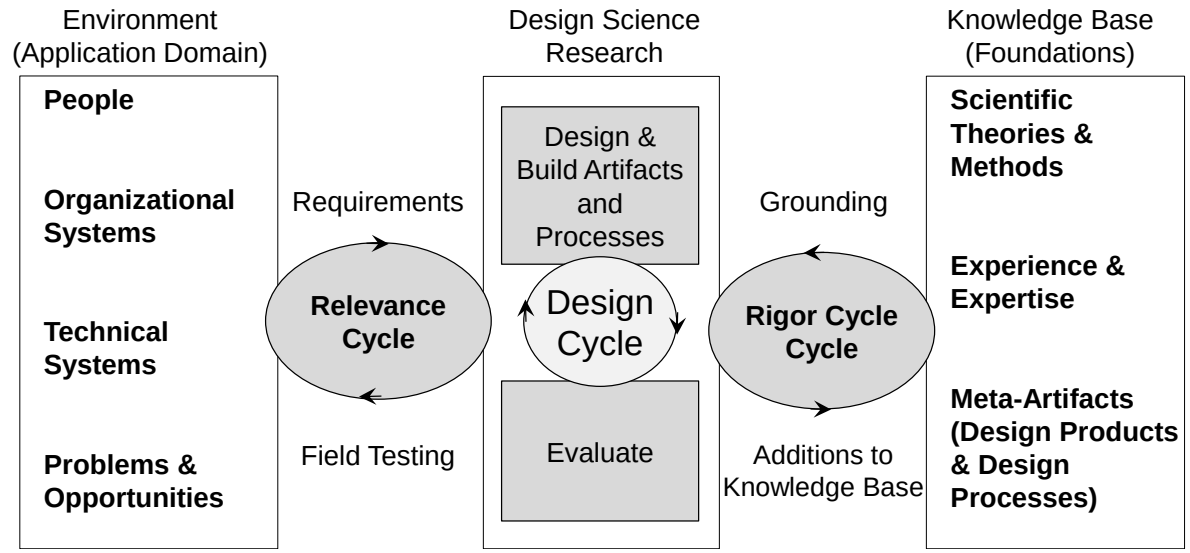


Figure 8: Design Science Research Cycles
Own illustration based on Hevner (2007)

The design science research paradigm is not without limitations. The design and evaluation of IT artifacts is strongly influenced by the application environment, its design problems, and requirements. Thus, IT artifacts may not be usable without adaptions in other application environments.

3.1.3 Experiment

There are basically two approaches to research. While the inductive approach relates to data collection and analysis to identify relationships between variables, the deductive approach moves towards hypothesis testing to confirm or modify existing assumptions and theories (Gray 2009). Experiments belong to the inductive approach to research.

In experiments, subjects are randomly assigned to either an experimental group that receives treatment, or a control group that does not receive the treatment (Gray 2009). The results of the treatment and control group are compared to each other to see whether the treatment made a difference. In this context, researchers manipulate independent variables (e.g., interface design) and measure the effect of the manipulation on the dependent variable (e.g., test scores or time required to complete a task) (Gray 2009). In the publications P4 and P5, this doctoral thesis employs a laboratory experiment to test the effect of the design of toolkit interfaces (hedonic and utilitarian interface design as independent variable) on individuals' emotional reactions (dependent variable measured through the construct task enjoyment) and perceptions (dependent variables measured through the constructs perceived process effort and experienced tool support).

In laboratory experiments, researchers have a great leverage of control over the selection and random assignment of participants to the treatment and control group (Levy/Ellis 2011). This randomization is essential to enhancing internal validity by ensuring that the measured effects and variations between treatment and control groups are actually determined by the manipulation of the independent variable rather than other influences (Levy/Ellis 2011). Further, to enhance validity of the measured effect of the treatment, the sample for the study should be as homogenous as possible. For instance, in a medical experiment mice breed as bear-identical siblings can be used. In IS research, participants that are similar in their characteristics can be used (e.g., IS students) (Levy/Ellis 2011). For the experiments conducted in terms of this doctoral thesis, we invited students in the fields of IS, engineering, and technology management to participate. In total 302 students participated with a mean age of 24.6 years. 218 (72.2%) of the experiment participants were male, 80 (26.5%) were female, and 4 (1.3%) refused to state their gender (see P5).

There are many variants of randomized experimental designs (e.g., basic design, pretest-posttest control group design, factorial design, longitudinal design) (Levy/Ellis 2011; Shadish et al. 2002). The experiment design used in this doctoral thesis (see P4 and P5) is a factorial design, which is therefore described in detail in the following. We selected a factorial design as it provides three major advantages: 1) A factorial design requires fewer units in terms of smaller sample sizes required, 2) allows testing combinations of treatments more easily, and 3) allows to test interactions among factors (Shadish et al. 2002).

A factorial experiment design uses two or more independent variables (called factors) (Shadish et al. 2002). Each factor has at least two possible values. An example is the comparison of Factor A having the values 1) one hour of tutoring and 2) four hours of tutoring, also compared to Factor B having the values 1) tutoring done by a peer and 2) tutoring done by an adult (Shadish et al. 2002). This 2x2 factorial design can be visualized by a matrix containing four cells (see Figure 9). Additionally, factors can be distinguished in between- and within-subjects factors. If a subject is exposed to one single treatment in an experiment, the experiment uses a between-subjects design. In contrast, a within-subjects design refers to the exposure of subjects to all of the treatments (Greenwald 1976). A mixed-factorial design is present, when an experiment contains both, at least one within-subjects and one between-subjects factor.

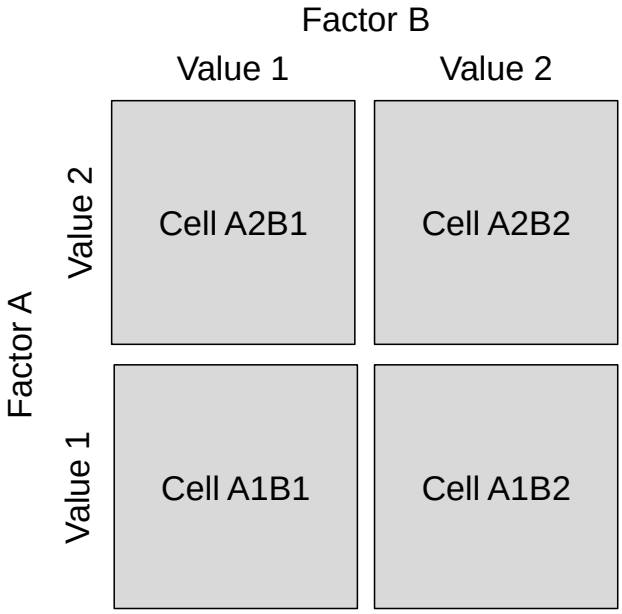


Figure 9: Factorial Experiment Design

In our research, we had two factors: toolkit interface design, and type of product attributes. Both factors had the two values: hedonic and utilitarian. All subjects performed the same task of customizing hedonic and utilitarian product attributes, but we made a distinction between the two groups of subjects by either providing a visual (hedonic) or a textual (utilitarian) toolkit interface. Thus, product attributes was our within-subject factor, and toolkit interface design our between-subject factor (see P4 and P5).

Experiment data is analyzed by using quantitative statistical techniques. Internal validity by controlling variables is the primary strength of experimental research. Researchers need to identify and control extraneous variables that can influence the dependent variable(s). In contrast, the weakness of experimental research is limited external generalizability of research findings (Bhattacherjee 2012).

3.1.4 Focus Group

The focus group method has found adaption not only in academic contexts but also in business (Billson 1989).

Rather than interviewing a single person, the focus group method uses group interaction encouraging the focus group participants to discuss ideas, ask questions, exchange anecdotes, and comment on each other's ideas (Kitzinger 1995). The strength of the focus group method is clearly the discussion, exchange, motivation, and inspiration of one another, also called “the group effect” (Morgan 1996). Additionally, the moderator of the focus group can ask the participants to compare their experiences themselves, instead of collecting individual data through e.g. interviews and speculating about how and why interview data differ (Morgan 1996). The focus group method is particularly applicable to gather in-depth information on people's knowledge and experiences. Focus groups not only allow researchers to examine what but also how people think (Billson 1989; Kitzinger 1995).

A focus group typically consists of about four to eight participants (Kitzinger 1995). Smaller group sizes facilitate deeper involvement of the participants as they give each individual participant more time to describe individual experiences and knowledge. In contrast, larger groups can generate a higher amount of responses and ideas (Morgan 1996). We applied the focus group method in our publication P5 to gain in-depth understanding of a person's perceptions and experiences when using toolkits for user innovation and design to customize an individual product. We started with a group size of six participants, and reduced the size to four participants after executing two focus groups. The reason for this change was the possibility to give more reserved persons more space and possibility to communicate their ideas. With an increasing number of participants some participants and in particular reserved persons were more likely to reside in the background.

A trained facilitator moderates the focus groups and prepares a semi-structured interview guideline of open-ended questions (Bhattacherjee 2012; Kitzinger 1995). The semi-structured interview guideline ensures that all relevant questions to holistically understanding a research problem are asked. Further, the use of a semi-structured interview guideline enhances standardization and therefore allows a high level of comparability across focus groups (Bhattacherjee 2012; Morgan 1996). Usually four to six focus groups are conducted until saturation is reached as little additional information can be obtained through further focus groups (Morgan 1996).

The focus group method and obtained research findings are subject to some limitations. For instance, internal validity cannot be established in focus groups as researchers lack control of several possible influencing factors. Therefore, focus groups findings may not be generalizable to other contexts and are more applicable for explorative and explanatory research endeavors (Bhattacherjee 2012; Billson 1989; Gray 2009).

4 Conclusion

In the following, this doctoral thesis concludes with a summary of the research findings (chapter 4.1), the implications of this cumulative doctoral thesis to research and practice (chapter 4.2 and 4.3), the study limitations (chapter 4.4) and future research possibilities (chapter 4.5).

4.1 Summary of Results

To substantially contribute towards answering the three research questions, we have written and published seven research articles. In the following, the findings of the seven publications are presented. We discuss the contribution of each publication to answering a specific research question.

Research question 1: How can companies be supported in the selection of appropriate customer integration methods? (RQ1)

Summary of results in P1 "A Matrix for Selecting Appropriate Customer Integration Methods"

Based on a structured literature review according to Webster/Watson (2002) this publication identifies costs, duration, required skills, number of customers, infrastructure, phase in the innovation process, and customer type as relevant decision criteria for the selection of customer integration methods (Füller et al. 2014a; Krcmar et al. 2014) (see Table 4). We used these decision criteria to evaluate five active customer integration methods (focus group, idea competition, idea community, lead user workshop, toolkit for user innovation and design) and to build a multi-dimensional decision matrix. The proposed decision matrix will help practitioners in selecting appropriate customer integration methods in a systematic manner considering multiple relevant decision criteria (Füller et al. 2014a; Krcmar et al. 2014). In the following, we briefly describe the identified decision criteria. As an excerpt of the decision matrix, for each decision criterion we exemplarily describe a customer integration method that fulfills the decision criterion.

Costs: Customer integration methods can be expensive. The costs can vary significantly, from high, medium to low, depending on the customer integration method (Fähling et al. 2011; Größer 1992; Reinicke 2004). To date, there is a paucity of research providing insights into specific costs of conducting customer integration initiatives and employing digital technologies to virtually co-create new products and services with customers. The costs of customer integration initiatives include the preparation, implementation, and post-processing (Reinicke 2004). Focus groups and brainstorming session cost approximately 1,000 to 5,000 Euro and can be assessed as rather inexpensive customer integration methods. With costs of up to 50,000 Euro the lead user method can be categorized as "medium". The lead user method consists of sequential steps in which the project is defined, trend analysis is conducted, lead users are identified, and ideas and product concepts are generated and

discussed with lead users. For Hilti the lead user method required 9 months and 51,000 $ (Herstatt/Von Hippel 1992). Customer integration methods such as online communities may even require investments in 7-digit area (Bjelland/Wood 2008) because some idea and online communities are permanent online platforms that require permanent staff to moderate discussions, answer questions, control for harmful content, and export and analyze customer ideas.

Duration: The duration of a customer integration method can be classified as high, medium, or low (Fähling et al. 2011; Größer 1992; Reinicke 2004). Duration of preparation and post-processing is excluded (Fähling et al. 2011). Customer integration methods including focus groups that can be executed in a relatively short time (e.g., an hour or less) require "low amount of time" (Jin et al. 2012b; Ozer 1999). In contrast, customer integration methods that take up to a day are classified as "medium". Customer integration methods such as idea communities, the lead user method, or idea competitions last for several days or months and therefore require "high amount of time" (Ebner et al. 2009; Fähling et al. 2011).

Required skills: The preparation, execution, and post-processing of customer integration methods requires specific methodical and technical skills of the company (Fähling et al. 2011). Missing competencies in a company pose a barrier to the use of customer integration methods. For instance, the company needs to possess interviewing skills to properly interview customers, to generate an atmosphere of trust and to elicit the required customer input (Bruseberg/McDonagh-Philp 2000). Further, companies require know-how of digital technologies to define an IT-based open innovation strategy and implement IT-based customer integration methods.

Number of customers: The different customer integration methods require a different minimum or maximum number of participating customers to generate the required customer input for innovation in sufficient quality and quantity. For instance, for focus groups and lead user workshops two to seven customers are required (Fähling et al. 2011), for brainstorming 12 participants are sufficient (Reinicke 2004), whereas idea competitions and idea communities need to attract a much higher amount of participation (n = 100 – 1000) (Fähling et al. 2011).

Infrastructure: The decision criterion infrastructure includes meeting rooms, software, or internet capabilities. For instance, meeting rooms are required for lead user workshops (Fähling et al. 2011). Internet capabilities are required from both the company and the customers to host and participate in e.g., idea communities.

Phase in the innovation process: Customer integration methods are only applicable to generate certain types of customer input. For instance, idea competitions and idea communities can be used by companies to collect ideas for new products and services. Toolkits for user innovation and design are applicable to deliver product designs into the middle phase of the innovation process, while prototype testing and complaint analysis are suitable to generate required customer input for the late and use phases of the innovation and product development process (Bretschneider et al. 2009; Nambisan/Baron 2007).

Customer type: Based on customers' knowledge and skills, they can be differentiated into lead users and ordinary users (Kristensson et al. 2004; Magnusson 2009). So called lead users are ahead of market trends and are experiencing needs which later will be experienced by many other users in the marketplace (Franke et al. 2006). Lead users can be integrated into innovation processes through lead user workshops (Fähling et al. 2011). In contrast, ordinary users lack technological know-how or domain-specific skills but can provide original ideas through e.g. focus groups (Fähling et al. 2011; Franke et al. 2006; Kristensson et al. 2004; Magnusson 2009).

Table 4 provides an overview of the identified decision criteria and an example of an appropriate customer integration method that fulfills the decision criterion.

Costs	Low [1,000 - 5,000 €] e.g., brainstorming	Medium [approx. 50,000 €] e.g., lead user method	High [approx. 100,000 - 1,000,000 €] e.g., product test
Duration	Low [approx. 1 - 2 hour] e.g., focus group	Medium [approx. 1 day] e.g., product test	High [several days or months] e.g., lead user method
Company skills	Not necessary	Partly necessary e.g., focus group	Necessary e.g., lead user method
Number of customers	1 e.g., interview	2 - 7 e.g., focus group	8 - n e.g., idea competition
Infrastructure	Meeting room e.g., focus group	Internet capabilities e.g., idea competition	…
Innovation process phase	Early phase e.g., brainstorming	Middle phase e.g., concept test	Late phase e.g., product test
Customer type	Ordinary user e.g., focus group		Lead user e.g., lead user method

Table 4: Summary of Identified Decision Criteria

Summary of results in P2 "Decision Support for the Selection of Appropriate Customer Integration Methods"

This publication presents an extension of our work in P1, by introducing a Decision Support System (DSS) that supports the selection of appropriate customer integration methods. We designed, implemented, and evaluated the DSS following the three cycle view on information systems design as proposed by Hevner (2007): relevance cycle, design cycle, and rigor cycle.

Based on a systematic literature review (rigor cycle) we identified requirements for the design of the DSS. Further, we identified customer integration methods that the DSS needs to include

in its knowledge base. We conducted expert interviews to ensure the relevance of our research (relevance cycle). Through 14 interviews with experts in relevant areas including sales, marketing, research and development as well as product and innovation management, we identified requirements for the design of the DSS. Further, the expert interviews helped us to verify and further deduce the identified decision criteria in P1. According to the interviewed experts, the selection of appropriate customer integration methods is primarily based on the phase in the innovation process, the customer type, and the available time and budget for the customer integration initiative. Therefore, these decision criteria are mandatory and need to be met by a customer integration method in order to be suitable.

Based on the literature review and the expert interviews, we derived technical specifications and functionalities of the DSS. The most surprising requirement identified from the expert interviews was the desire for reporting and analysis tools as well as a support of the DSS that goes beyond the mere selection of customer integration methods. To this end, the experts demand for use cases and guidelines to support the appropriate design and implementation of the selected customer integration method. Therefore, our DSS provides links to academic articles and case studies on the design and implementation of customer integration methods. Additionally, as experts would like to have access to the DSS at any given time and place, we implemented the prototype as a web-based tool in HTML5.

Figure 10 shows the different functionalities of the web-based DSS. For instance, the web-based DSS provides an overview of the various customer integration methods stored in the database as well as links to downloadable academic articles on the customer integration methods (Figure 10, top). Through a questionnaire, the DSS derives the required information from the decision maker in order to recommend suitable customer integration methods (Figure 10, bottom left). In a forum experts can share their experiences in using certain customer integration methods (Figure 10, bottom right).

To evaluate the DSS we conducted a survey of 12 experts. The prototype of the DSS was evaluated as being capable of acquainting practitioners with information on the different customer integration methods and providing extrinsic cues such as links to further external information on the different customer integration methods (e.g., academic research) (Füller et al. 2015b).

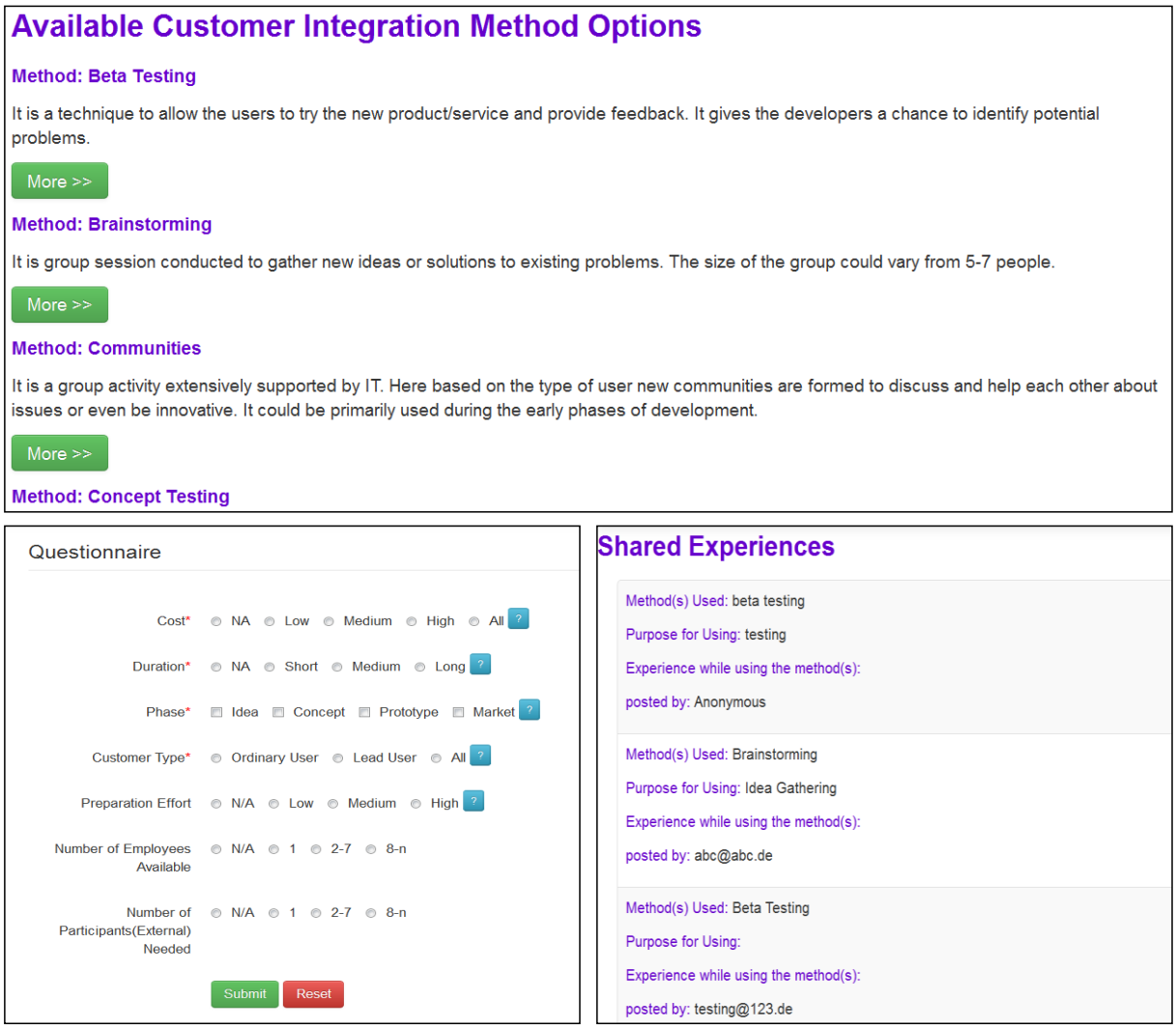


Figure 10: Screenshots of the User Interface to the Web-Based Decision Support System

Contribution of P1 and P2 to answer RQ1 "How can companies be supported in the selection of appropriate customer integration methods?"

Both publications (P1 and P2) offer insights into the decision criteria that are relevant to select suitable customer integration methods. We identified the decision criteria costs, duration, required skills, number of customers, infrastructure, phase in the innovation process, and customer type that guide the selection of suitable customer integration methods. Based on the expert interviews (P2), especially the decision criteria phase in the innovation process, customer type, costs, and duration are essential in practice to decide on the most suitable customer integration method.

Further, the publications P1 and P2 contribute customer integration methods that are frequently studied in literature and frequently used in practice as well as their evaluation with regard to the identified decision criteria. The outcomes of both publications can help companies to better understand customer integration methods, their benefits and prerequisites, in order to choose the most appropriate one.

According to our research and knowledge, there are no existing software solutions publicly available to simplify and accelerate the process of manually selecting appropriate methods. Therefore, our prototype of a DSS presents a first step to support the process of evaluating and selecting suitable customer integration methods. The experts evaluated the prototype as simple and easy to use. Additionally, the experts found that our DSS is useful in practice as it *"introduces a structured process to co-creating innovation with customers"*.

Research question 2: How can companies design IT-based customer integration methods with regard to a positive customer integration experience? (RQ2)

Summary of results in P3 "Leveraging Customer Integration Experience: A Review of Influencing Factors and Implications"

This publication sheds light on the discipline specific perspectives and approaches to study human experience (customer/ user/ flow/ co-creation experience). P3 derives influencing factors and implications of a positive experience, and discusses their relevance for the design of IT-based customer integration methods that create a positive customer integration experience.

Based on a structure literature review yielding 141 multi-disciplinary papers, we identified and classified the most frequently investigated influencing factors and implications of human experiences (e.g., customer/ user/ flow/ co-creation experience). In total, we identified 22 conceptually different influencing factors and 15 implications of customer integration experience. We organized these influencing factors and implications in four categories and analyzed their interrelatedness by drawing on motivation-hygiene theory.

Influencing factors that determine the experience that customers gain from participating in customer integration initiatives are (also see P3):

- The IT-based customer integration method including its non-instrumental (e.g., playfulness, aesthetics, design for competence, autonomy, relatedness) and instrumental (e.g., ease of use, usefulness, information presentation, relevance of content, security, privacy) qualities.
- The customer integration task (needs to be challenging but feasible, purposefully providing instructions and guidance).
- The customer including its personality and skills.
- The environment in which the interaction occurs.

Thus, in order to design IT-based customer integration methods with regard to a positive customer integration experience, companies need to consider these influencing factors and their interrelations. For instance, by applying motivation-hygiene theory in P3 we found that instrumental qualities as hygiene factors enable non-instrumental qualities as motivators. Instrumental qualities (e.g., ease of use, usefulness) ensure smooth interaction processes and intuitive co-creation systems that reduce the perceived burden, time, and effort required by customers to provide their input. Easy to use and intuitive IT-based customer integration methods (instrumental qualities) support the customers in successfully accomplishing their task which in turn results in positive emotions such as task enjoyment (non-instrumental qualities).

Implications of the customer integration experience are marketing-related, behavioral, emotional, and task-related implications. Marketing-related implications subsume positive impacts on a company's marketing related goals including enhanced customer loyalty and customer satisfaction (Nambisan/Nambisan 2008; Klaus et al. 2013). Willingness to

participate in customer integration initiatives in the future (Füller et al. 2011; Kohler et al. 2010) is an example for the behavioral implications of a positive customer integration experience. Further, the experience can influence customer's emotional reactions. Positive experiences were found to result in positive emotions such as fun while negative experiences can lead to negative feelings of frustration and failure (Éthier et al. 2006; Partala/Kallinen 2012). Finally, task/ innovation-related implications refer to the amount and quality of customer input (e.g., ideas) provided by customers (Füller et al. 2011; Kohler et al. 2010).

The proposed framework on influencing factors and implications of customer integration experience based on motivation-hygiene theory (see Figure 11), will help future research to explore the impact of specific factors on the customer integration experience in a more systematic manner. Further, the framework helps in gaining a more nuanced understanding of how to design for positive customer integration experience when using digital technologies to co-create innovations with customers.

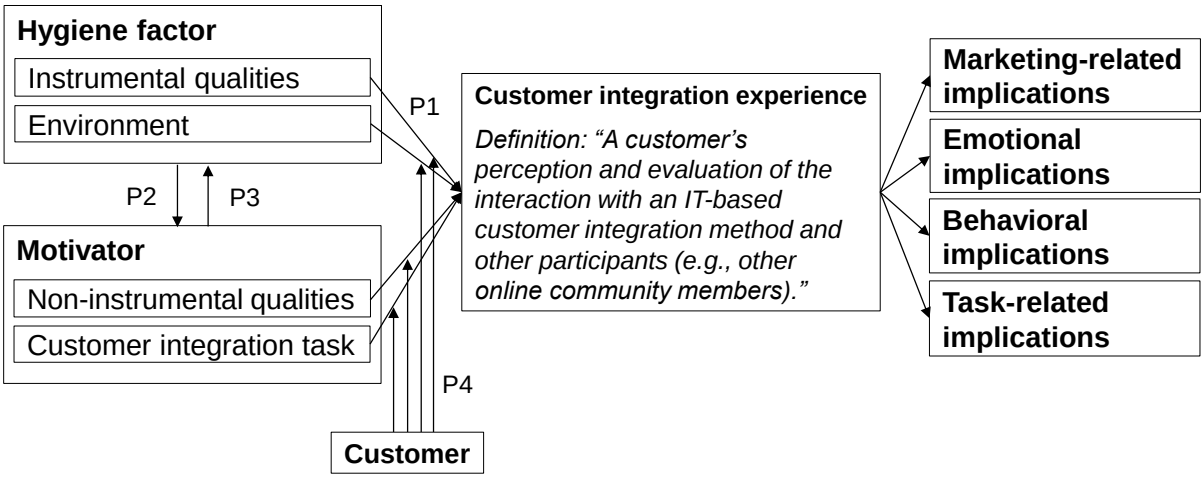


Figure 11: Framework on Influencing Factors and Implications of Customer Integration Experience based on Motivation-Hygiene Theory

Summary of results in P4 "Web-based Customer Integration for Product Design: The Role of Hedonic vs. Utilitarian Customer Experience"

In publication P3 we identified several influencing factors on the experience customers' gain from participating in customer integration initiatives. Key factors determining the customer integration experience are the customer integration method's instrumental/ utilitarian (e.g., usefulness, ease of use, information presentation) and non-instrumental/ hedonic qualities (e.g., visual design). Based on these findings, P4 describes an experiment idea and design to test the effect of the utilitarian design element "detailed information" and the hedonic design element "visualization" on participants' emotional reactions and perceptions.

We selected toolkits for user innovation and design as a case example for an IT-based customer integration method since toolkits assign customers with the active task of co-designing products. Toolkits for user innovation and design need to be designed in a way that

generates positive customer integration experience in order to keep customers engaged and prevent customers from abandoning the product design process.

The compatibility principle proposes that stimuli, matching the provided task, evoke appropriate response (Fitts/Deininger 1954; Kornblum/Lee 1995). For instance, vocal response is faster when the given stimulus is auditory, whereas a visual response is faster after a pointing-stimulus (Shafir 1993). Based on the compatibility principle we propose a match of a hedonic toolkit for the design of hedonic products and product attributes, and a match of a utilitarian toolkit for the design of utilitarian products/ product attributes in order to generate a positive customer integration experience and thereby to positively influence customers' emotional reactions (emotional implications), actual contribution (task/ innovation related implications), and willingness to contribute (behavioral implications). Figure 12 illustrates our research model on the compatibility of the design of toolkit interfaces and the product to be customized by customers. In P4 we also propose an experimental setup to test the research model.

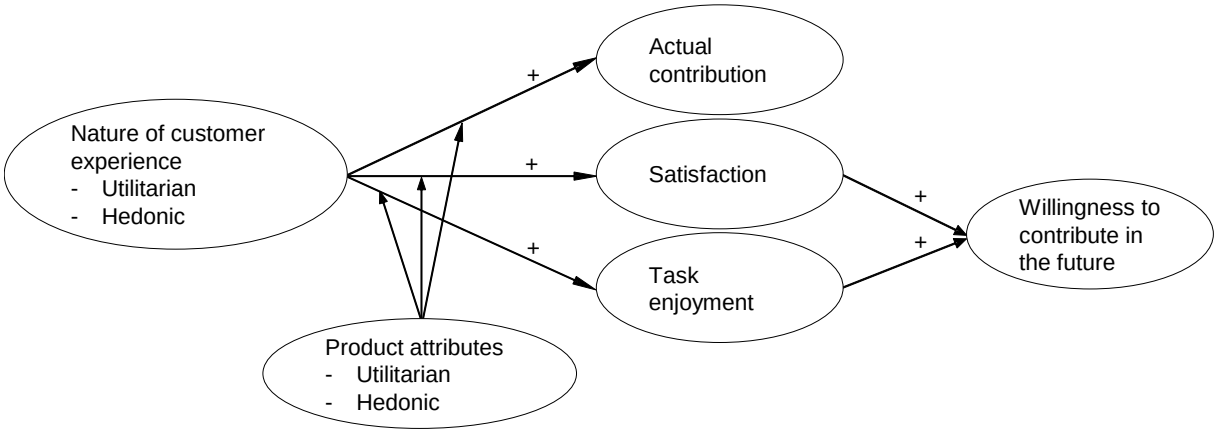


Figure 12: Research Model on the Compatibility of Toolkit Design and Product Type

Summary of results in P5 "Designing for Positive User Experience in Product Design: A Qualitative Analysis of Toolkit Design Elements and their Implications on Emotional Reactions and Perceptions"

In P5, we conducted the experiment as proposed in P4. After the experiment sessions, we conducted focus groups with some of the experiment participants to gain in-depth understanding of the product customization process, the toolkit design elements that made the process most/ least enjoyable, and ideas for improvement of the toolkit designs. We conducted 5 hedonic focus groups with participants after using the hedonic toolkit to customize a car. Analogously, we conducted 5 utilitarian focus groups, and 5 control focus groups. In total 64 students participated in 15 focus groups.

In this publication we compared the findings from the different focus groups (hedonic vs. utilitarian vs. control) to examine whether there are differences in participants' perceptions and emotions due to the three different toolkit interfaces. This research allowed us to systematically and separately investigate the influence of a single design element, and to gain

in-depth understanding of the implications of a toolkit design element on the emotional reactions and perceptions of individuals.

The final result of this publication is a summary of identified toolkit design elements and the linkage to the consequences of implementing these toolkit design elements. For instance, we found different *visualization* techniques including 3D visualization, videos, animations, or the selection of backgrounds, and their positive impact on realistic product understanding, virtual product experience, enjoyment, playfulness, clearness, and transparency. *Detailed information* provided in adequate amount, structure, and presentation formats was found to enhance clearness and transparency. It further supports customers in evaluating and selecting options. *Detailed information* also satisfies people's need for mental stimulation and learning about the current state of technology. Further, toolkit design elements that need to be considered by companies in order to designing toolkits for user innovation and design that are capable of providing a positive experience are the solution space and access to extrinsic cues in the form of discussion boards, blogs, communities. Additionally, access to retailers, and the recommendation of options, pre-configured products, or frequently selected options based on a customer profile are beneficial.

A further major contribution of this publication is the discussion of our findings with regard to the five layers of the model "The elements of user experience" by (Garrett 2006, 2010) (see Figure 13). The model comprises the five layers *strategy*, *scope*, *structure*, *skeleton*, and *surface*. The model allowed us to derive design guidelines for toolkits that provide a positive user experience referring to a specific layer of the model.

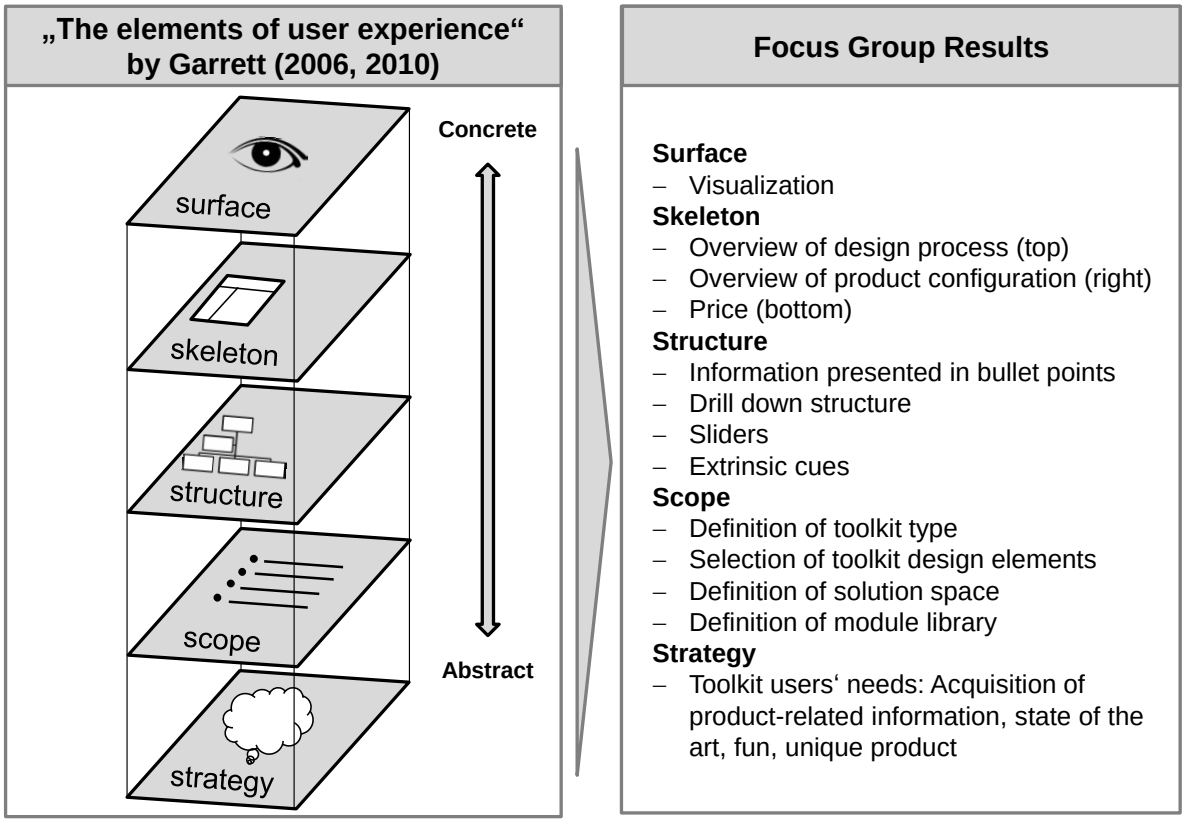


Figure 13: Application of Focus Group Results
Own illustration based on Garrett (2006)

Concerning the layer *strategy*, we identify the primary needs and goals of toolkit users, which encompass the acquisition of product-related information, learning about the state of the art, customization of a product for fun, and purchase of a unique, self-designed product.

The layer *scope* refers to content and functionalities that the toolkit needs to include in order to allow toolkit users to satisfy these needs. Based on our focus groups, we suggest the design of a hierarchically structured solution space that firstly asks the user to select the model of the product, then requires the user to customize some mandatory (utilitarian and hedonic) product attributes, and allows the customization of additional product attributes if desired by the toolkit user.

The *structure* refers to the user's navigation through the website. For this layer, we suggest the optimal provision of detailed information through bullet points. Further, information can be provided in a drill down structure that offers further information for interested users without overwhelming other users. Slide controls can be used to visualize the effects of selections on the product performance (e.g., engine type on speed and acceleration).

At the layer *skeleton* designers need to consider the proper selection and arrangement of elements and controls in the toolkit interface (e.g., text input fields, boxes). Based on our focus groups, we recommend a progress bar on the top of the website, an overview of the configuration (e.g., on the left side), and information on the overall price of the product (e.g., on the bottom of the site).

The layer *surface* describes how the design supports the user and its sensory experience. Based on our focus groups, we identified toolkit design elements that can positively influence users' emotions (e.g., enjoyment) and perceptions (e.g., realistic product understanding, decision support).

Contribution of P3, P4, and P5 to answering RQ2 "How can companies design appropriate IT-based customer integration methods with regard to a positive customer integration experience?"

In P3, P4, and P5 we provide detailed answers for practitioners concerning the appropriate design of IT-based customer integration methods with regard to a positive customer integration experience.

In P3 we identify influencing factors and implications of a positive customer integration experience by conducting a multi-disciplinary literature review. Overall, we can see that human experience is researched in different disciplines. While information systems research concentrates on the design of appropriate information systems to enhance user acceptance and users' continuance intentions (Chen et al. 2004; Wang/Scheepers 2012), marketing and management literature aims at the design of appropriate online and offline stores that positively influence customers' shopping experience and thereby results in enhanced customer loyalty and positive word-of-mouth (Sathish/Venkatesakumar 2011; Verhoef et al. 2009). Under the concept of flow experience, the discipline of psychology researches the

optimal design of tasks, and the implications on individuals' enjoyment, focus, and perception of time and place.

According to our multi-disciplinary literature review in P3, few customer integration research has applied the concept of customer and user experience to analyze the design of customer integration methods (Kohler et al. 2010; Nambisan/Watt 2011; Nambisan/Nambisan 2008). We identify 141 relevant papers, of which only 26 papers address customer integration/ co-creation experience. Previous customer integration research particularly focused on the design for autonomy, competence, and relatedness (Füller et al. 2011; Matzler et al. 2011). With P3, we contribute a framework summarizing influencing factors and implications of the customer integration experience, and their interrelatedness. Further, we point out directions for future customer integration research concerning the design of IT-based customer integration methods and customer integration experience.

While P3 provides a general overview of existing research on influencing factors and implications of a positive customer integration experience, P4, and P5 delve deeper into the appropriate design of toolkits for user innovation and design as a case example of an active IT-based customer integration method. P4 describes an experiment idea, which was subsequently conducted. P5 presents the qualitative results of the focus groups that we conducted with a subset of the experiment participants after using a car configurator – a toolkit for user innovation and design – to self-design a car to their individual preferences.

Together, P4 and P5 provide extensive insight into hedonic toolkit design elements (visualization techniques including 2D pictures, 3D product presentation, videos) and utilitarian toolkit design elements (information amount, structure, presentation formats, slide controls, information on costs), and their implications on toolkit users' emotional reactions and perceptions. This allows toolkit designers, to purposefully select from a range of toolkit design elements.

Based on the user segment targeted and the resource constraints (e.g., time, budget) faced by the company, the toolkits can be designed as a utilitarian toolkit, a hedonic toolkit, or a hybrid toolkit including both hedonic and utilitarian toolkit design elements. Further, the solution space can be designed from small to large. Based on our qualitative research in P5, there are different preferences of individuals to design hedonic or utilitarian product attributes. Thus, the solution space of a toolkit should be adapted to the user's individual preferences. To this end, a hierarchically structured solution space can be implemented (see P5).

The findings of P4 and P5 are not only applicable for appropriate toolkit interface design, but are also relevant for the design of other IT-based customer integration methods including lead user workshops, conjoint analysis, idea competitions, or idea communities. As our results show, IT-based customer integration methods can be designed in a way that either hinders or fosters creativity and enjoyment. Previous research found that a compelling experience can enhance the quality and quantity of customer contributions to the innovation process (Füller et al. 2011; Kohler et al. 2010). We confirm these research findings with publication P5. By analyzing and comparing the hedonic, utilitarian, and control focus groups, we experienced

differences in the participants' moods and creativity. The discussions in the hedonic focus groups were more vivid than in the utilitarian or control focus groups.

Further, we can confirm existing research on the positive impact of a compelling customer integration experience on fun and enjoyment (Éthier et al. 2006; Partala/Kallinen 2012). Participants using a utilitarian or control toolkit were more frustrated and in a more negative mood than participants that used the hedonic toolkit: *"The missing visualization made the customization process very tedious and very abstract. There were no playful elements."*; *"For the first time, I used a non-visual toolkit and that was an extremely horrible experience for me."*

Overall, with our P3, P4, and P5 we advance general understanding concerning the design of appropriate customer integration methods with regard to a positive customer integration experience.

Research Question 3: How can companies manage knowledge in their innovation processes? (RQ3)

Summary of results in P2 "Decision Support for the Selection of Appropriate Customer Integration Methods"

In this publication we followed the design science paradigm (Hevner 2007; Hevner et al. 2004) to design, implement, and evaluate a DSS to support the selection of appropriate customer integration methods.

According to the experts interviewed, besides support for the selection of an appropriate customer integration method, support is also required for the appropriate design and implementation of selected customer integration methods. Therefore, we incorporated short introductions to the different customer integration methods, access to academic research on the methods, and a forum that enables practitioners to discuss challenges and share their experiences with particular customer integration methods. Thereby, the DSS enables the documentation and sharing of knowledge from previous customer integration, and to improve customer integration instead of making the same mistakes in customer integration initiatives over and over again. The prototype of the DSS was evaluated through a survey among 12 experts. Here, the experts found that the DSS provides relevant information and access to academic research on the different customer integration methods (Füller et al. 2015b).

Summary of results in P6 "Knowledge Management in Customer Integration: A Customer Input Ontology"

This paper proposes the Customer Input Ontology as means to address the existing challenge in practice of managing customer input (Franco et al. 2010; Song et al. 2013; Yang/Chen 2008; Zhang et al. 2011). The management of customer knowledge and customer input includes the documentation of customer input as well as the search, sharing, and (re)use of customer input across departments and innovation cycles.

An ontology can serve as a basis to foster common understanding, interoperability between tools, and cross-enterprise collaboration. The core of the Customer Input Ontology is the representation of customer inputs and their interrelationships to support companies in managing the customer inputs obtained by customer integration initiatives. The Customer Input Ontology provides a common format to capture and interchange customer input and therefore to facilitate knowledge sharing and reuse across departments and companies.

Based on a structured literature review following the recommendations of Webster/Watson (2002), we identify nine types of customer input and ten associated characteristics of customer input that customers can provide, and which the Customer Input Ontology therefore needs to consider. Customers can provide: Customer needs, preferences, requirements, ideas, concepts, prototypes, idea evaluations, concept evaluations, prototype evaluations, and feedback on existing products and services (positive feedback, or negative feedback in the

form of online reviews or complaints). Customer inputs are characterized by their quantity and quality. The quality of an idea is determined by its elaboration, relevance, feasibility, and novelty (Blohm et al. 2011a). Validity, completeness, and fidelity are characteristics of prototypes and prototype evaluations contributed by customers to the innovation process (P6) (Füller et al. 2015a).

For ontology design, we followed the ontology development approach by Noy/McGuinness (2001) as it focuses on the reuse of existing ontologies which is a desirable attribute of ontology design. Based on a second literature review, we identified two existing ontologies which include components that can be reused in the design of the Customer Input Ontology. We incorporated and adapted the class "Participant" and its subclasses "Internal Participant" and "External Participant" of the OntoGate Ontology by Bullinger (2008), since these classes cover all critical elements to describe the internal or external origin of a customer input. Further, we adapted the class "Customer Integration Method" from the OntoGate Ontology. This class allows the linkage of the customer input to the customer integration method with which it was generated.

Figure 14 illustrates our Customer Input Ontology. The different types of customer input are modelled as sub-classes of the class "Customer Input". The different characteristics a customer input can have (e.g., quantity, novelty) are modelled as attributes of the different customer input types. Additionally, customer inputs have the attributes title, abstract, description, creation date, and version as well as the relationships (has attachment, has realization). These attributes and relations are reused from the Idea Ontology developed by Riedl et al. (2009).

Based on the classes "Participant" (including "Internal Participant" and "External Participant"), "Customer Integration Method", and "Customer Input" as well as their interrelations, companies can identify creative external participants that provide customer input that are rated as of high novelty and quality. Further, internal participants (i.e., employees) responsible for successful customer integration initiatives, customer integration methods that lead to high quantity and quality of customer input (cost and duration of customer integration in relation to obtained customer input), or the development of customer input over time (idea, idea evaluation, concept, prototype) can be tracked and analyzed.

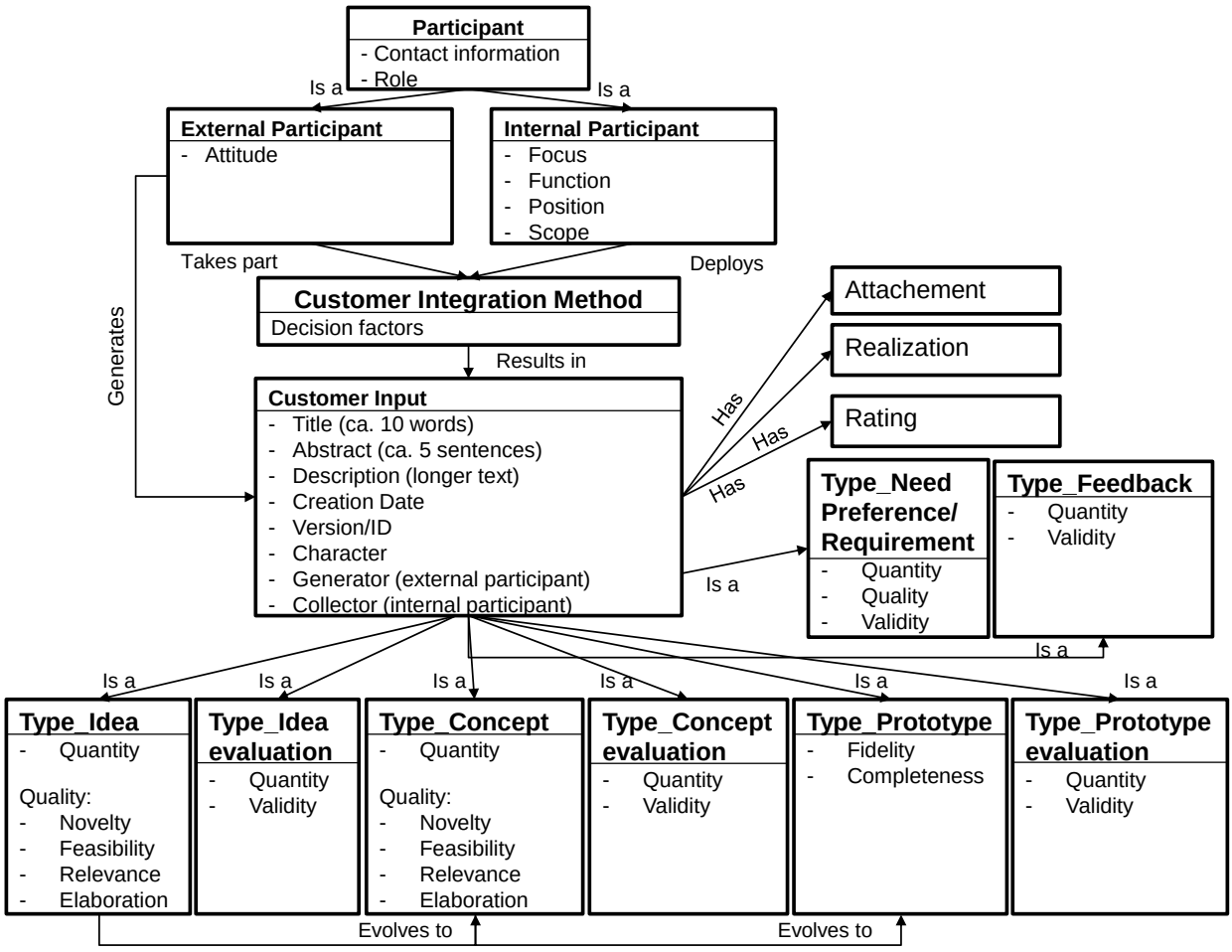


Figure 14: Customer Input Ontology

Summary of results in P7 "Knowledge Management in Customer Integration: A Customer Input Management System"

This publication presents an extension of our work in P6. In this publication (P7), we introduce a prototypical software platform for the management of customer input. We called the developed software solution "Customer Input Management System". The Customer Input Ontology served as a basis for deriving the data schema and requirements for the Customer Input Management System. Similarly to the design, implementation, and evaluation of the DSS in P2, we developed the Customer Input Management System following the three cycle view (relevance cycle, design cycle, and rigor cycle) of the design science research paradigm (Hevner 2007).

We ensured rigor of our research by conducting a literature review to integrate existing knowledge on approaches to organize customer inputs into the design of the Customer Input Management System (rigor cycle). Further, the literature review served to derive requirements for the design of the Customer Input Management System. According to our literature review, existing customer integration research focuses on digital technologies and IS implementations to generate customer input required for innovation. Research on administrative information

systems to manage huge amounts of heterogeneous customer inputs resulting from customer integration initiatives are scarce (Hrastinski et al. 2010). Additionally, customer integration research focuses on the generation and management of customer input in the early stages of the innovation process (e.g., Blohm et al. 2011c; Gassmann et al. 2005; Huang et al. 2011; Leimeister et al. 2009). Therefore, in P6 and P7 we propose more holistic and administrative solutions to knowledge management in customer integration.

To further verify and deduce the types and characteristics of customer input identified through our literature review in P6, and to elicit requirements for the design of the Customer Input Management System from the application environment, we conducted 12 expert interviews (relevance cycle). Based on our expert interviews, the software solutions used in practice appear to have little maturity. Standard office tools or self-designed tools are applied to capture, store, and edit customer input. Microsoft Office solutions including PowerPoint and Excel are frequently used, but raise problems of simultaneous work, tracking of changes, versioning, and redundancy since many inputs are written and stored in different places. Frequently, different departments use different software solutions to deal with a specific type of customer input in their daily business. For instance, marketing departments use customer relationship management (CRM) solutions, requirement management uses software tools to track requirements, and software development uses solutions that allow to track requirements and the status of software projects. These multiple solutions used in different departments to handle different types of customer input hinders interoperability, sharing, and reuse of customer input across departments and innovation cycles.

The insights from the literature review (rigor cycle) and expert interviews (relevance cycle) were combined in the design cycle, were we classified the requirements in functional and non-functional requirements, and derived functionalities of the Customer Input Management System. For instance, we found that the Customer Input Management System needs to simplify and accelerate the management of customer input, since many companies lack in time and other resources to manage customer input manually. To this end, we incorporated a tagging feature, which parses a text provided by customers and automatically suggests product related keywords or terms (see Figure 15, bottom right). Additionally, the Customer Input Management System provides tools to visualize and analyze customer input (see Figure 15, top left). A further important requirement was restricted access and permission of users to view, create, or modify data in order to ensure security of customer information. This requirement was met by restricting access to the software though user accounts and passwords.

To evaluate the proper functionality of the Customer Input Management System and proper implementation of the identified requirements, we 1) imported large amounts of customer input obtained through previous research projects, and 2) provided industry experts with the link to our web-based software and a survey to provide their feedback. In total, 18 experts evaluated the Customer Input Management System with regard to 16 questions concerning purpose and strategy, content and functionality, navigation and interaction, as well as media design and presentation of the Customer Input Management System. Overall, the evaluation of the Customer Input Management System was satisfactory. The Customer Input

Management System can be improved by incorporating analysis tools as well as text mining and sentiment analysis tools to automatically tag customer input, and identify and import relevant customer reviews, opinions, and ideas from social networks or online reviews from amazon.com. Additionally, IT-Security can be improved by applying the role-based access control approach to ensure data privacy.

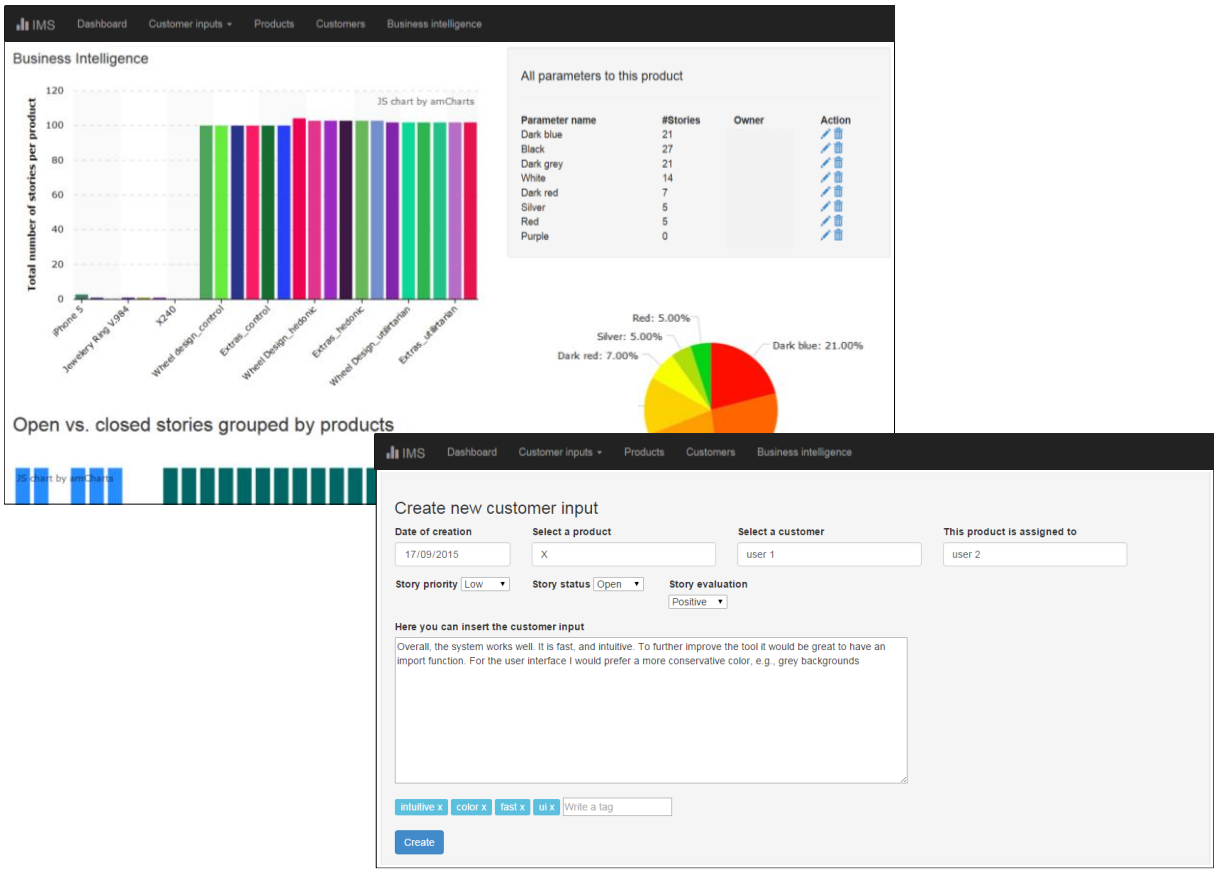


Figure 15: Screenshots of the Use Interface to the Customer Input Management System

Contribution of P2, P6, and P7 to answering RQ3 "How can companies manage customer knowledge in their innovation processes?"

After having selected, designed, and executed a customer integration method, companies face the challenge of managing the obtained customer input and the lessons learned of conducting a customer integration project. A central challenge in customer knowledge management and the use of customer input for innovation is data redundancy due to data stored in different places, and as a consequence a missing overview of available customer input (Alavi/Leidner 2001; Reinicke 2004). This leads to the collection of customer input that is already there, and repeatedly making the same mistakes when it comes to co-creating innovations with customers (Alavi/Leidner 2001; Reinicke 2004). A further major problem is the evaluation of customer input in order to filter relevant customer input from a huge amount of customer input (Riedl et al. 2010).

The introduced DSS in P2 helps companies to tackle the challenge of knowledge documentation and retrieval. The DSS provides a knowledge base of different traditional non-IT and IT-based customer integration methods. Additionally, the DSS includes a forum that allows experts to post, share and discuss their previous experiences and lessons learned with applying customer integration methods and digital technologies to co-create innovations with customers. Therefore, the DSS enables companies to document and share their knowledge on customer integration methods and initiatives. Furthermore, the DSS provides access to academic research on the different customer integration methods. Hence, the DSS poses an approach to bridge the gap between the theoretical concept of customer integration and research findings of academia and its implementation in practice.

The tackle the challenge of documenting and analyzing a huge amount of obtained customer data, in P6 and P7 we develop two administrative tools to support customer knowledge management. P6 introduces the Customer Input Ontology that provides a common understanding of the customer input concept across different disciplines and departments. This helps different departments and involved stakeholders from different disciplines and backgrounds to understand the input that customers can provide into innovation processes and how it needs to be documented in order to be useful for other departments and stakeholders. Therefore, the Customer Input Ontology supports companies in capturing and storing customer input in a common format, which in turn facilitates the sharing and reuse of customer input across departments, companies in innovation networks, and innovation cycles.

Based on the Customer Input Ontology, we derived the data scheme of the Customer Input Management System (P7). The Customer Input Management System poses a first prototype that allows different departments such as marketing, sales, research and development, innovation, and product management to insert, search for, analyze, and use customer input. The Customer Input Management System supports the whole innovation process from idea generation to prototype testing and market launch. Therefore, the Customer Input Management System allows executives to monitor and derive reports concerning customer input management and innovation projects. Concerning the problem of scarce resources for innovation projects, the Customer Input Management System can help managers in monitoring the overall number of customer integration initiatives or the obtained amount of customer input that needs to be analyzed in order to better estimate and allocate resources.

Figure 16 summarizes the key findings of this thesis with regard to the three research questions that guided this research endeavor.

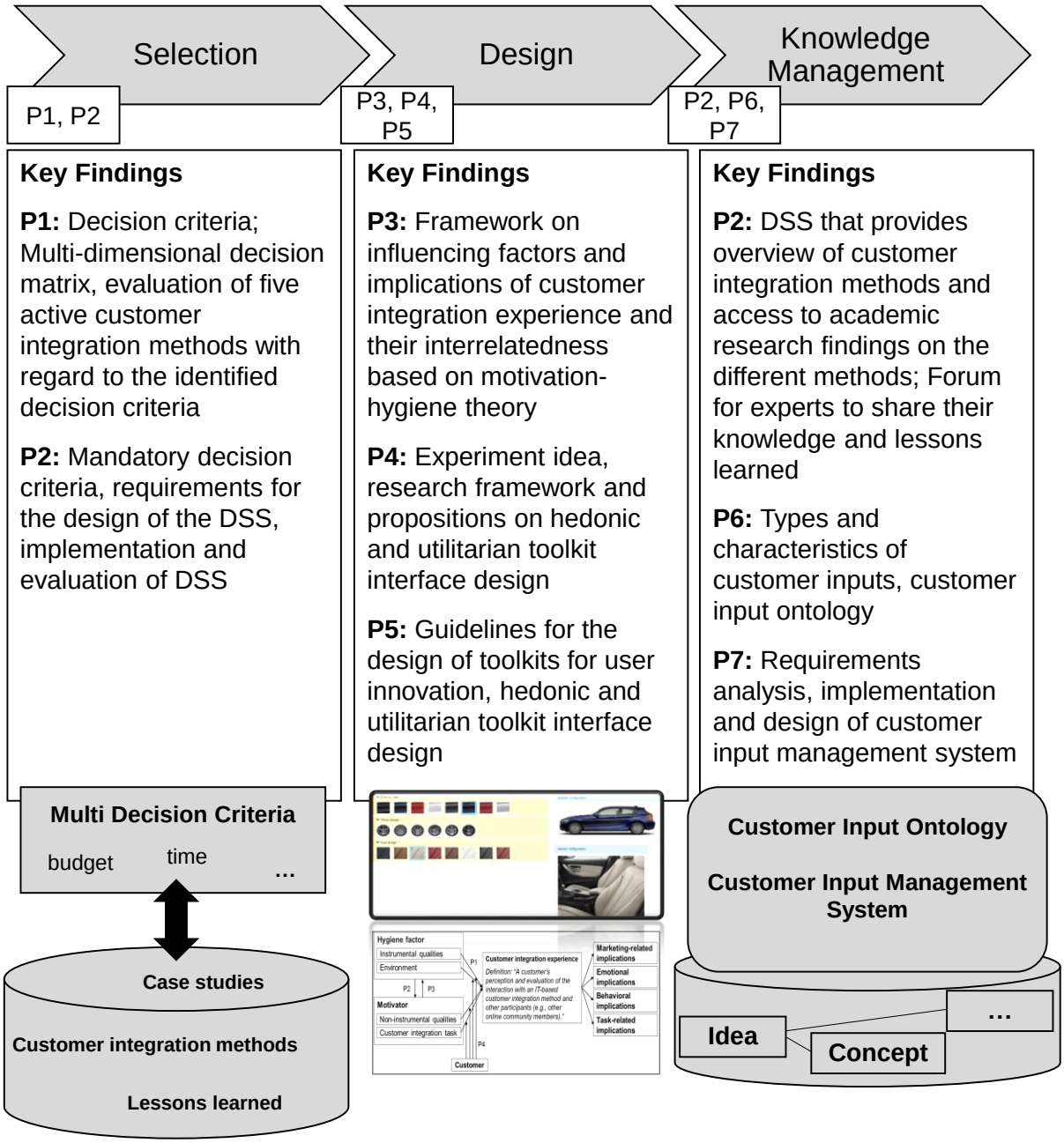


Figure 16: Overview of Results

4.2 Implications for Research

This doctoral thesis has several implications for customer integration research by addressing three central challenges to customer integration, each associated with a specific phase in the customer integration process.

1) Concerning the challenge of selecting customer integration methods, this thesis contributes to research seven decision criteria that need to be considered for the decision of which customer integration method is the most appropriate one (P1). With our multi-dimensional decision matrix we extend existing literature that basically provides two- or three-dimensional matrices and frameworks for the classification of customer integration methods (P1). Further, customer integration literature is fragmented (Alam 2002; Reichwald et al. 2004). Different research articles study, develop, and evaluate different customer integration methods. We contribute to research, by providing a structured overview and evaluation of different active and passive customer integration methods with regard to the decision criteria. The knowledge base of the DSS accumulates and provides access to an extensive body of research on customer integration methods (P2).

2) As for the challenge of designing customer integration methods that create a positive experience, we analyzed 141 relevant research articles from multiple disciplines. Based on motivation-hygiene theory, we contribute a framework that provides insight into the factors determining a positive customer integration experience and their interrelations. The framework comprises 22 conceptually different influencing factors and 15 implications of customer integration experience. Additionally, we synthesize the state of research on the different influencing factors and implications and therefore provide a research agenda for future research on customer integration experience (P3).

   Moreover, by focusing on the appropriate design of toolkits for user innovation and design, we address the design phase of the innovation process that is less researched compared to the early phases of idea generation and evaluation (P4 and P5). Concerning the design of toolkits for user innovation and design, existing literature proposes rather generic design elements including an appropriate solution space, module library, and a trial-and-error process (Prügl/Schreier 2006; von Hippel/Katz 2002). We contribute to research an extended list of toolkit design elements and their implications on toolkit users' emotional reactions and perceptions (P4 and P5).

3) The challenge associated with the last step of the customer integration process concerns the appropriate management of knowledge and expertise in customer integration. There is a lack of appropriate solutions and common languages in companies to systematically store, integrate, share knowledge across departments and customer integration initiatives (Song et al. 2013). Further, existing research provides ontologies, frameworks, and software solutions that address the early phases of generating and evaluating ideas (Bullinger 2008; Hrastinski et al. 2010; Riedl et al. 2009). We address this research gap by proposing more holistic solutions for companies to manage knowledge across all phases of the innovation process. Further,

in contrast to previous research that basically distinguishes in need and solution information (von Hippel 1994; von Hippel/Katz 2002), the proposed Customer Input Ontology provides a more detailed differentiation of customer input (P6).

4.3 Implications for Practice

Our research bears several implications for practice:

1) From a practical perspective, the proposed decision matrix supports practitioners in the process of selecting customer integration methods that are suitable to generate the needed customer input in sufficient quality and quantity, within time, budget, and other resource constraints (P1). To support the manual decision process, we propose a web-based knowledge-driven DSS that recommends suitable customer integration methods to the decision maker based on the provided input. The DSS searches for customer integration methods in its knowledge base that fully or partially match the decision marker's input concerning the phase in the innovation process, customer type, available budget, time, and personnel for the customer integration initiative. According to the experts that used and evaluated the DSS, it is capable of acquainting practitioners with information and research articles on the different customer integration methods. Further, it provides the possibility for experts to post their experiences with certain customer integration methods in a forum. Therefore, the DSS can function as a platform between experts and researchers to exchange research findings on customer integration and the implementation of customer integration in daily business (P2).

2) For practitioners, we contribute guidelines for the design of customer integration methods. When companies plan to design IT-based customer integration methods, they need to consider the customer integration tool including its instrumental and non-instrumental qualities, the customer itself, the customer integration task, and the environment in which the interaction occurs. Further, practitioners need to acknowledge that instrumental qualities including ease of use, usefulness, and customers' security and privacy issues need to be addressed in order to create a sound basis for non-instrumental qualities (e.g., playfulness, visualization) to evoke customer motivation and customer satisfaction (P3).

   By conducting focus groups with students after using a toolkit to customize a car, we analyze the non-instrumental/ hedonic design element *visualization* and the instrumental/ utilitarian design element *detailed information*. We identify *visualization* as an important design element as it provides customers with visual feedback, which makes it easier for customers to grasp the virtual product. Further, *visualization* helps in being creative and articulating preferences. Most importantly, *visualization* generates positive emotions and a flow state, which is crucial to keeping customers engaged. The design element *detailed information* generates mental stimulation, supports transparency and understanding of the virtual product, its attributes, and functionality (P5).

3) Concerning knowledge management in customer integration, we propose solutions for practitioners to document and exchange knowledge in their innovation processes. In P2, we propose a DSS that allows experts to share their knowledge and lessons learned in customer integration. Further the DSS stated that the developed DSS can serve as a platform to bridge the gap between the theoretical concept of customer integration including the methods that can generally be used to co-create innovations with customers and the mundane functioning of daily business.
   The Customer Input Ontology acquaints presented in P6 acquaints practitioners with a common understanding of the core concept of customer input that can foster information sharing and interoperability between tools (P6). Based on the Customer Input Ontology, we designed the Customer Input Management System that supports companies in the last step of the customer integration process. It provides functions to insert, import, export, tag, and analyze customer input. Through structure analysis or big data and other data analysis techniques, companies can analyze the stored customer data, e.g., with regard to customer integration methods that particularly result in high/ low quality and quantity of customer contributions, or circumstances (e.g., number of customers, composition of customer group, atmosphere) of successful vs. less successful customer integration initiatives. Thus, this analysis allows companies to learn about internal and external factors influencing the success or failure of their customer integration initiatives (P7).

4.4 Limitations

As any research endeavor, this doctoral thesis and the embedded publications are subject to several limitations. In the following, we discuss the thesis limitations regarding the three research questions that guided this research endeavor.

1) The first challenge in customer integration and the corresponding research question has been tackled by conducting a structured literature review and applying the design science research paradigm. Thus, the identified seven decision criteria, the customer integration methods stored in the knowledge base of the DSS as well as their evaluations with regard to the degree to which they fulfill the decision criteria are limited by the scope of the literature review (i.e., selected keywords, databases, journals, conferences, inclusion/ exclusion criteria) and the interviewed experts (i.e., application environment). Hence, our findings are limited to the selected sample.

2) Based on a multi-disciplinary literature review and focus groups, we derived guidelines for the design of appropriate customer integration methods. The derived research framework and propositions on influencing factors and implications of a positive customer integration experience are strongly determined by the scope of our literature review (P3). The guidelines for the design of toolkits for user innovation the design proposed by this thesis are limited by the defined product (i.e., car), the selected product attributes (hedonic product attributes: exterior color, seat design, wheel design; utilitarian product attributes: engine, extras, service packages), and the defined solution space (eight options for exterior color and seat design, six different

options for wheel design, engine, extras, and service packages). In P4 and P5, this doctoral thesis used students as subjects. Although this is a common research approach, this limits the generalizability of our research findings.

3) Similarly to RQ1, RQ3 has been addressed by conducting a structured literature review and applying the design science research paradigm. Therefore, the identified types and characteristics that the Customer Input Ontology needs to cover, and the identified ontologies that can be reused are limited by the scope of our literature review (P6). The identified requirements for the design of the Customer Input Management System and its evaluation are limited by the interviewed experts (P7).

4.5 Future Research

Given the results and limitations of this doctoral thesis, there are several possibilities for future research.

1) Concerning the selection of appropriate customer integration methods (RQ1), we propose the following avenues for future research. First, we found that the current body of literature on customer integration into innovation processes lacks quantification (Füller et al. 2015b). Frequently, customer integration methods are categorized in terms of implying low, medium, or high costs/ time. We propose, that the more quantifiable parameters are available, the better the performance in terms of predictions/ recommendations of the DSS (Füller et al. 2015b). If direct interrelationships are not known but only assumed, only vague recommendations can be made. Thus, future research attempts can try to collect quantitative data concerning the benefits and prerequisites of customer integration methods.

   Second, the developed DSS presents a first prototype. It can be improved by allowing the users of the system to weight decision criteria according to their importance in the decision process. Further, the DSS could provide detailed information on why a specific method is recommended and to which extent the different decision criteria are fulfilled by a recommended method. Additionally, statistics on the success of the different customer integration methods and the factors determining the success can be incorporated. To derive these statistics and success factors, multiple customer integration case studies published in research articles can be analyzed by applying the case survey method (Jurisch et al. 2013; Larsson 1993; Lucas 1974; Yin/Heald 1975).

   Third, we evaluated the DSS with a small sample of 12 experts. We recommend future research to evaluate the refined version of the DSS with a larger sample of experts. In-depth interviews and focus groups could be used to obtain qualitative feedback from experts in the fields of DSS and customer integration.

2) In order to derive guidelines on the appropriate design of customer integration methods with regard to a positive customer integration experience (RQ2) we conducted a literature review, and focus groups with students after using different user interfaces of car configurator (i.e., toolkit for user innovation and design). We looked at toolkits for user innovation and design, and the task of designing hedonic and

utilitarian product attributes. Future research can replicate the study with other sample populations, and other products. Further, cars present relatively expensive products. The customization of an individual car can result in huge price differences to the standard product. Therefore, future research can investigate the appropriate design of toolkits or other customer integration methods with regard to the underlying product type (utilitarian, hedonic, price category). To this end, an interesting avenue for future research could be a cross-industry study including laboratory experiments and interviews with toolkit users after using toolkits to customize low, medium, and high-price products, or utilitarian and hedonic products from different industries (e.g., automotive, food, furniture, jewelry, clothing, and financial services). Besides the focus on utilitarian and hedonic design principles, future research can also consider social aspects. For instance, community and communication functions can be implemented to test the effect of social influence on participants' contributions, perceptions, and emotions.

In order to derive guidelines on the appropriate design of customer integration methods, in P3 we analyzed the state of research in different disciplines on the concept of customer experience and the appropriate design of e.g., information systems, websites, or stores. In information systems research, the TAM is the most frequently used theory to study the factors that influence the acceptance and adoption of information systems. The TAM originally included rather utilitarian aspects such as perceived usefulness and perceived ease of use (Davis 1986; Davis et al. 1989). Its derivatives also consider more hedonic aspects such as computer playfulness and perceived enjoyment in TAM3 (Venkatesh/Bala 2008), or hedonic motivation in UTAUT2 (Venkatesh et al. 2012). Future research should also consider more hedonic aspects including information presentation, visualization, and a visually appealing design of information systems as factors in further derivatives of the TAM.

3) Concerning the challenging task of effectively and efficiently managing obtained customer input (RQ3), we propose the following future research possibilities. First, to further enhance the tool support for knowledge management in customer integration, our first prototype of the Customer Input Management System can be improved by elaborating the tagging system and incorporating more advanced analysis (e.g., statistics, simulations) and visualization techniques. Further, alerts for newly received customer input, or customer inputs not viewed and processed up to a pre-defined deadline might be helpful. Second, the design and evaluation of the Customer Input Management System is based on a small sample of experts. The improved version of the Customer Input Management System should be evaluated through a longitudinal study and application of the system in practice.

Part B: Publications

Publication 1: A Matrix for Selecting Customer Integration Methods

Title:	A Matrix for Selecting Appropriate Customer Integration Methods
Authors:	Füller, Kathrin* (kathrin.fueller@in.tum.de) Engel, Tobias* (tobias.engel@in.tum.de) Benz, Maximilian* (maximilian.benz@tum.de) Goswami, Suparna* (suparna.goswami@in.tum.de) Krcmar, Helmut* (krcmar@in.tum.de) *Technische Universität München, Chair for Information Systems, Boltzmannstraße 3, 85748 Garching, Germany
Publication:	Production and Operations Management Society (POMS) International Conference
Status:	Published

Abstract

Integrating customers into innovation processes is gaining popularity to develop new products and services. While customer integration can be beneficial, firms lack a clear understanding on how to actually integrate customers. Based on a systematic literature review, we analyze different customer integration methods and provide a decision matrix considering innovation phases and organizational constraints. The proposed decision matrix supports practitioners in selecting customer integration methods that are suitable to generate required customer input for the innovation process. Further, this study contributes to theory by identifying and classifying customer integration methods, allowing researchers to design an IT-based decision tool.

Keywords: Customer integration, customer integration method, decision matrix

Individual contribution of Kathrin Füller: For this publication, I participated in the study design, data analysis, and interpretation. Further, I significantly contributed to the creation of the manuscript. The collection of relevant literature was conducted by one of my co-authors. Additionally, my co-authors helped me in developing the paper, its story and building the main contribution of the paper, which is the decision matrix.

1 Introduction

Companies have to be innovative in order to stay competitive in the market place (Drucker 1998). Co-creating innovations with external stakeholder such as customers is gaining popularity among companies as means of addressing some of the competitive and market pressures (Chesbrough 2003). Previous research found that opening up innovation processes to integrate customers' ideas and knowledge can result in better fit with customer needs and faster time to market (Erat et al. 2006). In the open innovation approach, customers provide input to the different phases of the innovation process by creating and evaluating ideas and concepts, designing new products, or testing prototypes (Dahan/Hauser 2002). These customer inputs can be gathered by companies through a variety of customer integration methods such as surveys, lead user workshops, toolkits, or idea competitions (Zogaj/Bretschneider 2012).

Research has developed and tested a notable number of customer integration methods (Hemetsberger/Godula 2007). While literature provides in-depth information on a few customer integration methods, there is only little research on the evaluation and comparison of different customer integration methods (Jin et al. 2012b; Olsen/Welo 2011; Ozer 1999). A few existing approaches categorize different customer integration methods in a two or three-dimensional framework, neglecting further dimensions. Yet, companies face various constraints such as time, budget, or the availability of other resources such as facilities, personnel, or skills to integrate customers into innovation processes (Fähling et al. 2011) which need to be considered in a multi-dimensional decision matrix. For instance, Kaulio (1998) classifies customer integration methods along the dimensions phase in the innovation process and type of customer involvement. Thereby, customer involvement refers to the role customers in the innovation process. As an addition, Hemetsberger/Godula (2007) incorporated a third dimension describing the extent to which a particular method allows customers to share tacit or explicit knowledge with the company. Furthermore, Reichwald et al. (2004) proposed a three-dimensional framework to categorize customer integration methods using the three dimensions type of customer input, phase in the innovation process, and type of customer. Therefore, a multi-dimensional decision matrix considering other important dimensions of customer integration is needed.

To develop such a multi-dimensional decision matrix, we conducted a systematic literature review to identify decision factors that guide the selection of customer integration methods and therefore can be used as further dimensions in a multi-dimensional framework. We analyzed different customer integration methods with regard to the identified decision factors to subsequently build a decision matrix considering innovation phases and organizational constraints. The proposed decision matrix allows researchers to design and implement an IT-based decision support tool to automate the selection of an appropriate customer integration method.

The remainder of this paper is structured as follows: First, we provide some theoretical background information on the concept of customer integration. Second, the research methodology is described. Third, the findings from the literature review are presented and

synthesized in a decision matrix. Finally, we conclude with limitations and further research possibilities.

2 Theoretical Background

Companies increasingly embrace the notion of open innovation as means of overcoming some of the competitive and market pressures that they face (Desouza et al. 2008; Gassmann et al. 2005). Customers can give input across all phases of the innovation process, e.g., in the form of ideas, concepts, or prototype evaluations (Dahan/Hauser 2002). These customer inputs can be gathered by companies through the use of different customer integration methods such as idea competitions, concept testing, toolkits, customer interviews, surveys, or lead user workshops (Dahan/Hauser 2002; Zogaj/Bretschneider 2012).

The emergence and proliferation of information and communication technologies such as the internet, personal computers, and high speed broadband connections, have allowed companies to integrate their customers into the development of new products and services in a faster and more affordable way (Erat et al. 2006; Füller et al. 2009). Further, web-based tools also increase interactivity and flexibility among manufacturers and their customers, and enhance the accessibility of geographically distributed customers (Erat et al. 2006; Roberts/Grover 2012). An example for IT-based customer integration is Swarowksi Enlightened™ that asked creative customers and designers to submit designs to their jewelry design competition. For this purpose, Swarowski hosted a virtual platform providing several community functionalities enabling customers to comment on designs and give suggestions for improvement. This innovative community also provided a jewelry configuration toolkit allowing customers to create their own items of jewelry by selecting from a set of components such as gemstones or chains (Füller et al. 2011).

In a systematic literature review, Zogaj/Bretschneider (2012) identified 15 customer integration methods. Five of these methods, lead user workshops, toolkits, idea competitions, idea communities, and focus groups workshops represent so-called active customer integration methods. Since these active customer integration methods directly relate to the context of open innovation we focus on these methods and briefly introduce them in Table 5.

Active customer integration method	Description
Focus group workshop	Focus group workshops can be defined as planned discussions with groups of invited customers to discuss a certain topic and obtain customers' perceptions, needs and ideas (Jin et al. 2010).
Idea community	Via an internet platform users can generate and evaluate ideas and discuss with other customers. This customer integration method is basically used in the early phases of the innovation process and allows customers to be innovative and to collaboratively experiment with ideas (Ebner et al. 2009).
Idea competition	Idea competitions are in particular used to generate ideas in the early phases of the innovation process. An idea competition invites the public or a selected group of customers to submit ideas within a predefined period of time on a certain topic of interest to the company. Experts of the company evaluate the submitted ideas and select the winner (Ebner et al. 2009; Leimeister et al. 2009).
Lead user workshop	Lead user workshops refer to the systematical identification and integration of innovative customers, so-called lead users, through workshops within a company. Purpose of the workshop is the generation of ideas and the elaboration of these ideas into more concrete concepts for new products or services (von Hippel 1986).
Toolkit	Toolkits, an internet platform or software application, allow customers to design products or services according to their individual needs and preferences (Jeppesen 2005; von Hippel/Katz 2002).

Table 5: Active Customer Integration Methods

Customer integration methods can be classified on a continuum ranging from passive to active customer integration (Alam 2002; Schultze et al. 2007). Passive customer integration methods are surveys or ethnography where the customer serves as a source of information and innovative ideas. However, customers can take a more active role in the innovations process. As a co-creator or co-producer customers can help companies in generating and evaluating ideas, concepts, or prototypes (Nambisan/Nambisan 2008).

3 Research Methodology

In order to conduct a systematic and thorough review of the existing literature on customer integration into innovation processes, we followed the guidelines provided by Webster/Watson (2002). The purpose of the review is to identify decision factors in selecting appropriate customer integration methods. Based on these decision factors we develop a decision matrix that supports practitioners in selecting customer integration methods that are suitable to generate required customer input for the innovation process. The literature review was carried out in the following steps:

Identifying sources for relevant research articles: Customer integration is researched in different disciplines such as marketing, technology and innovation management, or information systems. We therefore selected the databases Business Source Premier covering business research, Emerald Management allowing access to management journals, and IEEE Xplore providing access to publications in computer engineering.

Definition of keywords: To conduct a keyword search on customer integration into innovation processes we initially based our literature search on the keywords ‘customer integration method’ and ‘decision criteria’. For both of these keywords we identified synonyms used in the research articles which we also included in our keyword search. As synonyms for the keyword ‘customer integration method’ we identified ‘customer involvement method’, ‘user integration method’, ‘user involvement method’, ‘consumer integration method’, and ‘customer involvement method’; for the keyword ‘decision criteria’ we identified ‘decision factors’, ‘selection criteria’, and ‘framework’ as synonyms. With this final set of keywords we conducted a full text search using an “and” as well as ”or ”combination of keywords from category 1 and 2 (see Table 6).

Category 1	**Category 2**
- Customer integration method	- Decision criteria
- Customer involvement method	- Decision factor
- User integration method	- Selection criteria
- User involvement method	- Framework
- Consumer integration method	
- Consumer involvement method	

Table 6: Keywords for Literature Review

1. *First screening:* The initial search yielded a rather high amount of 1625 results. After removing duplicates, and reading the title, abstract, and keywords of all research articles to identify their relevance for the underlying research we narrowed the number of useable articles down to 43.

2. *Second screening:* In order to reduce the number of research articles to those that are actually relevant for the purpose of developing a decision matrix for the selection of customer integration methods, we conducted a second screening process. In this second screening process we evaluated each of the 43 papers by reading the whole paper. In both screening processes, we excluded research articles not studying criteria that influence the selection of suitable customer integration methods. Research articles were only discarded if two of the authors agreed that the article was not suitable for the purpose of this study. Finally, we found 22 relevant articles for building a decision matrix for selecting appropriate customer integration methods.

4 Results and Discussion

In our literature review, we identified costs, duration, required skills, number of customers, infrastructure, phase in the innovation process, and customer type as relevant decision factors that guide the selection of customer integration methods. We use these decision factors to evaluate the presented customer integration methods (see section 2) and to build a multi-dimensional decision matrix.

Costs: The costs of co-creating innovations with customers vary significantly depending on the customer integration method selected. According to Fähling et al. (2011), there are non-recurring investment costs necessary for method execution and expenses which occur during the method execution such as expenses for equipment. Investment costs and expenses can be

high, medium or low (Fähling et al. 2011). In general, costs are one of the most determining decision factors in companies. However, managers should avoid “light” or ”slimmed-down” concepts for customer involvement as this increases the risk of generating unusable, low quality customer input (Reinicke 2004).

Duration: A fast execution of a customer integration method and therefore fast availability of required customer input for the innovation process is decisive and the main reason for the use of customer integration methods such as surveys (Creusen 2011). Thus, a short duration of customer integration allows firms to adapt their products faster to customers’ needs which may result in a competitive advantage. The decision factor duration is defined as the time needed for executing a customer integration method. Preparation and post-processing of a particular customer integration method are excluded (Fähling et al. 2011). This decision factor can take the value *high, medium, or low* amount of time (Reinicke 2004). Customer integration methods that can be executed within an hour or less are assigned to the category ‘low amount of time’. ‘Medium amount of time’ relates to customer integration methods that take up to a day whereas ‘high amount of time’ relates to methods that are conducted over several days or weeks (Reinicke 2004).

Required skills: The execution of some customer integration methods require specific methodical and technical skills (Fähling et al. 2011). Methodical skills can be defined as knowledge about a particular customer integration method. Some IT-based customer integration methods may require specific technical skills and therefore cannot be applied by each company (Fähling et al. 2011). Fähling et al. (2011) distinguish between skills that are *necessary, partly necessary, or unnecessary method execution*. Missing competencies in a company pose a barrier to the use of some customer integration methods. For instance, a lack of interviewing skills may influence the quality of interview questions asked and therefore the generated customer input (Bruseberg/McDonagh-Philp 2000). If there is no experience or expertise about a desired customer integration method available in the company, managers often assign external experts with the task of integrating customers through this particular method or turn to established methods (Reinicke 2004).

Number of customers: Different customer integration methods require a different number of participating customers in order to gather customer input in sufficient quality and quantity. Integrating a lot of customers increases the possibility to gain a huge amount of customer input. At the same time, the integration of a large number of customers may increase complexity and costs of a customer integration project (Kirschner et al. 2010). The number of participants in a customer integration project can be categorized in *1, 2-7, and 8-n* (Nunamaker et al. 1991).

Infrastructure: Another decision factor is the availability of required facilities and infrastructure. Fähling et al. (2011) describe infrastructure as elements that are not wasted or consumed after their usage. Elements of infrastructure are for instance *rooms* to conduct a meeting with customers or *internet capabilities*. Some methods, especially observation based methods, need to be conducted in the environment of the target customers. Therefore, this decision factor also differentiates among field and laboratory methods (Reinicke 2004).

Phase in the innovation process: Customers can give input at various stages of the innovation process. Since the different customer integration methods are only suitable in certain phases of the innovation process, this poses an important decision factors when selecting customer integration methods. In the *early phases* of the innovation process, companies require need information and innovative ideas which can be gathered through the use of idea competitions and communities. In the *intermediate stage* toolkits might be applied. For the *late phases* of the innovation process empathic design and product testing are applicable (Kirschner et al. 2010; Zogaj/Bretschneider 2012).

Customer type: Customers can be differentiated in different customer types based on the knowledge and skills they possess (Kristensson et al. 2004; Magnusson 2009). Innovative customers, so-called *lead users*, are ahead of market trends and are experiencing needs which later will be experienced by many other users in the marketplace (Franke et al. 2006). In contrast, *ordinary users* lack technological know-how or domain-specific skills. However, both types of customers possess information and ideas that are of importance for companies. Ordinary customers were found to create ideas outside of the prevailing dominant logic and thus rather original ideas. However, integrating lead users yields ideas that score high on feasibility and commercial attractiveness (Franke et al. 2006).

As described above, we use this set of decision factors to evaluate each of the five active customer integration methods (see Theoretical background) and subsequently built the decision matrix (see Table 7). The decision matrix enables companies to check how a customer integration method performs with respect to a certain decision factor versus other customer integration methods. This allows a direct comparison of methods and thus supports practitioners in selecting suitable customer integration methods. For instance, if costs are assessed as most important and decisive in the decision-making process, then the customer integration method that incurs the least costs can be identified and selected through the decision matrix.

Decision factor	Evaluation of customer integration method
Cost	*Low:* Focus group workshop (Jin et al. 2012a; Jin et al. 2012b; Ozer 1999) *Medium:* Lead user workshop (Fähling et al. 2011) *High:* Idea competition (Gourova/Toteva 2011)
Duration	*Low:* Focus group workshop (Jin et al. 2012a; Jin et al. 2012b; Ozer 1999), toolkit (Olsen/Welo 2011) *Medium:* N/A *High:* Idea community (Riedl et al. 2010), idea competition (Gourova/Toteva 2011), lead user workshop (Fähling et al. 2011)
Required skills	*Not necessary:* N/A *Partly necessary:* Focus group workshop (Ozer 1999), idea competition (Fähling et al. 2011) *Necessary:* Lead user workshop (Fähling et al. 2011), toolkit (Edvardsson et al. 2012)
Number of customers	*1:* - *2-7:* Focus group workshop (Ozer 1999), lead user workshop (Fähling et al. 2011) *8-n:* Focus group workshop (Ozer 1999), idea community (Riedl et al. 2010), idea competition (Gourova/Toteva 2011)
Infrastructure	*Meeting room:* Focus group workshop (Ozer 1999), lead user workshop (Fähling et al. 2011) *Internet* (Dahan/Hauser 2002): Toolkit (Füller et al. 2009), idea community (Ebner et al. 2009; Gourova/Toteva 2011), idea competition (Gourova/Toteva 2011)
Phase in the innovation process	*Early phases:* Idea competition, idea community, lead user and focus group workshop (Bretschneider et al. 2009) *Intermediate phases:* Toolkit (Bretschneider et al. 2009) *Late phases:* -
Customer type	*Ordinary users:* Focus group workshop (Jin et al. 2012b), toolkit (Edvardsson et al. 2012) *Lead users:* Lead user workshop (Edvardsson et al. 2012; Kaulio 1998; von Hippel 1986)

Table 7: Decision Matrix

All of the identified decision factors vary in their importance from use case to use case. For instance, in one customer integration project the availability of customers and the technical and methodical skills in the company to apply a particular customer integration method may be the most constraining factors, limiting the number of applicable customer integration methods. However, in another customer integration project, the research and development team may need information on customers' preferences as soon as possible. Therefore, time respectively duration of method execution has the highest impact factor on the decision which customer integration method to apply.

An exemplary scenario for customer integration method selection in a company may be the following: Methodical and technical skills are low, but cost and time pressures are high, the needed or desired customer input for the innovation process are ideas from ordinary customers. Using the proposed decision matrix will allow the company to identify a focus group workshop with a selected group of eight to twelve ordinary customers as an appropriate method. Another scenario might be that the selected customers are distributed all over the

world. In consequence, the customers cannot be involved at the same time and at the same place, limiting the suitability of customer integration methods to web-based methods.

Table 8 summarizes the evaluation of the customer integration methods based on the identified decision factors. Some of the fields in Table 8 remain unfilled since we could not find information for each of the five active customer integration methods with regard to each decision factor; this shows that literature provides information on some customer integration methods of similar kind, but lacks a systematic record and (numerical) evaluation of customer integration methods. However, to select appropriate customer integration methods, practitioners need to be provided with concrete information on specific aspects such as duration or costs as well as use cases on when and how to apply a particular method.

Active customer integration method	**Evaluation of customer integration method regarding decision factors**	**Key references**
Focus group workshop	Costs: low Duration: short Required skills: partly necessary Number of customers: 2-7, 8-n Infrastructure: Meeting room Phase in the innovation process: Early phases Customer type: Ordinary users, lead users	(Füller et al. 2009) (Jin et al. 2010) (Jin et al. 2012a) (Jin et al. 2012b) (Ozer 1999)
Idea community	Cost: N/A Duration: high Required skills: N/A Number of customers: 8-n Infrastructure: Internet Phase in the innovation process: Early phases Customer type: Ordinary users, lead users	(Ebner et al. 2009) (Gourova/Toteva 2011)
Idea competition	Costs: high Duration: high Required skills: necessary Number of customers: 8-n Infrastructure: Internet Phase in the innovation process: Early phases Customer type: N/A	(Ebner et al. 2009) (Gourova/Toteva 2011) (Riedl et al. 2010)
Lead user workshop	Costs: medium Duration: high Required skills: necessary Number of customers: 2-7 Infrastructure: Meeting room Phase in the innovation process: Early phases Customer type: Lead user	(Edvardsson et al. 2012) (Fähling et al. 2011)
Toolkit	Costs: N/A Duration: short Required skills: necessary Number of customers: N/A Infrastructure: Meeting room/Internet Phase in the innovation process: Intermediate phases Customer type: Lead user	(Edvardsson et al. 2012) (Olsen/Welo 2011) (Janssen/Dankbaar 2008)

Table 8: Evaluation of Active Customer Integration Methods

5 Implications, Limitations, and Future Research

While literature provides in-depth information on a few customer integration methods, there is little research on the evaluation and comparison of different customer integration methods (Olsen/Welo 2011). A few existing approaches categorize different customer integration methods in a two or three-dimensional framework (Hemetsberger/Godula 2007; Kaulio 1998; Reichwald et al. 2004). However, to support practitioners in comparing and selecting customer integration methods further dimensions reflecting organizational constraints need to be considered (Fähling et al. 2011).

Based on our literature review, we identified costs, duration, required skills, number of required customers, infrastructure, phase in the innovation process, and customer type as decision factors that guide the selection of suitable customer integration methods. Therefore, these decision factors can be used in a multi-dimensional decision matrix to evaluate the five relevant active customer integration methods; that in contrast to traditional market research methods (e.g., survey), are directly related to the open innovation concept. Further, our findings support practitioners in the selection process of suitable customer integration methods.

This paper contributes to theory by identifying decision factors and evaluating active customer integration methods with the help of identified decision factors. Based on the proposed decision matrix, researchers can design an IT-based decision support tool to automate the selection process. From a practical perspective, the proposed decision matrix supports practitioners in selecting customer integration methods that are suitable to generate the needed customer input in sufficient quality and quantity, within time and budget.

Nonetheless, our research is subject to some limitations: First, findings are based on the selected databases and the research articles found through our keyword search. Hence, our findings are limited to the selected sample. Second, we exemplarily evaluated five active customer integration methods. Our decision matrix is therefore limited to these customer integration methods. Future research should use the decision matrix to evaluate further customer integration methods such as passive methods of customer integration (e.g. surveys) to allow practitioners to select out of a wider range of customer integration methods. Furthermore, our work has only been conceptual and additional data from practice are needed; therefore, the proposed decision matrix should be empirically evaluated with industry experts.

Based on our literature review we found that existing literature does not allow the evaluation of each customer integration method with regard to each decision factor. To support practitioners in the selection of customer integration methods, researchers need to systematically record and (numerically) evaluate customer integration methods.

The different decision factors vary in their importance across different customer integration initiatives. Multi-criteria decision making techniques allow the consideration of multiple criteria and the flexible weighting of criteria in decision processes. Thus, future research could apply multi-criteria decision techniques to provide a numerical and automated approach for the selection of customer integration methods. Also, researchers could design, implement

and evaluate an IT-based decision support system to support practitioners in the selection of appropriate customer integration methods.

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Publication 2: Decision Support for Customer Integration Methods

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Abstract

Co-creating innovations with external stakeholders, such as customers, is gaining popularity among companies as a way to address the competitive and market pressures they face. To this end, research has brought forward a notable number of customer integration methods. The selection of a particular method is governed by various organizational constraints; there is, however, a paucity of research providing decision support for practitioners in terms of when to use which customer integration method. Using the design science approach, our research ad-dresses this research gap by implementing a decision support system to assist practitioners in the selection of appropriate customer integration methods. We elicit requirements from literature and expert interviews, and subsequently design, implement, and evaluate a prototype of the system. Based on identified requirements, the prototype is implemented as a web-based tool (HTML5). The DSS tool aims to acquaint practitioners with use cases and experiences with different customer integration methods.

Keywords: Open innovation, customer integration methods, decision support system, design science research

Individual contribution of Kathrin Füller: For this publication, I participated in the study design, data analysis, and interpretation. One of my co-authors collected the qualitative data for this paper by conducting a systematic literature review and semi-structured interviews. Further, the decision support system was implemented and evaluated by a co-author. My contributions include the study's idea of developing a decision support system, guiding the overall research project including data collection and data analysis, and providing relevant literature. Further, I contributed by writing all sections of the paper.

1 Introduction

Companies need to be innovative in order to stay competitive in the marketplace (Drucker 1998). One approach to enhance competitiveness is for companies to open up their innovation processes and co-create innovations with external stakeholders, such as customers, suppliers, or research institutions. Customers can give input across the entire in-novation and life-cycle of a product or service, e.g., in the form of ideas, concepts, or prototype evaluations (Dahan/Hauser 2002). These customer inputs can be generated by companies through the use of different customer integration methods which include idea competitions, virtual concept testing, toolkits, or lead user workshops (Dahan/Hauser 2002). The selection of an appropriate method for customer integration is limited by several restrictions such as available time, budget, or other resources in the company. Additionally, each customer integration method entails particular tasks for practitioners in terms of preparing in advance of customer integration or post-processing afterwards (Fähling et al. 2011).

Unfortunately, many companies fail to select a customer integration method which is appropriate to gather the needed customer input. For instance, a Swiss engineering company decided to integrate their customers through a survey. The survey confirmed obvious market trends but failed to generate the needed customer input in the form of unarticulated customer needs (Enkel et al. 2005b). As this example shows, it is crucial for companies to have an in-depth understanding of the benefits and prerequisites of different customer integration methods in order to choose the most appropriate one (Enkel et al. 2005b; Fähling et al. 2011).

To support practitioners in the selection of suitable customer integration methods, existing research provides decision criteria that guide the selection of customer integration methods (Fähling et al. 2011) as well as two or three-dimensional frameworks and matrixes (Füller et al. 2014a) to categorize and evaluate methods (Hemetsberger/Godula 2007; Kaulio 1998; Reichwald et al. 2004). However, according to our research and knowledge, there are no existing solutions to automate the process of selecting appropriate methods. One approach to ease this manual selection process is decision support systems (DSS) allowing companies to instantly gather relevant information for decision-making, to receive recommendations for actions, or to create forecasts (Power 2013). Sprague (1980) describes DSS as, *"interactive computer based systems, which help decision makers utilize data and models to solve unstructured problems"* (Sprague 1980, 1). Thus, a DSS aids the process of decision-making as it allows companies to gather information of relevance to the decision at the appropriate time (National Forum on Education Statistics 2006; Sprague 1980). Further, DSS are used in practice to mitigate prejudices and risks related to decision-making (Power 2013).

Therefore, as a means of supporting practitioners in the selection of customer integration methods, this paper designs, implements, and evaluates a knowledge-driven DSS congruent with the design science paradigm (March/Smith 1995). The knowledge-driven DSS developed in this research is intended to aid decision makers in selecting customer integration methods suitable to generating required customer input for the innovation process considering organizational constraints (e.g., budget, time). Furthermore, the proposed DSS acquaints practitioners with different customer integration methods, provides access to further

information on the methods, and allows experts to share and discuss their experiences with the different customer integration methods.

The remainder of this paper is structured as follows. First, the research methodology is described. Second, the findings from the literature review and the expert inter-views are presented and synthesized into a list of requirements which the DSS needs to meet. Third, in-depth information on the design, implementation, and evaluation of the DSS are provided. Finally, the results as well as challenges we faced while implementing the DSS are discussed. We conclude with implications and limitations of the underlying research as well as possibilities for future research.

2 Research Methodology

The design science methodology covers the elicitation of requirements, and the sub-sequent design, implementation, and evaluation of design artifacts. Therefore, the development of the DSS was congruent with the design science paradigm (March/Smith 1995), and in particular, the three cycle view on information systems design as proposed by Hevner (2007): relevance cycle, design cycle, and rigor cycle (Hevner 2007). The two basic activities of the "design cycle" are building and evaluating an artifact (March/Smith 1995). The evaluation of design artifacts is usually conducted with regard to evaluation criteria such as functionality, performance, or usability. Most of these attributes of an artifact are closely related to its application environment (March/Smith 1995). Thus, the requirements the artifact needs to fulfill must be identified in the specific application environment. These requirements provide the necessary background know-how to build and subsequently evaluate the artifact. These iterative activities of eliciting requirements from the application environment and designing artifacts compose the "relevance cycle". Further, the artifact design needs to be tied to a scientific knowledge base. The "rigor cycle" covers the iterative process of building on and adding to the knowledge base (Hevner 2007). In the following, we describe how we followed these three cycles in this paper.

2.1 Rigor Cycle

To build our research on the existing knowledge base, we elicited requirements for the DSS through a systematic literature review as recommended by Webster/Watson (2002). For this purpose, we identified and analyzed literature in the fields of customer integration and DSS. The concepts of customer integration into innovation processes and DSS are of interdisciplinary nature. Thus, databases that allow access to different research fields were considered as a means of analyzing and understanding DSS and the requirements a DSS needs to fulfill in the context of customer integration. We searched the selected databases (search fields: title, abstract, and keywords) using keyword combinations related to customer integration, requirements, and DSS (see Table 9). The initial search yielded 2013 results.

keywords	IEEE		Science Direct		EbscoHost	
	identified	relevant	identified	relevant	identified	relevant
"decision support system" AND "customer integration"	87	15	84	20	6	1
"decision support model "OR "tool" AND "customer integration"	11	4	24	10	154	10
"decision support system" AND "requirements"	111	20	842	40	247	30
"knowledge-based" OR "knowledge-driven DSS"	238	14	184	15	25	5
Total (relevant without duplicates)		53		85		46

Table 9: Overview of Identified and Relevant Papers

After removing duplicates and reading the title, abstract, and keywords of all obtained articles to identify their relevance for the underlying research, we narrowed the number of useable articles to 630. In order to reduce the number of research articles to those that are actually relevant, we conducted a second screening process. In this second screening process we evaluated each of the 630 papers by screening introduction, findings, discussion, and conclusion of the paper. In both screening processes, the research articles that were considered as relevant for the underlying research covered the concept of DSS, functional and non-functional requirements for the design of a DSS, as well as different customer integration methods and decision criteria that guide the selection of customer integration methods. Finally, we evaluated 184 articles as relevant for the underlying research. Customer integration methods described in these 184 papers as well as decision factors and use cases on the application of the different customer integration methods are stored in the knowledge base of the DSS.

2.2 Relevance Cycle

We followed the relevance cycle by eliciting requirements for the DSS from the application environment, respectively the target users, through expert interviews. We conducted 14 qualitative interviews with industry experts from 14 companies to gain detailed insight into the process of customer integration and the selection of customer integration methods in practice. We interviewed experts working for more than three years in relevant areas including sales, marketing, research and development, product and innovation management. To gather diverse opinions on customer integration and the requirements that a DSS needs to meet in order to actually support practitioners in the selection of appropriate customer integration methods, we interviewed experts from different industries. Data was collected from February to June 2014. Table 10 provides a short overview of the interviews.

ID	Industry	Position of expert	Experience in this field (years)	Interview duration (minutes)
I1	Automotive	Head Global Automotive	24	42
I2	Energy Sector	Senior Application Sales	11	37
I3	Health	Engineer	6	30
I4	Health	Application Developer	3	47
I5	Transportation	Equipment Developer	15	35
I6	Mobile Application	Executive Director	8	35
I7	Health	Interactive Media Manager	21	45
I8	Electronics	Associate Vice President	7	31
I9	Gaming	Senior Developer	12	23
I10	Automotive	Manager	35	30
I11	Software Industry	Vice President	13	33
I12	Banking	Senior Developer	25	49
I13	Gaming	Vice President	10	30
I14	Automotive	Senior Manager	5	35

Table 10: List of Interviews

We used a semi-structured interview guideline to interview all 14 experts to ensure comparability of our findings. Before the actual interviews, the guidelines were pre-tested by one expert working in the area of requirements management and two independent researchers from related areas (Yin 2009). Experts were asked to: (1) name customer integration methods they apply to co-create innovations with customers; (2) identify decision criteria relevant for the selection of customer integration methods (e.g., budget, time, skills); (3) describe their decision process of selecting appropriate customer integration methods; (4) identify requirements that they expect the DSS to fulfill; and (5) reveal their previous experience in using DSS. The interviews were carried out via phone or face-to-face meetings with sessions lasting 36 minutes on average. When allowed, the interview was voice recorded, transcribed and checked for accuracy by the interviewee. In cases where voice recording was not allowed, notes were taken manually. The collected data was analyzed using qualitative content analysis (Gläser/Laudel 2009). Building on our interview guidelines, we developed a coding scheme which has been adapted iteratively throughout data collection and analysis due to new insights (Gläser/Laudel 2009).

2.3 Design Cycle

The design cycle covers the design, implementation, and evaluation of the design artifact. Therefore, the requirements elicited from literature and experts have been analyzed to develop a set of requirements as a basis for the implementation of the DSS. To this end, the identified requirements were categorically classified as functional or non-functional requirements (Klein/Traunmuller 1993). Further, each requirement was thoroughly analyzed and marked as necessary, good to have, or not relevant (Berander/Andrews 2005). The priority of the requirements was based on the frequency with which a requirement was mentioned by the experts. Also, phrases used by the experts like “obviously” have been used to indicate the

importance of a requirement. Such categorization helped us to map the core functionality expected of the DSS and the associated requirements. Similar to the steps followed in the software development lifecycle (Power 2013), the core requirements were first considered to design the core functionality of finding suitable methods. Later, some of the good to have expectations were considered and added as extensions; for example, a forum for experts to share their experiences in customer integration.

3 Results

3.1 Requirements

In the following, we present the set of requirements used to design the DSS. The identified requirements were categorized as functional and non-functional requirements (Sommerville 2012). The functional requirements describe the expected core functionalities of the DSS (Berander/Andrews 2005). For instance, use cases that describe how to apply the different customer integration methods, reporting tools to understand the recommendations, or the ability to export the recommendations have been identified as functional requirements for the DSS (Table 11).

Requirement	Description	Source
Analysis tool	The DSS tool allows users to query, browse and understand large amounts of data available in the knowledge base.	(Power 2013), Interview I1
Criteria and weights	The tool must deduce a subset of recommended customer integration methods based on an optimality condition and by weighting the contribution of each decision criterion.	(Ben-Bassat 1982), Interviews I7, I11
Data export	The tool must allow the export of further literature and information on the different customer integration methods in downloadable format.	(National Forum on Education Statistics 2006), Interviews I1, I6
Facilitation	The tool must assist the decision maker by providing recommendations for the most suitable customer integration method(s).	(Xiao et al. 2012), Interviews I1, I3
Input to the DSS	The DSS must use clear and well defined ranges for inputs.	(Power 2013; Xiao et al. 2012), Interview I7
Pre-supposed questionnaire	The tool's questions asked must be objective in nature aiming to accept data that can be used to generate suitable recommendations.	(Power 2013), Interview I1
Reporting tool	The tool needs to include a reporting tool which is able to explain why the method is recommended and how to apply the recommended customer integration method.	(Klein/Traunmuller 1993), Interviews I7, I11, I6, I13
Use case	The tool needs to provide specific use cases for the application of the recommended customer integration method.	(Power 2013), Interviews I4, I6, I7, I12, I13

Table 11: List of Functional Requirements

The non-functional requirements, by contrast, describe the technical requirements (e.g., accessibility, navigability, user interface) that the tool is expected to satisfy (Sommerville 2012). The identified non-functional requirements for the DSS are summarized in Table 12.

Requirement	Description	Source
Accessibility	The tool must be accessible at any given time and place.	(National Forum on Education Statistics 2006), Interviews I1, I6, I7, I8, I12
Extensible interface	The tool must be easily extensible with respect to the user interface or the core logic.	(Roth et al. 2010)
Interoperability of the tool	The tool must provide transparent mechanisms for the interactions and be compatible with other systems.	(Yang et al. 2008), Interviews I1, 12, I14
Navigability	The tool must provide easy navigation using links to web pages (internal or external).	(Oppenheim/Ward 2006), Interviews I1, I11, I13
Responsive design	The tool should be responsive in adapting to various screen sizes.	(Heilala et al. 2010), Interviews I1, I7, I8, I14
Scalability	The tool must be scalable and handle several concurrent requests in parallel without any performance degradation.	(Yang et al. 2008), Interviews I1, I6
User interface	The tool's interface must be designed efficiently using good visualization techniques.	(Heilala et al. 2010; Power 2013), Interviews I1, I7, I13, I14
Web-based	As a web-application, the tool has advantages such as better accuracy, more acceptance of the tool, accessibility.	(Feghali et al. 2011), Interviews I2, I5, I8, I10, I11, I12, I14

Table 12: List of Non-Functional Requirements

3.2 Architecture of the DSS

The simplest level of abstraction that helps to understand the designed DSS is the architectural design of the system (Tsui et al. 2011). The architecture used in this research comprises three distinct tiers which provide dedicated functionality as illustrated in Figure 17. These are the storage, business logic, and presentation tier (Schuldt 2009).

Storage tier: The most important tier for any knowledge-driven DSS is the storage tier. It comprises the knowledge base required for the proper execution of the tool (Klein/Traunmuller 1993). In this research, the knowledge base of the DSS comprises all the details gathered about different customer integration methods through the literature review. The necessary knowledge in this context is the description and evaluation of the different customer integration methods with regard to the decision factors, as well as use cases and experiences shared by experts in applying customer integration methods.

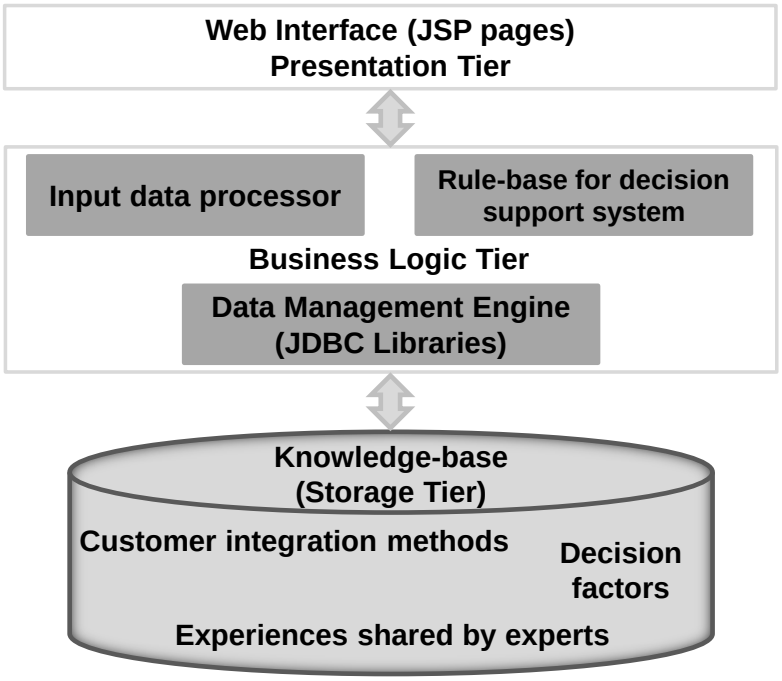

Figure 17: Architecture of the DSS

Business logic tier: This tier is the heart of the system, engulfing the analytics, the interaction of the decision makers with the system, and the generation of recommendations (most appropriate customer integration methods) based on the provided input by the decision maker (Klein/Traunmuller 1993; Power 2013). The selection of a particular customer integration method is governed by various organizational constraints and considerations such as available budget and time for customer integration, preparation effort of a method, required number of employees and customers, or phase in the innovation process (Fähling et al. 2011). The decision maker needs to provide information on these constraints, also called decision criteria, which enable the DSS to search for matching methods.

The DSS's logic is based on a decision tree. The main motivation for using a decision tree is the efficient traversal techniques that can be easily implemented as well as the ability to re-iterate through the decision tree. Thus, the decision maker is able to re-consider or even omit some of the decision criteria while searching for possible recommendations (Beemer/Gregg 2010; Dey 2012). The DSS first tries to find an exact match for the inputs provided by the user. If no exact match can be found, the DSS delivers a partial matching recommendation. In the underlying research, we ask the decision makers to provide multiple inputs to the system. Therefore, it is important that if no exact match is found, then the tool must search through its knowledge base if any partially matching method can be found by omitting some of the decision criteria.

To support partial matching, an iterative look up is conducted to find the most appropriate customer integration method. For this iterative look up, all the inputs and customer integration methods are considered as nodes of a decision tree. For each comparison, the tree is navigated iteratively to identify the most suitable customer integration method. The iterative traversal methodology used in this paper is the breadth-first search technique (Cormen et al. 2009) using two steps of filtering to identify the matching customer integration methods. In the

iterative traversal methodology, filtering rule 1 searches for customer integration methods that match the mandatory inputs from the decision makers. Filtering rule 2 checks for the optional inputs to further deduce the most suitable customer integration methods. According to the experts that we interviewed, the selection of customer integration methods is primarily based on the phase of the innovation, the target user of the innovation, and the available time and budget for the entire customer integration project. This helped us to identify phase, cost, duration, and customer type as mandatory inputs. In the filtering rules 1 and 2, the '&' defines a 'logical AND' combination.

Filtering rule 1: Phase & Cost & Duration & Customer type
Filtering rule 2: Customer count & Employee count & Preparation effort

For each match/customer integration method found after applying filtering rule 1, the second filtering rule is applied to search for further partial or full matching methods. The filtering rule 2 is only applied to the result subset (first order child nodes) identified from filtering rule 1. The tool is designed so that it aims to identify an exact match of an appropriate customer integration method based on the inputs given by the decision maker. In case there is a match identified from filtering rule 1, then filtering rule 2 checks for methods fulfilling the optional decision criteria. The results from filtering rule 2 are presented as final recommendations. If no exact match is found, then for both the filtering rules 1 and 2 one of the decision criteria is dropped and the whole search is re-iterated to check for partial matches. If filtering rule 1 fails to identify any match, then the tool is designed to recommend all customer integration methods that are identified based on the decision makers input regarding phase of the innovation process. If filtering rule 2 is unable to find any matches, then the results identified from filtering rule 1 are presented as the recommendations to the practitioners. The functional requirement “criteria and weights” (see Table 4) is specified in the business logic tier of the tool and the implemented filtering rules to search for matching customer integration methods.

Presentation tier: To meet the non-functional requirements “web-based” and ”accessibility” the tool is implemented as a web-based application. To achieve a responsive design of the web-based tool, HTML5 has been used as a technical solution.

The presentation tier is the first level of a web-based application having a multi-tier architecture (Chau/Phung 2012). The main function of this tier is to provide an interface to display information and to enable the user to interact with the system. The goal of this tier is to attain a clear and understandable interface for the decision makers (refers to the non-functional requirements navigability and user interface) (Jocic et al. 2012). Figure 18 depicts the website of the developed DSS. The web-based tool is available at *http://customer-integration.informatik.tu-muenchen.de/*. The structure of the website clearly shows the available functionalities of the web-based tool. For instance, one can have a brief overview of the open innovation and customer integration concept (Figure 18, top left). To meet the functional requirements “use case”, “facilitation”, “reporting tool” and “data export” (see Table 11), the website provides an overview of the various customer integration methods stored in the database as well as links to download academic articles on a certain customer integration method (Figure 18, bottom left), and a forum that allows experts to share their

experiences in using certain customer integration methods (Figure 18, bottom right). A questionnaire asks the decision makers to provide the required input to process and recommend suitable customer integration methods. Each input has a tooltip providing a brief description of the required information (Figure 18, top right). This refers to the functional requirements “pre-supposed questionnaire” and “input to the DSS”.

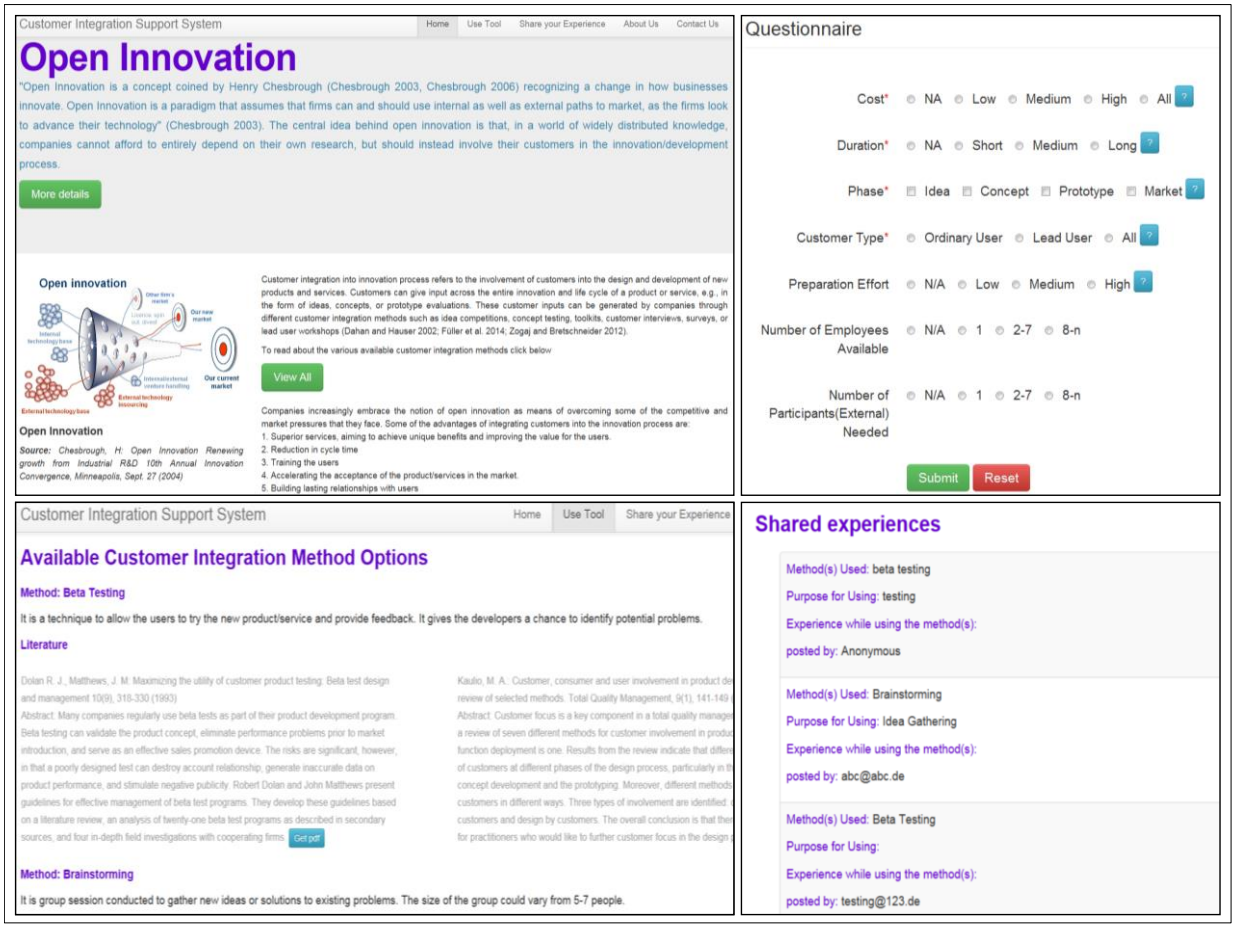

Figure 18: Web-Based DSS

3.3 Evaluation of the DSS

Similar to the evaluation of any product or service developed following the steps in a software development lifecycle, the implemented tool is also evaluated to assess if it satisfies the requirements of the user. To evaluate the DSS, we shared the link to the web-based DSS with experts and asked them to evaluate the tool by giving feedback through a survey. A semi-structured questionnaire containing 13 closed questions and three open questions was designed. The questions were selected in a manner to cover the identified requirements as well as evaluation criteria usually used to evaluate web-based prototypes (e.g., consistency, navigability). Table 13 shows the questions asked to gather the expert’s opinion and feedback on the developed DSS. We emailed the survey to all 14 experts from the expert interviews and to others with experience in designing DSS. A total of 17 people were contacted, 12 completed the survey.

To understand and analyze the findings of the survey a coding scheme was developed based on heuristic evaluation for the gathered feedback data (Sutcliffe 2002). From the gathered feedback a mean value and variance were computed (Fisher et al. 2002).

Evaluation criteria		Questions	Mean	Variance
Architecture and Navigability	Consistency (Hasan et al. 2012; Oppenheim/Ward 2006)	Is the same format used consistently throughout the site?	4.8	0.81
	Navigation (Webb/Webb 2004)	Is the navigability within the website easy?	4.6	0.26
	Relevance of links (Chen/Macredie 2005)	Are the links relevant to the concept?	5.0	0.42
Content	Information about content provider (Oppenheim/Ward 2006)	Is sufficient information shared regarding the content provider?	5.0	0.15
	Graphics (Oppenheim/Ward 2006)	Do the shared graphics enhance the understandability?	3.0	1.18
	Access to relevant literature (Basu 2003)	Is sufficient information provided for supporting literature?	3.5	2.08
	Relevance of information (González/Palacios 2004; Oppenheim/Ward 2006)	Is the recommendation relevant to the described scenario?	4.0	0.51
Usability	Working links (Fisher et al. 2002)	Are internal and external links working properly?	3.9	0.56
		Are the links to further information on the customer integration methods helpful and appropriate?	4.0	0.52
	Ease of use (Sligar/Zeng 2011)	Are you able to move around within the web-based interface of the DSS with ease?	4.6	0.26
	Help prompts (Webb/Webb 2004)	Is the information clearly labeled and organized?	4.5	0.27
UI	Aesthetic features (Chen/Macredie 2005; Sutcliffe 2002)	Is the tool's homepage attractive having a strong eye appeal?	5.0	0.44
Satisfaction	Satisfaction (Hasan et al. 2012)	What is your overall satisfaction with the tool?	4.0	0.38
Participants used a 5-point scale to rate each question with 1=complete disagreement, 5=complete agreement.				

Table 13: Survey to Evaluate the DSS

Some of the positive feedback on the DSS we received was the simplicity and easy to use interface, the clear user workflow, and the easy navigability throughout the website. The tool was found to be able to impart knowledge as it provides a platform for experts to share and discuss previous experiences with the preparation and execution of customer integration methods. Some experts shared the opinion that the developed DSS could serve as a platform to bridge the gap between the theoretical concept of customer integration including the methods that can generally be used to co-create innovations with customers and the mundane functioning of business. Thus, the DSS could definitely ease the selection and the application of methods.

Suggestions for improving the DSS included metrics like hit-ratios in real time about the recommended and actually selected customer integration methods, and statistics about the past performance of each method or the ability to access the data programmatically for expert users. For future versions of the introduced web-based DSS, we can open source the project in some technical communities to acquire more feature requests from interested users which possibly further increase the value of the DSS.

4 Conclusion and Future Research

Previous research has brought forward and tested a notable number of customer integration methods (Hemetsberger/Godula 2007). However, methods need to be selected carefully to outweigh benefits (e.g., market success, customer satisfaction) over costs and risks related to customer integration (Enkel et al. 2005b). There is a paucity of research providing decision support for practitioners in terms of when to use which method. Using the design science approach, our research addresses this gap by designing, implementing, and evaluating a knowledge-driven DSS that recommends suitable methods to the decision makers.

The paper contributes to theory by gathering requirements for a DSS that supports practitioners in the selection of customer integration methods. Based on the identified requirements, the prototype is implemented as a web-based tool in HTML5. The most surprising requirement identified from the expert interviews was the desire for different kinds of reporting and analysis tools.

According to previous research, customer integration literature is fragmented (Alam 2002; Reichwald et al. 2004). Thus, this paper contributes to theory as the DSS accumulates knowledge and provides access to a knowledge base covering different customer integration methods, as well as experiences and use cases for the application of the different methods. Further, in our research we found that the body of literature on customer integration into innovation processes lacks quantification. Customer integration methods are frequently categorized in causing low, medium, or high costs, and taking low, medium, or high amount of time (Fähling et al. 2011). A DSS is better the more quantifiable parameters are known. If direct interrelationships are not known, only vague recommendations can be made.

From a practical perspective, this paper introduces a web-based knowledge-driven DSS that recommends suitable customer integration methods to the decision maker based on the provided input. The tool asks decision makers to provide information on the available time

and budget for the entire customer integration project as well as information on the phase in the innovation process and customer type to search for matching or partially matching customer integration methods. Thus, the developed DSS offers an automated process of selecting suitable methods. To our knowledge, besides frameworks and matrixes (Füller et al. 2014a; Hemetsberger/Godula 2007; Kaulio 1998; Reichwald et al. 2004) to categorize and evaluate customer integration methods, no such automatic approach for selecting suitable methods is available.

To evaluate the DSS, we shared the link to the developed web-based DSS with experts. Here, the tool was found to be capable of acquainting practitioners with information on the different customer integration methods and to provide access to further information on the methods (e.g., academic research). Additionally, the developed DSS can provide a platform to bridge the gap between the theoretical concept of customer integration and its implementation in practice.

The challenge encountered while designing the DSS was the classification of the identified decision factors into mandatory and optional. The classification was primarily achieved using input from the interviews. The other challenge was to effectively and efficiently iterate multiple times amongst the various criteria and methods without omitting any possible recommendation. This challenge was met by iteratively traversing a decision tree using the breadth-first search technique (Cormen et al. 2009).

Our research is subject to some limitations. First, the knowledge stored in the knowledge base of the DSS is based on the customer integration methods identified through the literature review. The literature review findings were obviously limited through the selection of the keywords and the three databases to use for the search. Second, the evaluation is based on a relatively small sample of experts that served as respondents to the survey. Further, the prototype presents a first rough version of the DSS. Future versions could provide even more information, use cases, and guidelines on the design and application of the different customer integration methods. The evaluation of the developed web-based DSS suggested the incorporation of metrics such as hit-ratios in real time about the recommended and actually selected customer integration methods in future versions of the tool. Further metrics or statistics could include success rates of the different customer integration methods. Research should evaluate the designed DSS with a larger sample of experts. To this end, in-depth interviews and focus groups could serve as methodological approaches to gain qualitative feedback from experts in the fields of DSS and customer integration.

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Publication 3: Leveraging Customer Integration Experience

Title: Leveraging Customer Integration Experience: A Review of Influencing Factors and Implications

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Abstract

There has been an ever-increasing trend to co-create innovations with customers in idea communities, idea competitions, or lead user workshops. Yet, many customer integration methods fail to attract sufficient customer participation and engagement. We draw on previous research to identify customers' experience as an important determinant of the success of the whole customer integration initiative. However, the notion of experience has rarely been applied in the context of customer integration. We conduct a cross-disciplinary literature review to identify the factors that constitute a positive customer integration experience and the implications of the customer integration experience. Based on 141 papers from marketing, technology and innovation management, information systems, human-computer interaction, and psychology research, we derive a classification of influencing factors and implications of customer integration experience. The contribution of our review is a framework that integrates 22 conceptually different influencing factors, 15 implications, and their interrelatedness based on motivation-hygiene theory. The framework sheds light on the current state of research on customer integration experience and identifies possibilities for future research.

Keywords: open innovation, co-creation, customer integration experience, user experience, framework, motivation-hygiene theory, literature review

Individual contribution of Kathrin Füller: For this publication, I significantly contributed by collecting, analyzing, and coding literature. Further, by drawing on motivation-hygiene theory, I developed the research model and the propositions. Additionally, I have written all sections of the paper. My co-authors helped me in improving the paper by pointing out ways to strengthen the paper and its contributions to theory and practice. After the first review

round, my co-authors helped me in discussing the reviewers' comments. Subsequently, I revised the paper to address the reviewers' comments.

1 Introduction

In a competitive business environment, the need for innovation continually increases because value creation through profitable growth can only be achieved by innovation (Prahalad/Ramaswamy, 2003). One approach for companies to innovate is to integrate customer knowledge and to co-create innovations with their customers (Chesbrough 2003). Technological advances and the proliferation of information and communication technology have made the co-creation of innovations and the collection of customer knowledge (e.g., customers' ideas and preferences) more affordable and faster (Dahan/Hauser 2002; Hemetsberger/Godula 2007). IT-based customer integration methods including idea competitions, online communities, or crowdsourcing enable participants to contribute their knowledge and ideas (Ebner et al. 2009; Leimeister et al. 2009).

Despite the ongoing research on IT-based customer integration methods, many customer integration initiatives fail to generate sufficient customer interest and participation. For instance, in a SAP idea competition 68 percent of registered users did not submit an idea (Ebner et al. 2009). This quote leaves a lot of space for improvement since generating customer participation and engagement can play a critical role in terms of the overall success of the customer integration initiative. Several customer motives are also subject to network effects. As the number of participants and contributions increases, participation gets more interesting and worthwhile for customers (Leimeister et al. 2009).

Customer participation is primarily voluntary and customers invest considerable time and effort to contribute to customer integration initiatives (Ebner et al. 2009). To attract customer participation and engagement, the experience customers' gain from co-creating a product or service plays a critical role (Füller et al. 2011; Nambisan/Nambisan 2008). Yet, it is not clear what factors constitute a positive customer integration experience and what implications the customer integration experience has for the customer and the company. In order to create positive customer integration experience, companies need to be aware of the influencing factors and their interaction effects. Additionally, companies need to know the positive and negative implications that customer integration experience can have. When implications and their measurement are known, the impact of modifying influencing factors by changing the design of an IT-based customer integration method can be measured.

The experience, as an individual's subjective, momentary perception and evaluation of an event or interaction (Klaus/Maklan, 2011; Knijnenburg et al. 2012) is a concept researched in multiple disciplines. For instance, the discipline of human-computer interaction has defined user experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system, or service" (Van der Geest et al. 2013, p. 93). In order to design websites and interactive products that create positive user experience, both instrumental (i.e., pragmatic/ utilitarian value, usability) and experiential (i.e., hedonic value, pleasure-producing) design aspects have been considered (Hassenzahl/Tractinsky 2006; Law/Van Schaik 2010). Under the term customer experience, marketing and consumer behavior researchers have analyzed the appropriate design of stores, web stores, or marketing

campaigns (Bridges/Florsheim 2008; Fiore et al. 2004; Sathish/Venkatesakumar 2011; Sheng/Teo 2012).

In contrast to other disciplines, customer integration research has rarely applied a customer experience or user experience perspective. The experience that customers gain from participating in customer integration initiatives by using IT-based customer integration methods has only scarcely been investigated (Füller et al. 2011; Füller et al. 2009). We propose that influencing factors and implications of experiences that have been identified in human-computer interaction, information systems, or marketing research are transferrable to customer integration research. Previous customer integration literature has already shown that some implications of positive experiences such as loyalty, trust, commitment, and long-term customer relationships (Füller/Matzler 2007) primarily investigated in marketing research are transferrable to the field of customer integration. Similarly, the importance of influencing factors including ease of use, playfulness, competence, and autonomy have been confirmed in terms of designing appropriate IT-based customer integration methods (Füller et al. 2011; Nambisan/Nambisan 2008).

For the purpose of our research, we define customer integration experience as a customer's perception and evaluation of the interaction with an IT-based customer integration method and other participants during a customer integration initiative (e.g., other members of an idea community). Previous research showed the potential of combining different theories and constructs from different disciplines into one framework (Chen 2003; Douglas/Craig 1992). Therefore, we conduct a cross-disciplinary literature review (Okoli 2015; Schryen 2015; Templier/Paré 2015; Webster/Watson 2002) to identify influencing factors and implications from different disciplines that have studied human experiences. We subsequently develop a theoretical framework and propositions concerning influencing factors and implications of customer integration experience from previous multi-disciplinary literature.

We apply motivation-hygiene theory (Herzberg 1971, 1974) that proposes two distinct factors determining job satisfaction and dissatisfaction at the workplace. As customer integration tasks or crowdsourced tasks provide alternatives to traditional operational work (Tavakoli et al. 2015), we propose that customer integration underlies the mechanisms described by motivation-hygiene theory. Motivation-hygiene theory allows us to analyze customers' motivation and attitudes towards performing customer integration tasks. Drawing on motivation-hygiene theory, we analyze the underlying mechanism of the identified factors, their interrelationships, and their impact on the customer integration experience.

The main contribution of our research is a theoretical framework summarizing influencing factors and implications of customer integration experience, and their interrelationships based on motivation-hygiene theory. Further, we provide an overview of research on user, customer, flow, and co-creation experience and suggest paths for future research endeavors. To help practitioners in designing for positive customer integration experience, we discuss the identified influencing factors and their implications on the appropriate design of IT-based customer integration methods.

The paper proceeds as follows. In section 2, we present theoretical background information on customer integration and define basic terms and constructs. In section 3, we describe our research approach to identify and analyze relevant literature. Following this, in section 4 we present influencing factors and implications of human experiences studied in the different disciplines. In section 5, we discuss the identified influencing factors and implications in the context of customer integration. Further, applying motivation-hygiene theory we structure our findings in a framework, which includes propositions concerning influencing factors of customer integration experience, and their interrelatedness (section 6). Subsequently, in section 7 we conclude with limitations, implications for theory and practice, and future research possibilities.

2 Theoretical Background

In a dynamic economic environment, the need for innovation is undisputed. Due to constantly accelerating changes in society, technology, and markets, companies are under increasing pressure to innovate (Drucker 1998). Triggers for new products, services, or process and procedural innovations can either be unsatisfied customer needs and customer problems (i.e., market pull) or new technological possibilities (i.e., technology push) (Brem/Voigt 2009).

Of 100 innovative ideas, only two lead to successfully introduced innovations at the marketplace. In order to reduce risks and costs associated with innovation, companies can open up their innovation processes to ask their customers for their opinions, preferences, and ideas (Chesbrough 2003; Dahan/Hauser 2002; Erat et al. 2006). The open innovation approach describes the process of opening up innovation processes to use external and internal ideas as well as internal and external paths to market (Chesbrough 2003).

In the open innovation paradigm, customers are no longer passive consumers but active partners in value creation who help companies in shaping and developing products and services (Prahalad/Ramaswamy 2004a, 2004b). Researchers have developed and tested a notable number of customer integration methods (Hemetsberger/Godula, 2007) as means to gather customer ideas and to co-create new products and services with customers. For instance, crowdsourcing is defined as the act of outsourcing a task once performed by an employee to a large, undefined group of people in the form of an open call (Howe 2008). Therefore, one way for companies to outsource creative tasks related to their innovation efforts are online crowdsourcing platforms. Several firms including Dell or Starbucks have implemented online crowdsourcing systems in order to obtain creative ideas for new products and services (Ogawa/Piller 2006; Sullivan 2010).

Another means of IT-based customer integration are toolkits for user innovation and design. Toolkits are software or web applications that allow customers to self-design products according to their individual preferences (Franke/Piller 2004; Franke/Schreier 2010; von Hippel/Katz 2002). For instance, by using a car configurator, an online toolkit for user innovation and design, BMW customers can design the roof of their Mini Cooper with own pictures and graphics (Walcher/Piller 2012).

To elicit customers' preferences, companies can apply virtual concept testing. In this IT-based customer integration method, participants are shown new product concepts and are asked to express their preference by purchasing the most favored concept at a certain price. Virtual concept testing therefore allows companies to compare and evaluate different concepts before carrying them forward and launching them in the marketplace. By using different multimedia options such as images or videos, virtual concept testing provides a low-cost alternative of testing virtual prototypes, rather than real physical prototypes (Dahan/Hauser 2002).

All these IT-based customer integration methods make customer integration into innovation processes faster and more affordable for companies (Erat et al. 2006; Füller et al. 2009). Yet, many IT-based customer integration methods fail to attract customer contribution, or fail to keep the customers engaged during the process of providing input (Kohler et al. 2011). Thus, it is important for companies to understand how IT-based customer integration methods need to be designed in order to provide positive experiences to customers, so that they remain engaged and provide input, which is of value to companies.

3 Research Methodology

Reviewing past research is essential to any type of research (Webster/Watson 2002) as literature reviews can help in understanding and building on what already has been done (i.e., standing on the shoulders of giants) (Vom Brocke et al. 2015). We undertook a structured review of the literature on user, customer, flow, and co-creation experience to investigate how human experiences have been conceptualized to date. Based on previous research we develop a conceptual framework of influencing factors and implications of customer integration experience, and their interrelationships.

From a method perspective, literature reviews are distinguished in narrative and systematic literature reviews. While narrative literature reviews usually do not follow any systematic review process, systematic literature reviews consider a structured process of searching for, analyzing, and synthesizing literature to answer a specific research question (Paré et al. 2015; Vom Brocke et al. 2015). As we systematically search and analyze literature to identify influencing factors and implications of customer integration experience, our review paper presents a systematic literature review.

Additionally, we classify our review paper as a theoretical review. Theoretical literature reviews develop a set of research propositions, hypotheses, or a conceptual framework by drawing on existing conceptual and empirical studies from diverse research streams (Paré et al. 2015). These characteristics describe well our review work that draws on qualitative and quantitative research studies from multiple disciplines and develops a framework on influencing factors and implications of customer integration experience.

A high quality literature review should consider the following dimensions: rigor, relevance, and methodological coherence. Rigor refers to a sound review process, relevance to the usability and contribution of the review, and methodological coherence to the fit between the review's goals and the guidelines selected to conduct the review (Templier/Paré 2015). To ensure those quality criteria and, therefore, to conduct a high quality literature review,

existing research provides guidelines and frameworks (Okoli 2015; Schryen 2015; Templier/Paré 2015; Webster/Watson 2002). Accordingly, a literature review should

(i) formulate a clear problem and research question,

(ii) select sources to search for relevant and high quality literature,

(iii) define criteria to evaluate the relevance and quality of identified literature,

(iv) describe the extraction of data from identified and included literature, and

(v) compile data into a whole that exceeds the sum of its parts (Levy/Ellis 2006; Webster/Watson 2002).

In section 3.1, we present the keywords, databases, and journals used to search for literature. Additionally, we provide detailed information on our search and screening processes. In section 3.2, we describe our approach to extract data from the identified and included papers. Section 4, 5, and 6 present the results of extracting and compiling data from literature.

3.1 Literature Search

To include high quality literature in our literature search process, we searched the eight major, peer-reviewed information systems journals in the AIS senior scholar basket. The AIS senior scholar basket consists of the European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of the Association for Information Systems, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems, and Management Information Systems Quarterly.

Besides the senior scholar basket, we searched major journals in the fields of information systems, management information systems, computer information systems, and business information systems as identified by Lowry et al. (2004): Management Science, Communications of the Association for Information Systems, Communications of the ACM, Decision Science, Decision Support Systems, IEEE Transactions Journals, Information and Management, and ACM Transactions Journals.

As customer integration, open innovation, crowdsourcing, and (user/ customer) experience are interdisciplinary research topics, we also searched the databases EbscoHost, Science Direct, Emerald, ACM, IEEE, and SSRN that provide access to multiple disciplines (Tavakoli et al. 2015). For instance, Emerald provides access to management journals, and IEEE Xplore provides access to publications in the field of computer engineering.

We searched these journals and databases using “and” combinations of keywords from category 1 and 2 listed in Table 14.

Category 1	Category 2
• Customer experience • User experience	• Customer integration • Co-creation • Open innovation • Crowdsourcing

Table 14: Keywords for Literature Search

The initial search yielded 2,495 results. After removing duplicates, and reading meta-information (title, abstract, and keywords) of all research articles to identify their relevance for understanding the basic concept of human experience, we narrowed the number of relevant articles down to 432. In order to reduce the number of research articles to those that are actually relevant, we conducted a second screening process in which we evaluated the remaining articles by reading their introduction, discussion, findings, and contribution sections. In both screening processes, we considered research articles as relevant if they covered the experience concept in general, and specifically in the open innovation context. The second screening process reduced the number of relevant articles to 183.

As recommended by Okoli (2015) and Webster/Watson (2002), we conducted a backward and forward search based on the 183 papers. The backward and forward search resulted in 47 additional articles. We conducted a third screening process of the remaining 230 papers in order to identify papers focusing on influencing factors and implications of experiences. In this third screening process, we reduced the number of relevant articles to 141. Figure 19 summarizes our literature search and screening process.

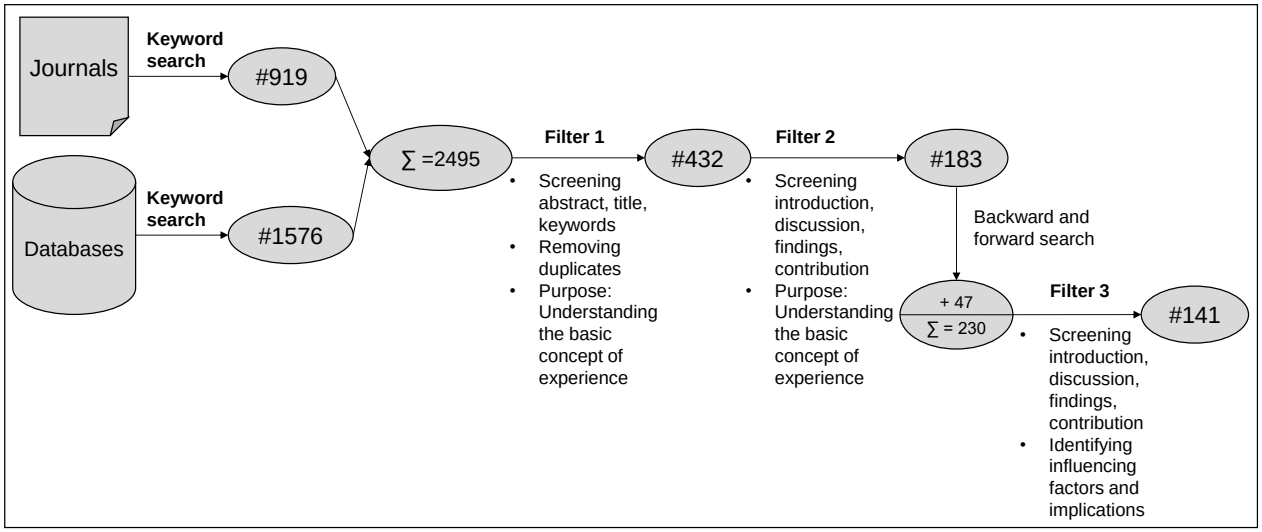

Figure 19: Literature Search and Screening Process

3.2 Qualitative Data Analysis

Our research objective was to identify influencing factors and implications of customer integration experience. For this purpose, we conducted a cross-disciplinary literature review. Further, we iteratively developed a coding scheme to extract data from literature. The coding scheme and our coding process are described in detail in the following. Additionally, Figure 20 summarizes our coding and qualitative data analysis process.

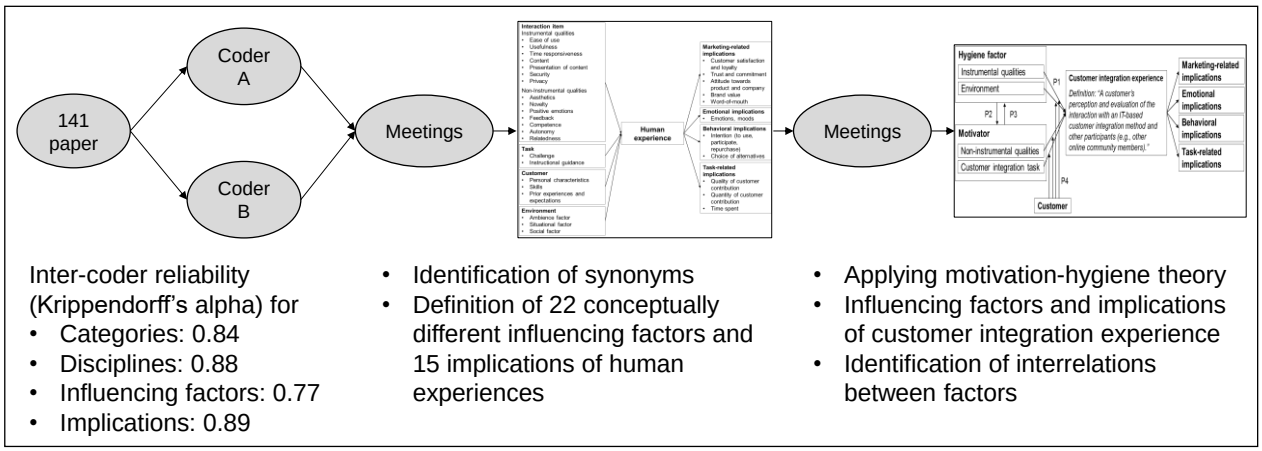

Figure 20: Coding Process

Two coders independently coded the 141 papers identified in the literature search process. First, we categorized the 141 papers into papers studying influencing factors, implications, or both. Inconsistencies between coder A and coder B were resolved by discussion. We used Krippendorff's (1980) alpha to determine inter-coder reliability (Krippendorff 1980). Krippendorff's alpha averaged 0.84, indicating that inter-coder reliability was satisfactory. We found that 51 articles solely dealt with influencing factors, 27 articles addressed possible implications, and 63 articles addressed both, implications and influencing factors. Additionally, only 26 of the 141 papers studied experience specifically in the context of customer integration and co-creation between the company and customers (2 on influencing factors, 8 on implications, and 16 on influencing factors and implications). Table 16 in the Appendix (Appendix A) provides an overview of these 26 papers.

Second, for each of the 141 papers, two researchers independently coded its discipline, and the influencing factors and implications discussed in the paper. Regarding the disciplines, our open coding resulted in a coding scheme (Miles/Huberman 1994) consisting of six categories: Information systems, human-computer interaction, marketing and management, technology and innovation management, psychology, and "others". The category "others" describes papers that we could not assign to one of the five disciplines (see section 4.6). Krippendorff's alpha averaged 0.88, suggesting substantial agreement between coders.

Besides the journal or conference in which a paper was published, we used a list of keywords to code a paper to these six categories. Based on the content of the papers, we iteratively developed the keyword list for coding. For instance, if a paper contained the keywords user experience (UX), UX heuristics, goodness, usability, usability study, UX evaluation methods, UX measurement, UX modelling, or UX framework, this indicated a coding to the discipline human-computer interaction.

Some papers applied theories from different disciplines in order to study customers' experience. Coding these papers to one of the pre-defined categories was challenging. Papers that we could not clearly assign to one category, were assigned to two categories. For instance, Yoon et al. (2013) draw on information systems, marketing and management, and social psychology literature to propose and empirically test a theoretical model on the moderating effects of product knowledge and online shopping experience. Their theoretical

model consists of several marketing-related constructs such as satisfaction, loyalty, and product knowledge. The study provides implications on the use of recommendation agents and the design of e-commerce websites. Therefore, we coded the paper to both disciplines, information systems and marketing and management. Overall, we coded eight papers to two disciplines. The results of our coding and analysis by discipline are presented in section 4.

Third, regarding the influencing factors and implications, two coders independently extracted a list of influencing factors and implications of customers' experience. Krippendorff's alpha averaged 0.77 for influencing factors and 0.89 for implications. In meetings, we discussed and clearly defined the identified influencing factors and implications. Existing literature uses different aliases for the same influencing factor or implication. For instance, in our coding the influencing factor "relatedness" included the synonyms belongingness and sense of community. Similarly, the implication "intention" included the synonyms "willingness" and "future interest" to participate/ use/ repurchase. As a result, we clearly defined 22 conceptually different influencing factors and 15 implications.

4 Analysis by Discipline – Influencing Factors and Implications of Human Experiences

We found that the experience concept is primarily studied in the disciplines information systems, human-computer interaction, marketing and management, technology and innovation management, and psychology. In the following, we provide insight into the influencing factors and implications studied in the different disciplines and derive a classification of 22 conceptually different influencing factors and 15 implications of human experiences.

4.1 Information Systems

In our iterative open coding process, we found that information systems research frequently addresses technology acceptance, behavioral intentions, or user acceptance. From the 141 identified papers, we coded 37 papers to the discipline of information systems. Three of these 37 papers study individuals' co-creation experience in virtual environments and therefore directly refer to the context of customer integration in innovation processes.

Information systems research focuses on the appropriate design of information systems in order to enhance users' acceptance, satisfaction, and intentions to use a system (Chen et al. 2004; Wang/Scheepers 2012). In this respect, the Technology Acceptance Model (TAM) emerged as a theory to analyze the appropriate design of information systems and their adoption by users (Davis 1986; Davis et al. 1989).

The influencing factors discussed in the 37 information systems papers basically refer to the design and quality of information systems (e.g., ease of use, usefulness, security, privacy, reliability) (Chen et al. 2012; De Wulf et al. 2006; Devaraj et al. 2006; Hsu/Tsou 2011; Vijayasarathy 2004). Information systems research also considers the individual that uses and interacts with the information system. For instance, normative beliefs (Vijayasarathy 2004),

prior experiences (Chen et al. 2004; Devaraj et al. 2006), and the user's skills (Guo/Klein 2009) can impact the experience of using a certain information system.

Implications of positive experiences are satisfaction (Devaraj et al. 2006; Khalifa/Liu 2007), intention to use (Bhattacherjee 2001; Vijayasarathy 2004; Wakefield/Whitten 2006), and continuance intentions (Chen et al. 2012; Devaraj et al. 2006). As these implications concern users' behavioral change, we classify them as behavioral implications.

4.2 Human-Computer Interaction

We coded 43 papers to the discipline of human-computer interaction. One of the 43 papers examines the co-creation of value in user communities and living labs (Pallot/Pawar 2010) and therefore directly refers to the context of customer integration.

Researchers and practitioners in the field of human-computer interaction are faced with the challenge of designing usable products, services, or systems to a wide variety of users with diverse requirements (Choi et al. 2006). *User experience* is the experience users gain and subsequently memorize after using an interactive product, service, or system (Pallot/Pawar 2010; Van der Geest et al. 2013). Initially, human-computer interaction research concentrated on the instrumental (i.e., pragmatic) goals of systems including ease of use, usability, and functionality. This narrow perspective on user experience was expanded by more non-instrumental (i.e., hedonic) aspects including aesthetics, self-expression, and mental stimulation (Hassenzahl/Tractinsky 2006). Besides these influencing factors, human-computer interaction research has identified users' emotional reactions (e.g., enjoyment) (Mahlke/Thüring 2007; McCay-Peet et al. 2012; Partala/Kallinen 2012) and users' behavior (e.g., focused attention, task performance, willingness to recommend) as positive implications of positive user experience (Kujala et al. 2011; Mahlke 2007; McCay-Peet et al. 2012).

4.3 Marketing and Management

We coded 50 papers to the discipline of marketing and management; 13 papers view customers as active co-creators of value (Eichentopf et al. 2011; Grönroos/Voima 2013; Hakanen/Jaakkola 2012; Prahalad/Ramaswamy 2004a; Zine et al. 2014) and study the experience customers gain from co-creating products and services (Fiore et al. 2005; Payne et al. 2009; Prahalad/Ramaswamy 2000, 2003).

In terms of *customer experience management* marketing and management literature studies the organization of operations and processes of a company around the needs of the customers (Sharma/Chaubey 2014). The goal of customer experience management is to comprehensively manage a customer's cross-channel exposure and interaction with a company, its products, brands, and services (Parandker/Lokku 2012). Further, marketing and management research strives to understand what delights the customer in a retail-shopping context. To understand and deliver a positive customer experience, researchers often apply surveys (Bridges/Florsheim 2008; Fiore et al. 2004; Sathish/Venkatesakumar 2011; Sheng/Teo 2012) or take a conceptual perspective by reviewing existing literature and building conceptual models.

The influencing factors of customer experience discussed in the 50 marketing and management papers mainly focus on the retail environment including the atmosphere (e.g., scents, temperature, and music), the assortment (e.g., variety, uniqueness, and quality), and social factors (e.g., nice, friendly, and helpful salespersons) (Fiore/Kelly 2007; Kourouthanassis et al. 2007). Implications of a delightful shopping experience refer to positive emotions and marketing objectives including customer satisfaction with the store, customer loyalty (Yoon et al. 2013), word-of-mouth (Klaus/Maklan 2011; Sharma/Chaubey 2014), and repurchase intentions (Rose et al. 2011; Sathish/Venkatesakumar 2011).

4.4 Technology and Innovation Management

We coded 11 papers to this discipline. All 11 papers are directly associated with the research field of customer integration into innovation processes. Technology and innovation management research focuses on new technologies (e.g., virtual reality) and their application to co-create innovations with customers. Participants of online customer integration initiatives (e.g., communities, idea and design competitions) are observed, surveyed, or interviewed (Janzik/Raasch 2011; Kohler et al. 2010; Nambisan/Watt 2011).

Researchers in the field of technology and innovation management show the importance of the co-creation experience for encouraging participation and enhancing the quantity and quality of customer contributions (Füller et al. 2011; Kohler et al. 2010; Nambisan/Nambisan 2008). Influencing factors of a positive co-creation experience are the design of IT-based customer integration methods that are visually appealing and consider usability aspects (Pals et al. 2008). Additionally, customers' needs to acquire product-related information as well as to feel autonomous, in control, and related to others should be considered (Füller et al. 2011; Matzler et al. 2011; Nambisan/Nambisan 2008). Implications of a positive co-creation experience are positive innovation-related outcomes in terms of the quality and quantity of customer contributions, and customers' willingness to participate in future customer integration initiatives (Füller et al. 2011; Kohler et al. 2010; Nambisan/Nambisan 2008).

4.5 Psychology

Under the term flow experience, the discipline of psychology has studied the state of total involvement, deep concentration and enjoyment of an activity (Csikszentmihalyi 1975, 1977, 1990; Nakamura/Csikszentmihalyi 2002). From the 141 papers, we coded four to the discipline of psychology. None of the four papers directly relates to the co-creation of value with customers.

The four papers coded to this category study the appropriate design of tasks and how a state of total involvement in an activity evolves. To this end, Csikszentmihalyi (1975) and Csikszentmihalyi (1990) conducted interviews with rock climbers, basketball players, modern dancers, chess players, and composers of modern music to study intrinsically rewarding experiences and activities that allow flow to occur. The design of the task, e.g. whether instructions and information on the target outcome are given, influence the experience that individuals gain when performing the task (Dahl/Moreau 2007). Factors that constitute flow experience are a challenging task that matches an individual's skills (not too difficult not too

simple), clear goals of the task, and immediate feedback provided by the task. Consequences of flow experience are the loss of self-consciousness and transformation of time. Further, the state of flow has been identified as a source of enjoyment and customer value (Csikszentmihalyi 1975, 1990; Higgins 2006).

4.6 Other Disciplines

The category "others" includes four papers we were unable to code to one of the pre-defined categories. These papers apply the concept of user experience to e-government, construction, and contracting. For instance, Winckler et al. (2013) apply user experience to e-government research in order to design mobile-phone applications that users accept and use to report urban incidents. McArthur (2011) examines how user experience design principles can be useful for the design of spaces of learning.

None of the four papers directly relates to the context of customer integration and co-creation. From the four papers, we could identify transcendence, responsiveness, and visualization of information as influencing factors of user experience (Li et al. 2013; McArthur 2011; Passera 2012; Winckler et al. 2013). Positive implications mentioned in the papers are trust, mutual respect, and transparency (Passera 2012).

4.7 Summary of Influencing Factors and Implications

In the different disciplines, different influencing factors and implications are in the focus of research. Table 15 summarizes the identified influencing factors and implications in the different disciplines.

Discipline	**Influencing factors**	**Implications**	**Number of papers coded to the discipline (number of papers addressing customer integration)**
Information Systems	*Information systems quality:* Ease of use, usefulness, security, privacy, reliability, time responsiveness, information quality	Satisfaction with the system	37 (3)
	User: Normative beliefs, self-efficacy	*Behavioral implications:* Intention to use, continuance intentions, user acceptance	
Human-Computer Interaction	*Instrumental qualities:* Ease of use, usefulness	*Emotional user reactions:* Pleasure, frustration	43 (1)
		Behavioral implications: Intention to use	
	Non-instrumental qualities: Beauty, aesthetics	*Task-related implications:* Task performance	
Marketing and Management	*Environment:* Atmosphere (e.g., scents, temperature, music), assortment (e.g., variety, quality), and social factors (e.g., personnel)	*Emotional user reactions:* Perceived autonomy, competence, task enjoyment, pleasure	50 (13)
		Marketing-related implications: Satisfaction, loyalty, word-of-mouth	

Technology and Innovation Management	*Design of IT-based customer integration method:* Ease of use, usability, aesthetics, satisfy customers' needs to feel competent and to acquire information	*Task-related/ innovation-related implications:* Quality and quantity of customer contributions	11 (11)
		Behavioral implications: Willingness to participate	
Psychology	*Task:* Skills in balance with challenge, clear goals, feedback, instructions, clear target outcome	*Emotional user reactions:* Enjoyment	4 (0)
Others	*Qualities of interaction:* Visualization of information, visual aesthetics, responsiveness	*Marketing-related implications/ customer relationship:* Sense of trust, transparency	4 (0)

Table 15: Influencing Factors and Implications Studied in Different Disciplines

Previous research showed the potential of combining different theories and constructs from different disciplines into one framework (Chen 2003; Douglas/Craig 1992). Therefore, we draw from the above-discussed disciplines to identify and classify the most frequently investigated influencing factors and implications of human experiences.

In total, we identify 22 conceptually different influencing factors and 15 implications affecting human experience. We aggregate the 22 identified influencing factors and the 15 implications into four categories (see Figure 21).

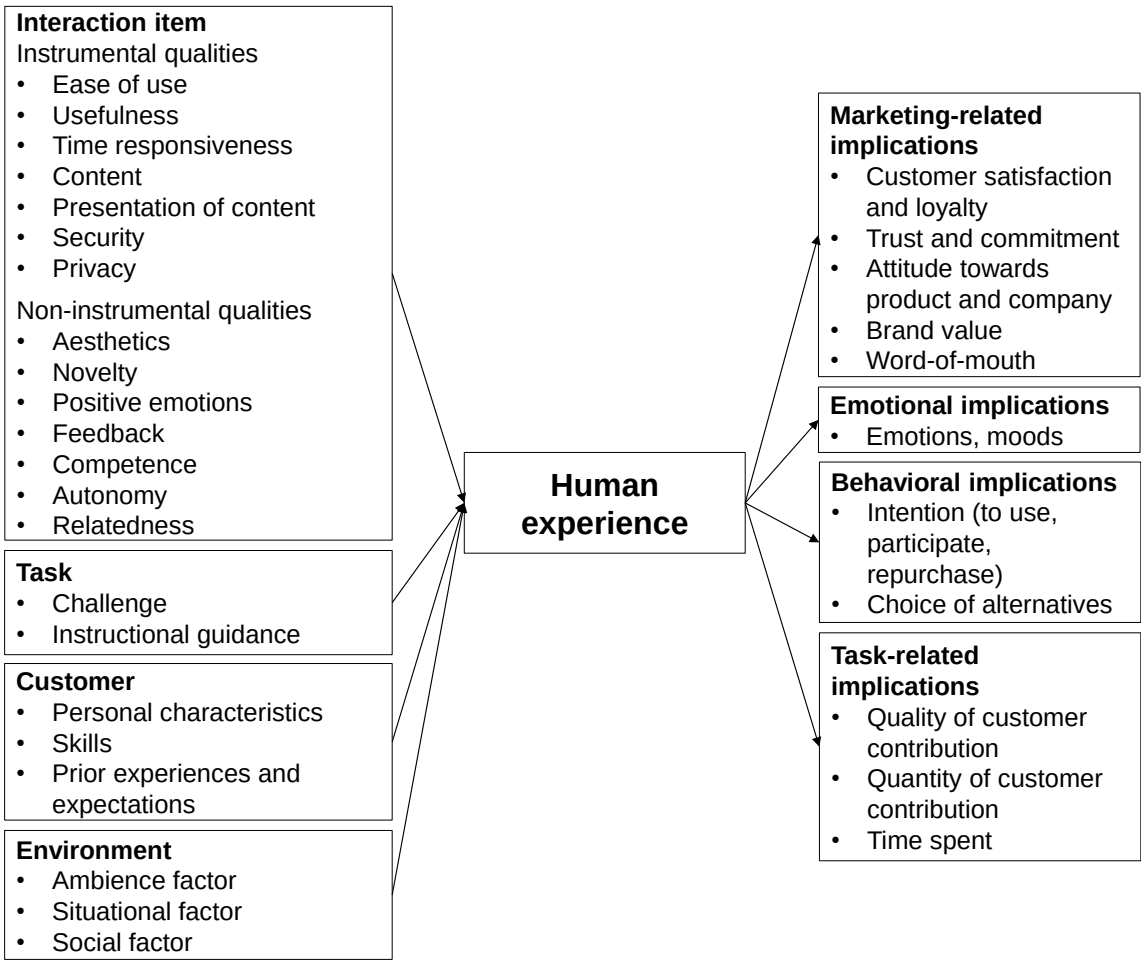

Figure 21: Influencing Factors and Implications of Human Experience

One factor influencing the experience is the design of the interaction item (e.g., system, product). This includes instrumental and non-instrumental qualities of the interaction item. Other influencing factors are the task, the customer, and the environment in which the interaction occurs (own classification based on Mahlke/Thüring (2007) and Knijnenburg et al. (2012)).

Implications of the experience can be categorized in marketing-related implications, emotional implications, behavioral implications, and task-related implications (own classification based on Mahlke/Thüring (2007) and Nambisan/Nambisan (2008)). Marketing-related implications refer to marketing-related company goals such as enhancing customer satisfaction, customer loyalty, or brand value (Klaus et al. 2013; Nambisan/Nambisan 2008). Emotional implications subsume the impact of the experience on emotions and feelings. A positive experience results in positive emotions such as fun. In contrast, a negative experience results in negative emotions such as frustration (Éthier et al. 2006; Partala/Kallinen 2012). Behavioral implications, in contrast, include individuals' intention to use a system or web store in the future (Bhattacherjee 2001; Vijayasarathy 2004; Wakefield/Whitten 2006).

5 Influencing Factors and Implications of Customer Integration Experiences

In the following, we discuss the above identified influencing factors and implications in the context of customer integration experience. In section 5.1, we describe the identified influencing factors and their consequences for the design of appropriate IT-based customer integration methods and tasks. Similarly, in section 5.2 we present the implications that customer integration experience can have.

5.1 Influencing Factors of Customer Integration Experience

We discuss each influencing factor separately and provide guidelines for practitioners to consider the influencing factors in the design of IT-based customer integration methods. Table 17 in the Appendix (Appendix B) summarizes the relationships between identified influencing factors and customer integration experience that have already been empirically tested in quantitative studies.

5.1.1 Instrumental Qualities of IT-based Customer Integration Methods

Instrumental qualities of systems concern the experienced support of the system to accomplish tasks and goals. This includes the perceived ease of use, usefulness, functionality, effectiveness, and the satisfaction of product-related informational goals (Mahlke/Thüring 2007; Nambisan/Nambisan 2008). In the following, we describe the instrumental influencing factors identified in our literature review. Afterwards, we give a short summary and guidelines for practitioners who want to implement an IT-based customer integration method.

Ease of use: Ease of use is related to the usability of systems (Mahlke 2007; Mahlke/Thüring 2007) and can be defined as the degree to which an individual believes that using a particular system would be free of physical and mental effort (Davis et al. 1989). According to existing customer integration literature, IT-based customer integration methods suffer from severe usability problems. For instance, virtual worlds frequently face the challenge of conceptual disorientation or unintuitive navigation (Matzler et al. 2011). Ease of use is an important determinant of the customer integration experience. This influencing factor has already been studied in the context of customer integration experience (Matzler et al. 2011).

Usefulness: Particularly information systems and human-computer interaction research has identified and studied usefulness as an influencing factor of user experience. Usefulness is related to the utility of a system (Mahlke 2007; Mahlke/Thüring 2007). IT-based customer integration methods need to be designed in a way that supports customers in understanding the virtual product, being creative, and articulating their preferences (Füller et al. 2009).

Time responsiveness: In the context of online shopping, speed or time responsiveness refers to the time required for loading and displaying the website (De Wulf et al. 2006; Devaraj et al. 2006). In terms of servicing, time responsiveness is conceptualized as the timely delivery of services (Joshi 2014; Rowley et al. 2007; Sharma/Chaubey 2014).

Content: Marketing and management research found that the content provided by a website affects its success (De Wulf et al. 2006). Analogously, information systems research views information quality as an important factor affecting user satisfaction (Chen et al. 2012). The content provided by systems and websites needs to be credible, trustworthy, current, sufficient, and relevant (Chen et al. 2012; De Wulf et al. 2006). Some customers only participate in customer integration initiatives to gain information about an existing product and the current state of technology (Nambisan/Nambisan 2008).

Presentation of content: Previous information systems and marketing research on the design of e-commerce websites found that the organization and presentation of content at a website increases the probability that the customer will experience a positive association with the website (De Wulf et al. 2006).

Security: Customers' security concerns affect the experience they gain when using a system (Arhippainen 2013). Security refers to confidentiality, availability, and integrity of data (Vijayasarathy 2004). Previous research on the design of e-commerce websites and mobile services found that security concerns have a significant effect on customers' intention to prefer one online shopping website over another. Thus, security is a critical factor for the overall success of online retailers (Devaraj et al. 2006).

Privacy: Particularly marketing and information systems research on e-commerce websites has identified privacy concerns as an important factor. Customers' privacy concerns refer to the potential misuse of personal information (Vijayasarathy 2004), and can influence how people interact with and evaluate a system (Knijnenburg et al. 2012).

Summary and design guidelines: Designers of IT-based customer integration methods need to consider a clear structure, a highly intuitive navigation, understandability, and findability to increase ease of use (Matzler et al. 2011). Further, the system needs to support the customer in successfully completing their customer integration task to ensure usability. Thereby, the system needs to respond quickly to customers' requests and input (time responsiveness). For instance, a website that allows customers to self-design a product needs to provide instant visual feedback of the customized product (e.g., car exterior needs to be immediately visualized in the selected color).

Further, it needs to supply the customer with interesting and current content that is relevant for successfully completing the customer integration task. This content needs to be sufficient: Too much information can cause information overload that overwhelms customers and leads to feelings of failure and frustration (Huffman/Kahn 1998). Misleading, inaccurate or unclear information, the use of ambiguous terms, or information that is not easily accessible are further obstacles. Besides the content, also its presentation is important. For instance, to customize a product to individual needs, the customer requires detailed information on the product, its functionality, the product attributes that can be customized, and the options that can be selected. This content needs to be presented in an adequate structure and format to aid customers in absorbing relevant information to perform the customer integration task (Huffman/Kahn 1998). Finally, companies need to ensure security and privacy by using

secure and reliable systems with restricted access to customer data. Companies can show their credibility by communicating their efforts and certificates (Xu et al. 2012).

5.1.2 Non-Instrumental Qualities of IT-based Customer Integration Methods

Besides instrumental qualities, designers need to acknowledge non-instrumental qualities of systems. Examples for non-instrumental qualities are playfulness, entertainment, competence, and autonomy (Hassenzahl et al. 2010; Hassenzahl/Tractinsky 2006). In the following, we describe the non-instrumental influencing factors identified in our literature review. To design for positive customer integration experience, we derive guidelines for the appropriate design of IT-based customer integration methods and customer integration tasks.

Aesthetics: This influencing factor has particularly been studied in human-computer interaction research and considers users' visual, haptic, and acoustic perceptions of systems (Mahlke 2007; Mahlke/Thüring 2007). For designing visually appealing user interfaces, designers should use appropriate colors and graphics (Moczarny et al. 2012), which make user interfaces more understandable, consistent, and guiding. In contrast, cluttered page layout, inappropriate use of color, and visually overloaded interfaces evoke rather negative emotions and user experience (Moczarny et al. 2012; Stelmaszewska et al. 2004).

Novelty: Novelty relates to an individual's sense of discovery, adventure, experimentation, and curiosity. According to human-computer interaction research, it is a key factor in creating a hedonic and enjoyable experience (Stelmaszewska et al. 2004). Functionalities of information systems that allow the user to do something one would not expect, and that allow the user to experiment with technology help in creating positive user experience (Chung/Tan 2004; Stelmaszewska et al. 2004).

Positive emotions: Entertainment, task enjoyment, fun, and playfulness constitute a positive customer integration experience (Füller et al. 2011; Kourouthanassis et al. 2007; Sheng/Teo 2012). Customer integration research already acknowledged this influencing factor (Füller et al. 2011; Kohler et al. 2011).

Feedback: Research in the field of psychology found that feedback contributes to flow experience (Csikszentmihalyi 1975; Guo/Klein 2009). Clear and unambiguous feedback supports people in successfully completing challenging tasks leading to enjoyment of the activity for its own sake (Csikszentmihalyi 1975). Similarly, human-computer interaction research found that clear and unobtrusive feedback facilitates users' concentration on the task, provides users with a sense of being in control, increases confidence, and creates consciousness (Colombo/Pasch 2012; Guo/Klein 2009).

Competence: The fulfillment of psychological needs can be viewed as a source of positive experience (Hassenzahl et al. 2010). The self-determination theory views the psychological needs of competence, autonomy, and relatedness as important determinants for the well-being of an individual (Deci/Ryan 2000; Ryan/Deci 2000). Individuals have the psychological need to feel competent and to be able to master challenges (Partala/Kallinen 2012). Füller et al. (2011) studied competence in the context of customer integration into innovation processes.

According to their study, competence positively influences customers' co-creation experience and reflects customers' satisfaction derived from successfully completing a task.

Autonomy: Another psychological need of customers that constitutes a major source of positive experiences is autonomy (Hassenzahl et al. 2010). External influence, pressure, and restrictions on decision-making result in negative emotions and experiences (Partala/Kallinen 2012). In the context of customer integration, Füller et al. (2011) and Matzler et al. (2011) found that customers derive positive emotions and experiences from the freedom to choose the process of performing a creative task.

Relatedness: Individuals' desire to feel part of a community, to care for and to be related to others constitutes the social dimension of customer integration experience (Matzler et al. 2011). Participants of open innovation initiatives often engage in customer integration tasks because they enjoy interacting with others and want to build social relationships (Füller et al. 2011). Feeling as a part of the innovation community and interactivity with others has a significant positive effect on customer integration experience (Füller et al. 2011; Matzler et al. 2011).

Summary and design guidelines: Practitioners need to consider aesthetic user interfaces and novel functionalities as a source of positive customer integration experience. To generate enjoyment and a feeling of competency, elements of gamification (e.g., achievement badges or levels) can be employed (Hamari 2013; Hamari/Eranti 2011; Hamari et al. 2014; Kohler et al. 2011; Stelmaszewska et al. 2004). Companies also need to define challenging but feasible customer integration tasks to ensure competence and autonomy. Another important consideration is the integration of support and feedback systems to support customers when they experience uncertainty and frustration.

Further, IT-based customer integration methods should provide relevant and sufficient information to assist customers in mastering their customer integration task successfully (Zhang et al. 2015). Another means for designers to ensure feelings of autonomy and competence is providing customers with sufficient freedom for their decision and solution processes. For instance, toolkits for user innovation and design could provide a hybrid solution space that requires customers to customize some mandatory product attributes, but also allows customers to self-design a lot more product attributes optionally (Franke/Hader 2014; Franke/Schreier 2010; von Hippel 2001).

As customers frequently participate in customer integration initiatives to establish relationships and to feel part of a community, IT-based customer integration methods should enable vivid discussions, collaboration, and interactions between participants. Functionalities that allow customers to help each other or to build on and improve each other's input (e.g., ideas) can help in considering the influencing factors of feedback and relatedness.

5.1.3 Customer Integration Task

Besides the appropriate design of IT-based customer integration methods, practitioners also need to consider the design of the customer integration task. In the following, we present the identified influencing factors related to the task and provide guidelines for practitioners on

how to consider these influencing factors in the context of implementing customer integration initiatives.

Challenge: According to psychology and human-computer interaction research, tasks can be designed so that they are intrinsically rewarding and allow a person to experience flow. Flow occurs when individuals engage in challenging tasks that are in balance with their skills (Csikszentmihalyi 1975). Thus, a challenging but feasible task creates positive experiences, whereas a mismatch of challenge and skills (i.e., unfeasible task) negatively affects customer integration experience. Mastering challenges results in feelings of achievement, pleasure, and satisfaction (Stelmaszewska et al. 2004).

Instructional guidance: Marketing and consumer behavior research found that whether instructions are provided and whether the target outcome is specified or not will influence an individual's perceived competence, perceived autonomy, and overall task enjoyment. Purposefully defining constraints helps to achieve a balance between perceived competence and autonomy for customers. Customers enjoy creative tasks more when they engage in creative activities providing a sense of both autonomy and competence (Dahl/Moreau 2007).

Summary and design guidelines: Customer integration tasks need to be challenging but feasible. Companies can decide whether and how much assistance they want to provide to their customers. For instance, instructions on the task and information on the target outcome may or may not be provided.

5.1.4 Customer

The experiences that customers gain from interacting with a product, service, or system also depends on their personal characteristics, skills, and prior experiences (Fiore/Kim 2007; Knijnenburg et al. 2012). In the following we describe the influencing factors related to the individual itself. We conclude with guidelines for practitioners on how to consider the customer and its skills in the design of appropriate IT-based customer integration methods and tasks.

Personal characteristics: According to human-computer interaction and information systems research, a person's demographics, personality traits, interests, and domain knowledge influence the interaction and how the person evaluates and perceives the interaction with a system (Knijnenburg et al. 2012). For instance, individuals interested in a topic and eager to find out more about this topic are more focused, engaged, and absorbed in the activity (McCay-Peet et al. 2012).

Skills: Customers' competencies are a function of the knowledge and skills they possess (Prahalad/Ramaswamy 2000). Companies can harness customers' competencies by using online communities or other IT-based customer integration methods that allow them to engage in an active dialog with their customers. However, the experience customers gain when interacting or consuming a technology, product, or service is highly dependent on their skills (Prahalad/Ramaswamy 2000). Younger users may learn faster to apply a new technology or software application in order to complete a task than older users (Prahalad/Ramaswamy 2000).

Prior experiences and expectations: Based on the expectation-confirmation theory, the confirmation or disconfirmation of expectations impacts satisfaction (Bhattacherjee 2001; Oliver 1980). For instance, marketing research found that customer expectations prior to the encounter have a significant effect on post-purchase evaluations of the shopping experience (Verhoef et al. 2009).

Summary and design guidelines: Familiarity with the target customers' skills and adapting IT-based customer integration methods to these skills help in shaping customer integration experience. For instance, when companies invite the public (i.e., customers with a diverse set of skills) to contribute to their ideas, the IT-based customer integration method can be designed as an adaptive system that provides support to novice users and offers advanced features to intermediate and advanced users based on user behavior. When companies employ toolkits for user innovation and design, the toolkit's solution space as well as the information provided for the product design task can be adapted to the toolkit users' preferences (Füller et al. 2016). Thereby, more interested and eager toolkit users can get more information on product attributes and design options by clicking on an information button. Further, the solution space can be adapted to the users' preferences. A hybrid solution space requires customers to customize some mandatory product attributes, but also allows customers to customize a lot more product attributes if desired (Füller et al. 2016).

Further, prior experiences and expectations determine the customer integration experience. Customers have expectations on how the underlying system should support them in performing the task. Customers may expect specific outcomes and feelings (e.g., fun) when providing their input. In order to create a positive customer integration experience, these expectations need to be met or even surpassed by utility, novelty, challenge, and pleasure (Arhippainen 2013; Colombo/Pasch 2012; Stelmaszewska et al. 2004). Therefore, designers need to be aware of the current state of technology. Market analysis and competition-based benchmarking can be used to identify the best IT-based customer integration methods (e.g., best car configurators) and the employed technologies and functionalities (e.g., advanced visualization features, game elements).

5.1.5 Environment

Existing literature shows that human experiences are highly influenced by the environment in which interactions occur (Prahalad/Ramaswamy 2000). According to marketing research, customers' shopping experience depends on several store-related factors: The **ambience** (e.g., temperature, scent, and music), **situational** factors (e.g., crowding, budget constraints, time constraints, information overload, and promotion overload), and **social** factors (e.g., appearance, number, and behavior of other shoppers or personnel) (Fiore/Kim 2007; Jain/Bagdare 2009; Kourouthanassis et al. 2007). In the following, we describe how practitioners can consider these influencing factors in the design of appropriate IT-based customer integration initiatives.

Summary and design guidelines: Companies cannot influence the ambience (e.g., temperature, scent) through IT-based customer integration methods. However, when customers and companies meet in person to generate and discuss ideas and product concepts

in brainstorming sessions or focus groups, companies can influence the ambience in the meeting room. In contrast to the ambience, in IT-based customer integration initiatives companies can control situational factors in terms of the content provided (e.g., information amount and relevance). Providing too much information distracts customers from the customer integration task and can cause negative feelings of failure and frustration (Huffman/Kahn 1998).

Concerning social factors, customers frequently participate in customer integration initiatives to acquire contacts and build their reputation among other participants (Leimeister et al. 2009; Nambisan/Nambisan 2008), designers need to consider features and tools that foster conversations, discussions, and real-time interactive interactions of participants (Kohler et al. 2011). For instance, user profiles, private chats, discussion forums, guided discussions, and community rating of ideas provide means to create social experiences for customers (Kohler et al. 2011; Leimeister et al. 2009).

5.2 Implications of Customer Integration Experience

Drawing from research findings of different disciplines, we identify 15 conceptually different implications of human experiences. We categorized the implications in marketing-related, behavioral, emotional, and task-related implications. In the following, we describe each implication and its relevance in the context of customer integration experience. Table 18 in the Appendix (Appendix B) summarizes the relationships between customer integration experience and identified implications that have already been empirically tested in quantitative studies in the field of customer integration into innovation processes.

5.2.1 Marketing-Related Implications

Previous research found that the experience customers gain from a customer integration initiative has a significant and positive effect on common marketing objectives including customer satisfaction, loyalty (Klaus et al. 2013; Klaus/Maklan 2011), commitment, trust (De Wulf et al. 2006), attitude towards the product and the company (Nambisan/Watt 2011), brand value (Sheng/Teo 2012), and perceived customer value (Tu/Zhang 2013). Marketing literature suggests that these marketing-related implications are the main reasons why companies try to improve the experience of their customers (Johnston/Kong 1991). Based on our literature analysis, all of the following marketing-related implications have already been mentioned in the context of customer integration and co-creation of value with customers. Thus, a positive customer integration experience helps companies to achieve marketing-related objectives.

Customer satisfaction and loyalty: Companies that measured the impact of their customer experience improvement program could identify an increase in customer satisfaction (of 12 percent, from 85 percent to 97 percent) and customer loyalty (of 10 percent, from 71 percent to 81 percent) (Johnston/Kong 1991). A positive evaluation of the interaction with an IT-based customer integration method positively influences customers' satisfaction with the overall customer integration initiative as well as customer satisfaction and loyalty to the company and its brand (Nambisan/Baron 2009; Zine et al. 2014).

Trust and commitment: Customers that have a positive experience with purchasing a product online at a particular online store can convince themselves of the store's trustworthiness (Kim et al. 2004). Thus, trust evolves with positive experiences (Kim et al. 2004). The experience that customers gain from virtually participating and contributing to innovation processes can create trust, commitment, and long-term customer relationships (Füller/Matzler 2007). Customers may even become enthusiastic about the content they co-create and co-design. For instance, if customers are required to create ideas on a more sustainable future, they may feel committed to the topic such that they intend to live more sustainable and convince others of being more environmentally friendly (Füller/Matzler 2007).

Attitude towards product and company: Another reason for companies to create a positive customer integration experience is its impact on customers' attitudes towards the product and the company (Nambisan/Watt 2011). In virtual product communities, customers can discuss products, generate ideas on how to improve the product, or customize products to their individual preferences. Product-related interactions and the experiences customers gain in such virtual product environments can influence customers' attitudes towards the product (Nambisan/Watt 2011). Although the interactions are mainly product-related, positive experiences in virtual product environments may also have a lasting positive effect on customers' attitudes towards the company affiliated with the product. When customers gain negative experiences from interacting with the virtual product and the virtual product environment, customers may blame the company. Thus, customers may develop a negative attitude toward the product and the affiliated company (Nambisan/Watt 2011; Nambisan/Nambisan 2008).

Brand value: A further implication of a positive customer experience is the development of affective bonds between customers, or the customer and the company, which in turn leads to enhanced brand loyalty and brand value (Nambisan/Watt 2011). In contrast, negative customer experiences result in dissatisfied customers and the brand value suffers (Parandker/Lokku 2012).

Perceived customer value: Previous research found that customers need to be assigned with an active role in value creation as customer value is rather embedded in the experience stemming from the interaction than in the product or service itself (Prahalad/Ramaswamy 2003). Customers can derive value from co-creating products or services by acquiring product-related information (i.e., pragmatic value), interacting with other customers and establishing relationships (i.e., social value), or enjoying the customer integration task (i.e., hedonic value) (Nambisan/Watt 2011; Nambisan/Nambisan 2008; Zhang et al. 2015).

Word-of-mouth: Positive experiences and satisfaction with a service or product have a positive effect on customers' intention to recommend the company or the product to others. Negative experiences may also propagate through word-of-mouth (e.g., complaints and negative online reviews) (Sharma/Chaubey 2014). Matzler et al. (2011) found that a positive customer integration experience increases the probability that customers recommend and talk

positively about the customer integration initiative and the associated product and company (Matzler et al. 2011).

5.2.2 Behavioral Implications

Customer integration experience can shape the behavior and decisions of customers. In the following, we present the identified implications in the context of customer integration experience.

Willingness: Previous customer integration research found that a customer's willingness to engage in customer integration initiatives in the future is determined by their previous customer integration experience (Füller et al. 2011; Kohler et al. 2011).

Choice of alternatives: Due to positive experiences with the company, customers may decide for a product over an alternative from a competitor. Nambisan/Nambisan (2008) conducted interviews with customers that have participated in IT-based customer initiatives. One participant stated that the primary reason for buying a smart phone from the company was the active customer forum associated with it and the good experience he had while engaging in this forum (Nambisan/Nambisan 2008).

5.2.3 Emotional Implications

Between the most satisfying and unsatisfying experiences, there are significant differences in the emotions experienced by customers (Partala/Kallinen 2012). According to previous customer integration research, customers can derive positive emotions including enjoyment, pleasure, pride, and accomplishment from co-creating products and services (Franke/Piller 2004; Franke/Schreier 2010; Nambisan/Nambisan 2008). In contrast, negative customer integration experiences due to poorly designed co-creation tools and tasks lead to dislike and frustration (Füller et al. 2011).

5.2.4 Task-Related Implications

Existing customer integration research identified the time required by customers to complete the customer integration task and their contribution to the innovation process (e.g., quality and quantity of ideas) as important implications of a positive customer integration experience (Füller et al. 2011; Kohler et al. 2010; Nambisan/Nambisan 2008). A positive, flow-like customer integration experience fully engages customers into their customer integration task. Focused attention and enjoyment of the task results in increased persistence and facilitates individuals to perform at their peak level (Füller et al. 2011; Kohler et al. 2010). Therefore, a positive customer integration experience can result in participants spending more time, contributing more content, and most importantly submitting high quality content (Füller et al. 2011; Kohler et al. 2010; Nambisan/Nambisan 2008).

6 Framework Development on Influencing Factors and Implications of Customer Integration Experience

So far, we introduced and discussed the influencing factors and implications separately. However, existing literature proposes interrelations and moderating effects between the different influencing factors (Fiore/Kim 2007; Mahlke 2007). We draw on motivation-hygiene theory to analyze and explain the underlying mechanisms of the identified factors. In the following, we briefly introduce the motivation-hygiene theory (section 6.1). In section 6.2, we apply motivation-hygiene theory in the context of customer integration experience and derive propositions concerning influencing factors, and their interrelations. Finally, we discuss the current state of research concerning the proposed relationships (section 6.3).

6.1 Motivation-Hygiene Theory

Motivation-hygiene theory postulates that two factors, motivators and hygiene factors, determine satisfaction and dissatisfaction at the workplace. Hygiene factors are extrinsic to the job and include preventive and environmental conditions of the work (Herzberg 1974). Examples for hygiene factors are company policies, administration, salary, working conditions, and interpersonal relations (Herzberg 1971). In order to reduce job dissatisfaction, employers need to address hygiene factors by paying good wages and improving company policy and administration (Herzberg 1974).

In contrast, motivators are intrinsic factors to the work and are related to the content of jobs. Examples for motivators are responsibilities, achievement, recognition, advancement, and the work itself (Herzberg 1974). These job satisfiers are effective means to motivate individuals to superior performance and effort (Herzberg 1971). In order to generate job satisfaction, employers need to restructure jobs so that employees have some control over the way they manage their work and can realize feelings of responsibility and personal growth.

According to motivation-hygiene theory, companies need to consider both factors - hygiene factors and motivators - to enhance productivity and attitudes of employees at the workplace. While hygiene factors prevent job dissatisfaction, motivators satisfy psychological needs and generate motivation and positive feelings. Thus, the ideal situation includes both hygiene and motivation fulfillment (Herzberg 1968; Miner 2005).

6.2 Motivation-Hygiene Theory in the Context of Customer Integration Experience

Customer integration tasks or crowdsourced tasks can be viewed as a certain type of work that customers perform for a company (Tavakoli et al. 2015). Therefore, we propose that customer integration underlies the mechanisms described by motivation-hygiene theory.

Human-computer interaction research found that non-instrumental (i.e., hedonic) qualities of a system are more related to intrinsic motivation than instrumental (i.e., pragmatic, utilitarian) qualities (Hassenzahl et al. 2010; Valacich et al. 2007). This supports the notion of instrumental qualities as hygiene factors and non-instrumental qualities as motivators (Hassenzahl et al. 2010). Non-instrumental qualities as motivators capture a system’s ability

to generate positive experiences, while instrumental qualities as hygiene factors remove barriers and thereby prevent negative feelings (Hassenzahl et al. 2010).

Based on these findings and Herzberg's definition of hygiene factors and motivators, we classify the influencing factors of customer integration experience that we have identified in our literature review as follows. Instrumental qualities of an IT-based customer integration method (e.g., ease of use, usefulness, time responsiveness) are extrinsic aspects that support customers in successfully completing the customer integration task and thereby prevent frustration and dissatisfaction. Thus, we understand instrumental influencing factors of customer integration experience as hygiene factors. Further, the influencing factor "environment" including ambience, situational and social factors, comprises environmental conditions of a customer integration initiative. As an extrinsic aspect of the customer integration initiative, we classify the environment as a hygiene factor. In contrast, non-instrumental qualities of co-creation tools (e.g., entertainment, factors that provide a feeling of autonomy and competence) are motivators because they satisfy intrinsic, psychological needs of customers. The customer integration task presents the work itself and encompasses the content of the "job". Therefore, we define the customer integration task as a motivator.

Motivation-hygiene theory helps us to explain how motivation and job satisfaction evolve and how IT-based customer integration methods need to be designed. Customer participation is primarily voluntary and mostly customers do not stand to gain anything tangible for the effort expended in providing input (i.e., no extrinsic motives or rewards) (Füller et al. 2014). However, companies can provide customers' with other form of compensation or value for participating, for instance by providing a positive and unique customer integration experience. According to motivation hygiene theory, companies need to consider hygiene factors as well as motivators to create positive customer integration experience. Therefore, *we propose that instrumental qualities of IT-based customer integration methods and the environment as hygiene factors and non-instrumental qualities and the customer integration task as motivators influence customer integration experience (Proposition P1).*

Motivation-hygiene theory states that hygiene factors are not a source of positive experience themselves. Rather they enable the fulfilment of psychological needs (e.g., competence, autonomy) by removing barriers. If instrumental qualities of IT-based customer integration methods such as ease of use, security, and privacy are not fulfilled, they contribute to a negative feeling, but do not create positive feelings when they are fulfilled (Hassenzahl et al. 2010). Instrumental qualities of IT-based customer integration methods (e.g., ease of use, usefulness) ensure smooth interaction processes and intuitive co-creation systems that reduce the perceived burden, time, and effort required by customers to provide their input. Easy to use and intuitive IT-based customer integration methods (instrumental qualities) support the customers in successfully accomplishing their task which in turn results in positive emotions such as task enjoyment (non-instrumental qualities) (Stelmaszewska et al. 2004). When users of co-creation tools perceive the interaction as intuitive (instrumental qualities), emotions of playfulness, enjoyment and fun (non-instrumental qualities) increase as the associated burden with the participation (e.g., cognitive burden, spend time, and effort) is relieved. Therefore,

hygiene factors (environment, instrumental qualities of IT-based customer integration methods) need to be fulfilled and serve as a sound basis for motivators (customer integration task, non-instrumental qualities) to generate positive customer integration experience. Therefore, based on motivation-hygiene theory *we propose that instrumental qualities of IT-based customer integration methods and the environment as hygiene factors can support instrumental qualities of IT-based customer integration methods and the customer integration task (i.e., motivators) (Proposition P2).*

Vice versa, visually appealing user interfaces (non-instrumental qualities) are more understandable, consistent and guiding, and thereby can improve perceived usability (instrumental qualities) (Arhippainen 2013). Therefore, we propose that *non-instrumental qualities of IT-based customer integration methods (i.e., motivators) can improve the perception of instrumental qualities of IT-based customer integration methods (i.e., hygiene factors) (Proposition P3).*

According to human-computer interaction research, a person's demographics, personality traits, interests, and domain knowledge influence the interaction and how the person evaluates and perceives the interaction with a system (Knijnenburg et al. 2012). If the customer is not familiar with virtual reality, the customer may find an innovative toolkit for user innovation and design employing virtual reality as distracting and overwhelming. Companies need to be aware of their target customers' skills and need to adapt IT-based customer integration methods to these skills. Therefore, *we propose that the influencing factor "customer" moderates the impact of hygiene factors (instrumental qualities, the environment) and motivators (non-instrumental qualities, customer integration task) on the experience that customers' gain from participating in IT-based customer integration initiatives (Proposition P4).*

Figure 22 summarizes the identified influencing factors and implications of customer integration experience and their classification as hygiene factors and motivators. Further, Figure 22 illustrates the proposed relationships and interrelations based on motivation-hygiene theory.

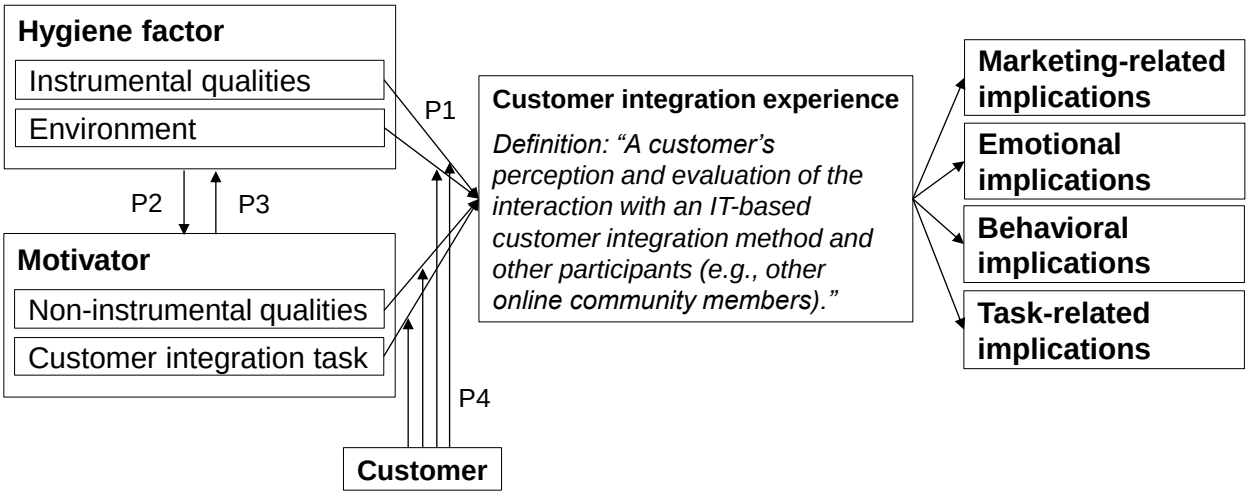

Figure 22: Framework on Influencing Factors and Implications of Customer Integration Experience based on Motivation-Hygiene Theory

6.3 Research Gaps

In the following, we present the current state of research concerning the propositions P1 – P4.

Concerning the impact of hygiene factors and motivators on customer integration experience (P1), customer integration research has already studied the effect of instrumental qualities on customer integration experience. For instance, there is a significant positive influence of ease of use on the experience that customers gain from using an IT-based customer integration tool to co-create a product or service (Matzler et al. 2011). The influence of other instrumental qualities including time responsiveness, content, security and privacy on customer integration experience have not yet been analyzed.

In terms of non-instrumental qualities, the positive impact of task enjoyment, competence, autonomy (Füller et al. 2011), control (Matzler et al. 2011), and relatedness (Füller et al. 2011; Matzler et al. 2011) on customer integration experience has been confirmed by previous customer integration research. However, in our literature basis there is no research evidence on aesthetic user interface design, feedback, and novelty.

We identified instructional guidance and challenges as task-related influencing factors of experience (Csikszentmihalyi 1975; Dahl/Moreau 2007; Stelmaszewska et al. 2004). The direct and positive impact of customer integration task design has not yet been studied in customer integration literature.

The environment as an influencing factor has been particularly researched in marketing literature. Store atmospherics, merchandise display, and the staff influence customers' shopping experience (Sathish/Venkatesakumar 2011). In the field of human-computer interaction, Partala and Kallinen (2012) analyzed the structure of the most satisfying and unsatisfying user experiences. According to their study, other people around and the level of hurry influence user experience. Based on our literature review, the impact of these

influencing factors on customer integration experience has not yet been studied by customer integration research.

Additionally, the proposed interrelationships of hygiene factors and motivators by P2 and P3 remain unresearched. Further, the customer including its skills, prior experiences, and expectations moderates the impact of hygiene factors (instrumental qualities, the environment) and motivators (non-instrumental qualities, customer integration task) on customer integration experience. The proposed moderating effect by P4 has not been researched in the context of customer integration experience.

7 Conclusion

Based on a structured, cross-disciplinary literature review yielding 141 relevant papers, we identified 22 conceptually different influencing factors and 15 implications of the customer integration experience. We classified the identified influencing factors and implications into four categories. We categorized the implications of a positive customer integration experience in marketing-related, emotional, behavioral, and task-related implications. The influencing factors are classified in instrumental and non-instrumental qualities of the IT-based customer integration method, the customer integration task, the customer, and the environment in which the interaction occurs.

The influencing factors of the customer integration experience pose important means for practitioners to design IT-based customer integration methods that create a positive customer integration experience and thereby result in positive behavioral, emotional, marketing, and innovation-related implications. A major contribution of our review is a framework based on motivation-hygiene theory structuring influencing factors of the customer integration experience as hygiene factors and motivators (see Figure 22).

Motivation-hygiene theory defines external factors of the job as hygiene factors. Therefore, we classified instrumental qualities of IT-based customer integration methods/co-creation tools and the environment in which the interaction happens as hygiene factors (Herzberg 1971, 1974). Hygiene factors do not create motivation or satisfaction. Yet, hygiene factors need to be considered by practitioners as their implementation results in intuitive and highly performant co-creation tools that help customers in successfully accomplishing their customer integration task. Hygiene factors help companies in avoiding dissatisfaction and negative feelings such as frustration. Thereby, hygiene factors prevent customers from quitting the customer integration task and lead to a higher number of customer generated content (e.g., a higher number of customer ideas submitted).

In addition to hygiene factors, companies need to consider motivators in order to design for positive customer integration experience. According to motivation hygiene theory, motivators are intrinsic factors, and create motivation and satisfaction. Motivators are related to the content of a task, achievement, and responsibility (Herzberg 1971, 1974). Based on this definition, we classified non-instrumental qualities (e.g., control, autonomy, and relatedness) of co-creation tools and the customer integration task (e.g., challenging task) as motivators. Non-instrumental qualities of IT-based customer integration methods and the customer

integration task are involved in generating positive user experience and satisfaction. Higher levels of satisfaction result in higher levels of effort and time spent by customers to solve their customer integration task. Thereby, motivators lead to higher quality of customer contributions (e.g., higher quality of customer ideas for new products or services submitted to the innovation process).

7.1 Directions for Future Research

The experiences individuals gain from interacting with systems, products, or other people can have profound effects. Customer experience is a crucial strategic component of company success (Klaus et al. 2013; Nambisan/Nambisan 2008). However, previous research has rarely applied a user or customer experience perspective to customer integration research (Füller et al. 2011; Kohler et al. 2010; Matzler et al. 2011; Nambisan/Nambisan 2008). Of the 141 papers identified in our literature search process, only a small number of 26 papers refers to the context of customer integration and co-creation. Thus, there is little empirical research on the experience customers' gain from co-creating a product or service and from interacting with an IT-based customer integration method.

As section 5.2 shows, existing customer integration literature mentions diverse impacts of the customer integration experience including marketing, behavioral, emotional, and task-related implications. Concerning the implications of a positive customer integration experience, enjoyment, customers' willingness to participate in the future, and higher quality and quantity of customer contributions have been identified (Füller et al. 2011; Kohler et al. 2011).

In terms of influencing factors of customer integration experience, existing customer integration research has primarily focused on influencing factors such as ease of use, sense of autonomy, competence, and relatedness. Thus, future research should examine the impact of social and cultural factors, trust, privacy and security concerns, the appropriate design of the customer integration task, and the customers themselves including their skills. Since privacy and security concerns of individuals may differ across cultures, it would be interesting to study the moderating effect of culture on the relationship between privacy/ security and customer integration experience. Additionally, the influence of the information provided (information relevance, information presentation format and structure, information visualization) on customers' task performance and customer integration experience are interesting paths for future research. Further, environmental and social factors can be significant predictors of participation in virtual communities (Bidar et al. 2016). However, the influence of social influence (e.g., identification with peers, compliance with group norms) on customer integration experience and its implications is unclear.

Previous research addressing the co-creation of value with customers stated the need of assuming customers with an active role in value creation. Customer value is rather embedded in the experience of co-creation a product or service than in the product or service itself (Prahalad & Ramaswamy 2003). Therefore, a positive and unique customer integration experience can be viewed as a compensation for customers' effort. Customers engage in customer integration initiatives to improve their skills (Spindeldreher/Schlagwein 2016), learn about the product and to satisfy product-related informational goals (i.e., pragmatic, utilitarian

value, pragmatic experience dimension) (Nambisan & Nambisan 2008). Further, customers participate in customer integration initiatives as they can derive hedonic value (i.e., hedonic experience dimension) by enjoying the activity of providing their input, or social value (i.e., sociability experience) from interacting with other customers, and establishing relationships (Nambisan & Watt 2011; Nambisan/Nambisan, 2008; Spindeldreher & Schlagwein 2016).

Besides these intrinsic motives, individuals participate as they wish to obtain monetary and material rewards (Spindeldreher & Schlagwein 2016). However, under certain circumstances, the impact of monetary rewards on individual's motivation may be negative (e.g., in pro-social/altruistically framed customer integration initiatives). This negative effect of extrinsic rewards on intrinsic motivation is termed the crowding-out effect, and has initially been investigated in the field of psychology (Janzik/Herstatt 2008; Lepper et al. 1973). According to our literature review, previous research did not study the effect of extrinsic aspects including prizes or monetary compensation on customer integration experience. However, motivation-hygiene theory suggests that extrinsic aspects (more related to hygiene factors) are important factors that need to be considered to prevent dissatisfaction. Therefore, future research should investigate the role of extrinsic motives and remuneration in creating positive customer integration experience.

Previous research studying human experiences used diverse measurement constructs, which makes the comparison and aggregation of existing research findings difficult (Klaus et al. 2013). For instance, researchers use measurement constructs labelled cognitive appraisal (Éthier et al. 2006), flow (Goel et al. 2013; Kim et al. 2013), cognitive absorption (Goel et al. 2011; Wakefield/Whitten 2006), online shopping experience (Khalifa & Liu 2007), compelling experience (Kohler et al. 2011; Matzler et al. 2011), co-creation experience (Füller et al. 2011), customer experience (Hsu/Tsou 2011; Sheng/Teo 2012), online community experience (Nambisan/Watt 2011), or customer experience quality (Klaus et al. 2013), which all comprising different items to measure experience. Even constructs with the same label frequently include different items.

Further, there is little empirical evidence on the customer integration experience. Of the 141 papers identified in our literature review, only 26 papers directly refer to customer integration. Of these 26 papers, 11 quantitative papers analyze the relationship of influencing factors and customer integration experience, and 17 quantitative papers analyze influencing factors (see Appendix). Therefore, quantitative studies are required to empirically analyze customer integration experience and to test the proposed relationships in this paper (see Figure 4). Additionally, future research should discuss a standardized measurement of customer integration experience to allow the synthesis of research findings (e.g., in a meta analysis).

7.2 Limitations and Implications for Theory and Practice

We acknowledge that our research is subject to some limitations. Our research findings, including the identified papers relevant for the underlying research and the identified influencing factors and implications, are limited by the keywords, and the databases and journals we used to search for relevant literature.

Our research has several implications for theory and practice. We contribute to theory by providing an overview of existing research in different disciplines on human experience. We analyzed the discipline-specific perspectives on experience, and the diverse constructs and items used to measure individuals' experiences. Based on our literature review, we derived a classification of influencing factors and implications of human experience. In total, 22 different influencing factors and 15 implications have been identified. Further, this study broadens the body of knowledge on customer integration by applying a user and customer experience perspective to customer integration research. Drawing on motivation-hygiene theory, we contribute a framework of influencing factors and implications of customer integration experience.

From a managerial perspective, we improve the general understanding on how to design IT-based customer integration methods for innovation processes that create enjoyment, playfulness, and support customers in successfully accomplishing their customer integration task. Thus, for practitioners we provide a more nuanced understanding of how to design for positive customer integration experience. By considering hygiene factors (instrumental qualities and environment) and motivators (non-instrumental and the customer integration task), companies can achieve a sufficient number and a high quality of customer contributions to the innovation process.

Appendix A – Experience in the Context of Customer Integration

Table 16 summarizes the 26 identified papers that study experience in the context of customer integration and co-creation with customers.

Author	Influencing factors	Implications	Research approach
Herd et al. (2009)	Design for pleasure Design coherent experience: multiple touch points/interactions between company and customer, if touch points are designed correctly, they create a coherent experience	N.A.	Conceptual paper
Pals et al. (2008)	Design (aesthetics, usability) Product interaction User's pre-disposition (e.g., moods, goals, preferences, earlier experience etc.) Context (e.g., physical, social and virtual) in which the interaction happens	N.A.	Conceptual paper
Eichentopf et al. (2011)	N.A.	Customer satisfaction Customer value	Conceptual paper
Füller/Matzler (2007)	N.A.	Ability to articulate needs Empowerment to participate Trust Commitment	Case study, AUDI, virtual lab as web-based interaction platform
Grönroos/Voima (2013)	N.A.	Customer value	Conceptual paper
Janzik/Raasch (2011)	N.A.	Quality of customizations improve Experience itself as main reason to return	In-depth netnographic analysis of online communities
Kohler et al. (2010)	N.A.	Further interest Evangelism Contribution Time Intention to act	Survey of Green Ideation Quest (a Virtual World) participants; n = 114
Nambisan/Watt (2011)	N.A.	Attitude towards product Attitude towards company Service quality	Web-based questionnaire survey, n = 178
Prahalad/Ramaswamy (2004b)	N.A.	Customer value	Conceptual paper
Tu/Zhang (2013)	N.A.	Customer value creation (pragmatic/hedonic value) Word-of-mouth Repeated use intentions	Survey, n = 485
Fiore et al. (2004)	Novelty Interface with advanced technology	Willingness to use co-design	Survey, n = 521

Füller et al. (2009)	Design of co-creation tool Self-determination Enjoyment	Willingness to participate in future virtual new product development projects Trust	Survey, n = 825
Füller et al. (2011)	Autonomy Competence Enjoyment Sense of community	Quality of contributions Amount of contributions Number of visits Further interest to participate	Online survey and log files, n = 174
Gouillart (2014)	Interaction design/experience design Gradually increase scope of interactions	Value Loyalty Repeat business	Conceptual paper
Hakanen/Jaakkola (2012)	Carefully designed processes and roles to clarify who provides or needs certain resources Suppliers' commitment to common goals as it affects the coherency of customer experience Commit all the suppliers to delivering a seamless customer experience Common customer interface.	Positive interaction experience with supplier Source of customer value	Multiple case studies, the empirical data comprise 51 interviews and observations made at 21 company workshops
Kohler et al. (2011)	Design principles: Pragmatic: Develop interactive objects Sociability: Attract critical mass; encourage collaboration; engage in conversations Hedonic: Nurture playfulness; provide challenging task Usability: Simplify the experience; provide clear navigation structure; promote intuitive usage	Actual participation Continued participation in such forums	Action Research, avatars in virtual worlds
Matzler et al. (2011)	Enjoyable activity Ease of use Perceived usefulness Feeling as a part of community	Perceived usefulness Word of mouth Further interest	Observation and tracking of user behavior in open innovation projects of KTM (n = 166) and Philips Design (n = 167); survey with n = 94
Nambisan/Baron (2009)	Characteristics of virtual customer environment: Product-related content (type and amount of information exchanged) Member identity (extent to which members reveal their identity) Human interactivity (extent to responsiveness or rapid feedback from members)	Customer participation and contribution (quality, quantity) Future participation	Survey, n = 152

Nambisan/Nambisan (2008)	Four components of customer experience: Pragmatic experience, sociability experience, usability experience, hedonic experience	Customer attitude towards product Customer attitude towards company Brand loyalty Customer perceived value Time to market Development cost Product quality	Conceptual paper
Pallot/Pawar (2010)	Design principles: Sensory: e.g., visual, auditory Perceptive: e.g., affordances Cognitive: e.g., human interface, cognitive artefacts Reciprocal: e.g., shared meaning, group consciousness Social: e.g., social networking, group dynamics Emotional: e.g., arousal Cultural: Habits, sense of community Empathical: e.g., helpfulness Technological: e.g., new functionalities, performance Economical: e.g., usefulness, availability Legal: e.g., privacy, Security	High rate of product adoption	Conceptual paper
Payne et al. (2009)	Easy-to-use systems Service processes need to be efficient and facilitate desired outcomes	Customer satisfaction Encourage the customer to participate increasingly in the process of co-creation	Cases study research, case of the City Car Club (CCC)
Prahalad/Ramaswamy (2000)	Create personalized experiences Shape customer expectations Experiences of customers varies according to their skills as users Choice and flexibility (in terms of distribution and communication channels)	Competition Customer value	Conceptual paper
Prahalad/Ramaswamy (2003)	Create personalized interactions Infrastructure/ experience environment for personalizes interactions: Experience environment as a networked combination of company capabilities (e.g., technical and social) and consumer interaction channels (devices, employees) View and analyze technology as a facilitator (e.g., technology can enable interactivity and connectivity)	Customer value Customers' willingness to pay Company revenue Profitable growth	Conceptual paper

Prahalad/Ramaswamy (2004a)	Create high-quality interactions Create personalized interactions Create experience environments Continuous company customer dialogue Building blocks of interactions between the firm and consumers that facilitate co-creation experiences: Dialogue, access, risk-benefits, transparency (DART approach for interaction design)	Interaction between company and customer and customer experience as source of customer value Competitive advantage	Conceptual paper
Prahalad/Ramaswamy (2004c)	Co-creation experience developed through purposeful interactions between consumer and company Dialogue, access, risk assessment and transparency (DART) as foundation for co-creation of value Dimension of choice (provide multiple channels) Quick, individual, and safe transactions Fair prices of experiences	Customer value Customers' willingness to pay	Book
Zine et al. (2014)	Personalized services leading	Customer satisfaction Customer loyalty	Conceptual, literature review

Table 16: Overview of Papers on Customer Integration Experience

Appendix B – Influencing Factors and Implications of Customer Integration Experience

Table 17 summarizes quantitative studies in the field of customer integration into innovation processes and co-creation of value with customers that have already statistically tested the impact of the identified influencing factors on customer integration experience.

Influencing factor (measurement construct)	**Experience** (dependent variable)	**Methodology, sample size**	**p-value**	**Test statistics/ effect size**	**Reference**
Influencing factors: Instrumental qualities of interaction item					
Ease of use	Compelling experience	Survey, n = 94	n.s.	ß = 0.025	Matzler et al. (2011)
Influencing factors: Non-instrumental qualities of interaction item					
Positive emotions: *Task enjoyment*	Co-creation experience	Survey, n = 174	p = 0.000	ß = 0.97	Füller et al. (2011)
Competence	Co-creation experience	Survey, n = 174	p = 0.000	ß = 0.81	Füller et al. (2011)
Autonomy	Co-creation experience	Survey, n = 174	p = 0.000	ß = 1.0	Füller et al. (2011)
	Compelling experience	Survey, n = 94	p < 0.001	ß = 0.326	Matzler et al. (2011)
Relatedness: *Sense of community*	Co-creation experience	Survey, n = 174	p = 0.000	ß = 0.55	Füller et al. (2011)
Relatedness: *Feeling as part of the innovation community*	Compelling experience	Survey, n = 94	p < 0.05	ß = 0.172	Matzler et al. (2011)
Influencing factors: Customer					
Characteristics: *Optimum stimulation level*	Exciting experience	Survey, n = 521	p < 0.001	t = 5.28	Fiore et al. (2004)
Characteristics: *Experience with appearance*	Exciting experience	Survey, n = 521	p < 0.001	t = 7.22	

â = Entire sample estimate
ß = Strength of relationship between influencing factor and experience
t = T-value/t-statistics
p = Significance of correlation
Z = Wilcoxon's matched pairs signed ranks tests for pairwise comparisons

Table 17: Influencing Factors of Customer Integration Experience

Similarly to Table 17, Table 18 summarizes quantitative studies in the field of customer integration into innovation processes and co-creation of value with customers that have already statistically tested the relationship between customer integration experience and the identified implications.

Implication (measurement construct)	**Experience** (independent variable)	**Methodology, sample Size**	**p-value**	**Test statistics/ effect size**	**Reference**
Marketing-related implications					
Attitude towards company	Pragmatic experience	Survey, n = 178	$p < 0.01$	ß = 0.19	Nambisan/Watt (2011)
	Hedonic experience	Survey, n = 178	$p < 0.05$	ß = 0.14	
	Sociability experience	Survey, n = 178	$p < 0.001$	ß = 0.30	
	Usability experience	Survey, n = 178	n.s.	ß = 0.09	
Attitude towards product	Pragmatic experience	Survey, n = 178	$p < 0.01$	ß = 0.21	Nambisan/Watt (2011)
	Hedonic experience	Survey, n = 178	$p < 0.05$	ß = 0.18	
	Sociability experience	Survey, n = 178	$p < 0.05$	ß = 0.17	
	Usability experience	Survey, n = 178	$p < 0.05$	ß = 0.17	
Word-of-mouth	Compelling experience	Survey, n = 94	$p < 0.001$	ß = 0.411	Matzler et al. (2011)
Behavioral implications					
Intention to act	Compelling experience	Survey of participants of an ideation question, n = 114	$p < 0.001$	$\gamma = 0.61$	Kohler et al. (2010)
Further interest	Compelling experience		$p < 0.001$	$\gamma = 0.83$	
Further interest	Compelling experience	Survey, n = 94	$p < 0.001$	ß = 0.357	Matzler et al. (2011)
Willingness to co-design	Exciting experience	Survey, n = 521	$p < 0.001$	ß = 0.34, t = 11.70	Fiore et al. (2004)
Further interest	Co-creation experience	Survey, n = 174	$p < 0.000$	ß = 0.73	Füller et al. (2011)
Emotional implications					
Task-related implications					
Quality of customer contribution	Co-creation experience	Top 30 (expert voting of 298 created items in a design competition)	$p < 0.05$	ß = 0.17	Füller et al. (2011)
Quantity of customer contribution	Compelling experience	Contribution (words contributed)	$p < 0.10$	$\gamma = 0.16$	Kohler et al. (2010)
	Co-creation experience	Number of contributed designs (analysis of log files of a virtual design competition	$p < 0,05$	ß = 0,22	Füller et al. (2011)

Time spent	Compelling experience	survey of participants of an ideation question, n = 114	p < 0. 05	γ = 0.23	Kohler et al. (2010)

â = Entire sample estimate
ß = Strength of relationship between influencing factor and experience
F = Multivariate analysis of variance (MANOVA) has been applied, results is a multivariate F-value (Wilkes λ)
t = T-value/t-statistics
p = Significance of correlation
Z = Wilcoxon's matched pairs signed ranks tests for pairwise comparisons
γ = Chi² test, results for main effects

Table 18: Implications of Customer Integration Experience

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Publication 4: Web-based Customer Integration for Product Design

Title:	Web-based Customer Integration for Product Design: The Role of Hedonic vs. Utilitarian Customer Experience
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Abstract

Integrating customers into the innovation process is gaining popularity among companies as means of addressing competitive and market pressures. At the same time, companies are faced with the challenge of selecting appropriate customer integration methods to sustain customers' engagement and elicit contributions that are useful. We draw from previous research in consumer behavior to identify customer experience as an important determinant of customers' overall participation in the design phase of the innovation process. Based on the compatibility principle, we propose a research model which examines the effect of a match between the type of product that customers are required to design, and the nature of customer experience (hedonic vs. utilitarian) they are provided with on their overall engagement with the customer integration process. A brief outline of the experimental study in which the proposed research model will be subsequently tested is presented. The aim of this research is to select and design appropriate web-based customer integration methods depending on the task that customers have to perform.

Keywords: Web-based customer integration, customer experience, hedonic experience, utilitarian experience, compatibility principle

Individual contribution of Kathrin Füller: For this publication, I participated in developing the research model and the experiment idea with my co-authors. I substantially contributed to the paper by collecting and analyzing relevant literature as well as writing the paper. My co-authors helped me in improving the paper and its story line.

1 Introduction

Companies have to be innovative in order to stay competitive in the market place (Drucker 1998). One approach for companies to innovate is to open up their innovation processes and leverage the knowledge of external stakeholders such as customers. This opening up of the innovation process is known as the open innovation approach (Chesbrough 2003). In open innovation, customers can give input along different phases of the innovation process. Customer input can be in the form of the generation and evaluation of ideas and concepts in the early and middle phases of the innovation process, in the design of product or service variations, or in the evaluation of prototypes as the innovation nears production and market launch (Dahan/Hauser 2002). Companies gather customer input through a variety of customer integration methods (CIM) like idea competitions, lead user or focus group workshops. In particular, technological advances and the proliferation of IT such as the Internet has resulted companies in using a lot of web-based CIMs (Jung et al. 2010).

These web-based CIMs make customer integration into innovation processes faster and more affordable (Erat et al. 2006; Füller et al. 2009). At the same time, many web-based CIMs fail to attract customer contribution, or fail to keep the customers engaged during the process of providing input (Kohler et al. 2011). This is of particular concern, as customers' engagement is primarily voluntary, and mostly customers do not stand to gain anything tangible for the effort expended in providing input. Therefore, from the perspective of the company integrating customers into their innovation process, it becomes imperative to provide customers with other forms of value from the customer integration process. For instance, customers could derive value from the experience of co-creating a product or service with the company (Holbrook 1996, 1998; Prahalad/Ramaswamy 2003). The experience customers gain not only helps in shaping the nature of their contribution, and in maintaining engagement, but can also influence their willingness to participate in customer integration projects in the future (Füller et al. 2011; Kohler et al. 2011). Thus, the nature of the experience that a customer gets can be an important determinant of the success of the whole customer integration project. Accordingly, companies need to pay particular attention towards selecting and designing the appropriate CIM to integrate their customers by focusing on the nature of experience that the CIM is able to provide to customers. Designing web-based CIMs that provide an appropriate customer experience is a multidisciplinary endeavor involving research findings on consumer behavior and emotions from marketing as well as fast and accurate information processing and task execution from information systems and human-computer interaction (Porat/Tractinsky 2012; Tractinsky/Lowengart 2007).

Previous research on customer integration has primarily focused on the early phases of the innovation process where companies aim at generating and evaluating ideas for new products and services (Blohm et al. 2011b; Gassmann et al. 2005; Huang et al. 2011; Leimeister et al. 2009). To this end, web-based CIMs such as virtual brainstorming (Jenkin et al. 2011; Nagasundaram/Bostrom 1995) or idea competitions (Leimeister et al. 2009) are used to integrate the customer as a source of information and creative ideas. However, customers can assume a more active role as a co-creator or co-producer in the innovation process. In this

role, customers can help the company in creating concepts or actually designing new products in the design phase of the innovation process (Nambisan/Baron 2007). Since these tasks require more effort, time and expertise from the customer, it is even more important to fully engage customers into the customer integration activity by offering a compelling customer experience. Therefore, we will focus on investigating the role of customer experience in web-based customer integration into the design phase. Our research is guided by the question: How does the nature of customer experience effect customer contribution in product design?

In marketing and consumer research, customer experience is often classified as utilitarian and hedonic experience (Addis/Holbrook 2001; Babin et al. 1994; Hirschman/Holbrook 1982). However, the notion of customer experience has rarely been applied in the context of customer integration (Kohler et al. 2011; Nambisan/Watt 2011; Nambisan/Nambisan 2008). It is not clear as to how customer experience will influence customers' engagement and contribution towards designing a product using a particular web-based CIM. We would therefore, study the effect of providing different (utilitarian and hedonic) customer experiences on customers' engagement and contributions to the customer integration process. We draw upon the compatibility principle that proposes that stimuli have to match with the provided task in order to elicit appropriate response and higher levels of task performance (Fitts/Deininger 1954; Kornblum/Lee 1995). Applying the compatibility principle in the context of web-based customer integration, we propose a research model underlining the effects of a match between customer experience and customer integration task on customers' contributions and engagement. We further elaborate on the design of an experimental study which we plan to conduct to subsequently test our proposed research model. Our findings will extend understanding regarding the role of customer experience in the design, selection and application of appropriate CIMs for obtaining high quality input from customers in the design phase of the innovation process. The study will contribute to the field of human-computer interaction by identifying stimuli (e.g. gamification, visualization) provided by web-based CIMs that activate different customer experience dimensions.

The remaining paper is structured as follows: Section 2 provides some theoretical background on the concepts of customer integration into innovation processes and customer experience. We introduce our research model in Section 3, and provide some initial descriptions of the research methodology with which we intend to validate the research model (Section 4). We conclude the paper by discussing the potential theoretical and practical contributions of this research.

2 Theoretical Background

2.1 Customer Integration into Innovation Processes

Companies are increasingly changing their innovation strategies to "innovating with customers" rather than "innovating for customers" in response to competitive business environments, shortened product life cycles, and increasing cost and innovation pressures (Desouza et al. 2008; Gassmann et al. 2005). Customer integration is a valuable approach in new product and service development and can result in better fit with market needs and faster

time to market (Erat et al. 2006). Customers can provide input to the different phases of the innovation process by creating and evaluating ideas and concepts, designing new products, or testing prototypes (Dahan/Hauser 2002).

Customer inputs can be gathered by companies through the use of different CIMs. Based on the responsibilities and the role assumed by the customer in the innovation process (Cavaye 1995), CIMs can be classified on a continuum ranging from passive to active customer integration (Alam 2002; Schultze et al. 2007). Passive CIMs are surveys or ethnography where the customer serves as a source of information and innovative ideas. On the other end of the continuum, active CIMs such as lead user workshops, focus groups, toolkits, and innovation communities enable customers to actively execute tasks such as getting involved in the generation of ideas, and/or in the design of products or services (Füller/Matzler 2007; Zogaj/Bretschneider 2012). However, integrating customers into the innovation process is often organizationally complex and entails physical restrictions.

The emergence of modern information technologies such as the Internet and high speed broadband connections offer significant opportunities to companies to alleviate some of the organizational and physical problems faced in customer integration into innovation processes (Parameswaran/Whinston 2007). The Internet makes customer integration faster and more affordable. Web-based tools increase interactivity and flexibility, enhance access to customers and therefore the size and scope of absorbable customer knowledge (Erat et al. 2006; Roberts/Grover 2012). For integrating customers into the product design phase, digital environments provide customers with a wide range of options for incorporating their ideas. For instance, customers can make minor changes to existing products or suggest more radical ones, choose between different product attributes or design the product entirely by themselves (Prandelli et al. 2006).

Virtual concept testing (VCT) is an example for a web-based CIM where participants are shown new product concepts and are asked to express their preference by purchasing the most favored concept at a certain price. VCT therefore allows companies to compare and evaluate different concepts before carrying them forward and launching them in the marketplace. Further, through the use of different multimedia options such as images or videos, VCT provides a low-cost alternative of testing virtual prototypes, rather than real physical prototypes (Dahan/Hauser 2002).

In order to make web-based customer integration successful, it becomes important to understand how web-based CIMs have to be designed in order to provide user-friendly and enjoyable experiences to customers so that they remain engaged and interested over the customer integration process, and therefore provide input which is of value to companies.

2.2 Customer Experience

Providing superior customer experience is a central objective for many companies, as this can result in brand loyalty, increased sales, and higher market shares (Nambisan/Nambisan 2008). Research in social science and psychology indicates that people are more likely to approach environments where they experience pleasure and avoid those that generate feelings of

displeasure (Russell/Mehrabian 1978). Accordingly, there has been a focus on identifying the antecedents and consequences of customer experience, as well as the different kinds of experience that can be provided to customers (Verhoef et al. 2009). In this context, the different forms of experience are outlined in Table 19.

Customer experience has been studied in terms of consumer's purchase and consumption experience in the field of marketing and consumer research. Here, customer experience was found to be determined by two basic dimensions, utilitarian and hedonic experience (Babin et al. 1994; Hirschman/Holbrook 1982; Noble et al. 2005; Overby/Lee 2006). Utilitarian customer experience is an outcome of utilitarian consumer behavior, which can be defined as task-related and goal-oriented. Thus, utilitarian shopping experience depends on task completion (shopping list) and product purchase in a deliberate, efficient, and fastidious manner. In contrast, the defining aspects of hedonic shopping are more related to fun, pleasure or playfulness that result from the activity (Babin et al. 1994).

Experience	Research field	References
Purchase, consumption experience of consumers (hedonic, utilitarian experience)	Marketing, consumer research	(Babin et al. 1994) (Hirschman/Holbrook 1982)
User experience	Human-computer interaction	(Hassenzahl/Tractinsky 2006) (Law et al. 2009)
Compelling co-creation experience	Marketing, technology innovation management, information systems	(Füller et al. 2009) (Füller et al. 2011) (Matzler et al. 2011)

Table 19: Research Streams on Customer Experience

In the context of developing IT systems, user experience has been researched within the domain of human-computer interaction. User experience refers to the experience individuals have when using and interacting with the Web, software, or IT systems. This research is based on the notion that for the development of IT systems not just the traditional usability framework but also users' feelings and motivation need to be considered (Law et al. 2009). As a means of providing more hedonic and intrinsically motivating systems, gamification has gained significant research interest (Hamari 2013).

Given the importance of customer experience in determining customers' ongoing engagement with a company, antecedents of a compelling customer experience that motivates customers to participate in web-based customer integration have been identified. Web-based CIMs need to be designed in a manner that empowers customers with varying capabilities to solve the given co-creation tasks (e.g. design of a product, creation of ideas). Further antecedents of a compelling co-creation experience are perceived autonomy (freedom to make choices and express creativity), sense of community (meet and connect to people), or ease of use of the web-based CIM (Füller et al. 2011; Matzler et al. 2011).

Despite acknowledging the role of compelling co-creation experience in customer integration, there is paucity of research that has considered designing and evaluating web-based CIMs that

incorporate the two major customer experience dimensions (hedonic and utilitarian) as means for providing a compelling co-creation experience.

Product type

Frequently the experience customers gain depends on the type of product and its features (Gentile et al. 2007). Analogous to the differentiation in utilitarian and hedonic customer experience dimensions, in marketing literature a widely accepted distinction of products is made in utilitarian and hedonic types of products (Addis/Holbrook 2001; Dhar/Wertenbroch 2000; Gentile et al. 2007; Hirschman/Holbrook 1982; Okada 2005). Hedonic products are defined as products that evoke heightened levels of fantasies and emotions such as fun. Examples for hedonic products are movies, music CDs, books, sport cars, designer clothes, or luxury watches (Addis/Holbrook 2001; Dhar/Wertenbroch 2000; Sen/Lerman 2007). On the contrary, the core value of utilitarian products such as washing machines, dishwashers, or printers lies in providing functionality (Hirschman/Holbrook 1982; Sen/Lerman 2007). Emotions do not affect whether and how the product works (Addis/Holbrook 2001; Dhar/Wertenbroch 2000). Utilitarian and hedonic products can have both objective/functional features as well as subjective/experiential ones. As for each product one aspect is dominating, a product can be categorized as being either utilitarian or hedonic (Addis/Holbrook 2001; Dhar/Wertenbroch 2000). For our research, in addition to distinguishing between utilitarian and hedonic dimensions of customer experience, we will also distinguish between utilitarian and hedonic types of products. This approach is consistent with previous research of Dhar/Wertenbroch (2000), Okada (2005), O'Curry/Strahilevitz (2001), Madlberger/Nakayama (2013), and Hirschman/Holbrook (1982).

3 Research Model

Our research will examine the role of customer experience in determining customers' contributions to the innovation process using web-based CIMs. In particular, we will investigate how the nature of customer experience (hedonic or utilitarian) provided to customers interacts with the type of the product (hedonic or utilitarian) that they are required to virtually design in determining the outcome of the design task. Figure 23 depicts the research model we intend to test in an experimental setting.

We rely on the compatibility principle whose basic idea is that stimuli that match with the provided task evoke appropriate response (Fitts/Deininger 1954; Kornblum/Lee 1995). For instance, vocal response is faster when the given stimulus is auditory, whereas a visual response is faster after a pointing-stimulus (Shafir 1993). When extended to the domain of marketing, the compatibility principle suggests that stimuli have to match with the product type (utilitarian/hedonic product). Consumers weight various store attributes differently depending on the products or services offered by those stores (Tractinsky/Lowengart 2007). To promote hedonic shopping, web-stores need to create feelings of fantasy, arousal and enjoyment (Tractinsky/Lowengart 2007). In the case of food shopping which is a strongly goal-oriented task of utilitarian product purchase, more performance-oriented characteristics of grocery-store design are important (Childers et al. 2001). Similarly, the stimuli provided in

advertising have to fit the advertised product. For utilitarian products, advertisement needs to be convincing and a problem-solving format focusing on the main benefits of the product is most suitable. In contrast, hedonic products have to be advertised in an emotionally appealing manner (Eisend 2009).

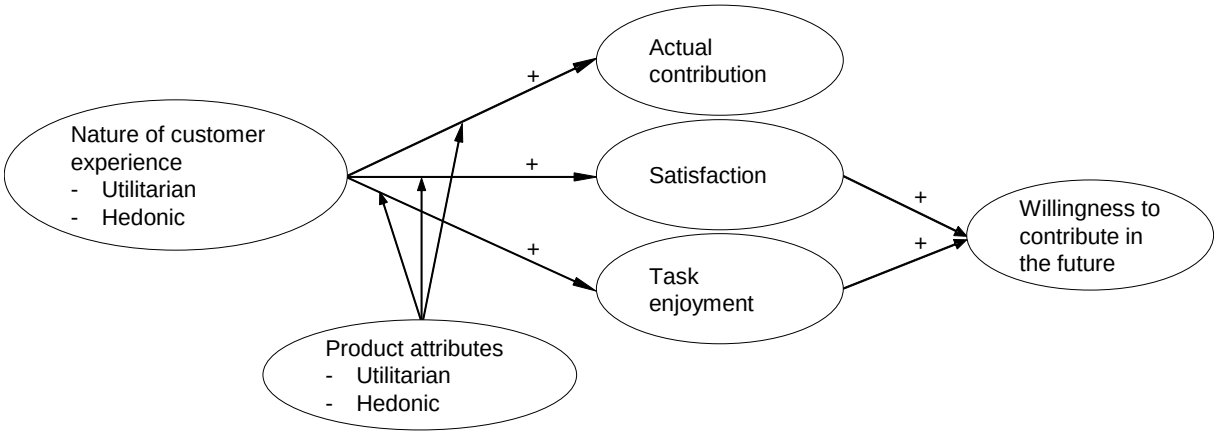

Figure 23: Research Model

Extending the compatibility principle in the context of web-based customer integration, we postulate that the stimuli provided to customers in the form of various aspects of the web-based CIM will influence customers' response, depending on whether there is a match between the stimuli and the task that they are required to perform in terms of the type of product they design. Therefore, our research model is based on the following proposition:

A match between the nature of customer experience provided by the web-based CIM and the product type will result in a positive effect on customers' response in terms of actual contribution to the innovation process, satisfaction, task enjoyment, and willingness to contribute in the future.

For the design of hedonic products customers prefer a hedonic customer experience. Since hedonic products are highly related with emotions, feelings, and fantasies, the design of hedonic products requires web-based CIMs to provide a playful and mentally stimulating environment that evokes emotions such as fun. For the design of utilitarian products, however, the web-based CIM needs to create a utilitarian experience that facilitates the customer in acquiring information on the underlying product and its functionalities.

Given that a match between stimulus and task makes performance easier, faster, and more accurate (Fitts/Deininger 1954; Kornblum/Lee 1995), we assume a positive effect of a match (e.g. utilitarian customer experience and utilitarian product) on customers' contributions measured in terms of the actual contributions made (e.g. quantity of product designs) (Füller et al. 2011). The contribution that customers make to the innovation processes is the most important factor determining overall success of a customer integration project. Thus, for companies it is crucial to understand the factors that influence the quality and quantity of customers' contributions (Jung et al. 2010).

Customers derive satisfaction from successfully completing a task (Füller et al. 2011). For utilitarian, primarily function-oriented products such as laptops or flashlights customers need to acquire information on the product's functionalities and how it works. Therefore, the web-based CIM needs to create a utilitarian customer experience that serves this need and facilitates the customer in completing his customer integration task. A match of customer experience and product type that allows customers to successfully complete tasks and derive a feeling of accomplishment leads to higher levels of satisfaction with the overall customer integration process (Füller et al. 2011).

Task enjoyment refers to the degree to which individuals perceive a task as enjoyable (Dahl/Moreau 2007). Proper stimuli of the web-based CIM create a customer experience that eases the customer integration task and therefore makes it more enjoyable. Thus, individuals who feel supported by the provided customer experience may perceive higher levels of enjoyment of the virtual product design task (Füller et al. 2009).

Individuals' previous experience with customer integration will determine their willingness to contribute to innovation processes through creating ideas or designing products in the future (Füller et al. 2011). Positive feelings such as enjoyment and satisfaction derived from web-based customer integration have a positive effect on customers' willingness to contribute to similar customer integration projects in the future (Füller et al. 2009; Mittal/Kamakura 2001; Oliver 1980). In contrast, web-based customer integration that evokes feelings of frustration or incompetence due to failure in task-completion will most likely be avoided by customers in the future (Füller et al. 2011). Thus, a match of the product type and the nature of customer experience positively impacts customers' satisfaction and task enjoyment, which in turn enhances willingness to contribute to further web-based customer integration projects. The above stated proposition can be used to develop testable hypotheses which correspond to the research model.

4 Research Methodology

We will test the proposed research model in an experimental setting. A laboratory experiment enhances internal validity by allowing the manipulation of the factors that are of interest to the study, and controlling all other factors that are not a part of the research model. In our research model, customer experience is a factor with two values – hedonic and utilitarian experience. Customer experience will be operationalized through a web-based CIM that provides different kinds of experience to customers. Similarly, product type will also have two values – hedonic and utilitarian product type. We will draw upon marketing and consumer research literature to identify hedonic and utilitarian products, which will then be incorporated in our experimental tasks. Therefore, the experiment has a 2x2 factorial design. Participants will be randomly assigned to one of our four treatment groups. Each subject will be given the task of coming up with different design variations of a particular product using a web-based CIM that allows them to modify features and attributes, and provides them with various product-related information. In the following we describe how we intend to activate utilitarian or hedonic customer experience dimensions in our experiment. Further, we provide information on how we plan to measure the moderating and dependent variables.

Operationalization of utilitarian and hedonic customer experience in a web-based CIM

We will design and use a web-based CIM that creates two different customer experiences. The web-based CIM will enable customers to select, combine, and design different product attributes. Utilitarian customer experience refers to the customer's experience in realizing product-related informational goals (Nambisan/Nambisan 2008). Therefore, we will keep the user interface as simple as possible. Further, we will make product-related information easy to access. For instance, information on various product attributes and how they affect the product's overall functionality will be provided. In order to operationalize hedonic customer experience, the design of the web-based CIM to gather product designs will incorporate playfulness through game elements. Additionally, interactive three-dimensional visualizations will show the effects of selecting and combining different product attributes (Childers et al. 2001; Kohler et al. 2011). For both, utilitarian and hedonic customer experience, participants will be provided with tutorials guiding them through the initial steps to get familiar with the web-based CIM. After the experiment, we will use a questionnaire to assess if the hedonic/utilitarian web-interfaces were indeed perceived as being more pleasant/enjoyable or useful/helpful (Batra/Ahtola 1990) by the subjects. This will ensure that our treatments (hedonic and utilitarian websites) were indeed effective. Further, the trial run will also serve the purpose of testing and ensuring that both versions of the web-based CIM are perceived equal in terms of usability.

Measurement of dependent variables

Among the dependent variables, satisfaction, task enjoyment, and willingness to contribute in the future will be measured using existing scales chosen from previous research (e.g. Dahl/Moreau 2007; Füller et al. 2011 and others). These will be measured using a post-experimental questionnaire.

Actual contribution of the participants will be objectively measured in our experimental setup. The experimental log data will be analyzed to determine the time subjects spent in performing the task, the number of product modifications they made to the product design, and the time needed for each modification.

Control variables

According to Hirschman/Holbrook (1982), some individuals are more eager to seek sensory-emotional and/or cognitive information stimulation. Therefore, we control for customer characteristics that might influence a customer's preference for a utilitarian/hedonic customer experience for the task of designing utilitarian/hedonic products. Further control variables are age, gender, product involvement, and previous experience with web-based customer integration or product design.

5 Conclusion

As companies embrace the notion of open innovation as means of overcoming some of the competitive and market pressures that they face, they are increasingly faced with the challenge of sustaining customers' engagement and willingness to provide meaningful input across the innovation process. Our research attempts to address this challenge, in particular in the context of integrating customers into the design phase of the innovation process using web-based CIMs. Drawing from previous research on consumer behavior and the compatibility principle, we postulate that a match between the kind of experience that customers get and the particular product design task that they have to perform, will have a positive effect on their contributions, and also on their satisfaction, enjoyment and willingness to contribute towards the design of the product. This research-in-progress paper presents the proposed research model which we plan to test empirically in an experimental setting. We also present some initial ideas on how the experiment will be designed and conducted.

The findings from this study are likely to have significant implications along various dimensions. Firstly, the underlying research will contribute to theory by investigating the design phase of the innovation process that is less researched compared to the early phases of idea generation. Further, this study will broaden the body of knowledge on customer integration by applying the concept of utilitarian and hedonic experience to web-based customer integration in order to study the outcomes of an appropriate customer integration experience. Finally, we apply the compatibility principle, which has previously mostly been used in the domains of consumer behavior and marketing, to a new research context. Based on the compatibility principle, we provide a research model that proposes that stimuli provided to customers in the form of various aspects of the web-based CIM have to match with the customer integration task in order to elicit high quality input from customers.

From a practical perspective, the findings of this research will provide insights regarding the design of web-based CIMs that are suited for different customer integration tasks. By identifying stimuli such as gamification that activate different customer experience dimensions and deriving design guidelines for web-based CIMs to provide the appropriate customer integration experience we contribute to the domain of human-computer interaction.

Publication 5: Designing for Positive User Experience in Product Design

Title:	Designing for Positive User Experience in Product Design: A Qualitative Analysis of Toolkit Design Elements and their Implications on Emotional Reactions and Perceptions
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Abstract

Companies increasingly equip their customers with toolkits for user innovation and design to address the challenges of growing customer demand for unique products and increasingly heterogeneous customer preferences. Yet, compared to buying a product off the shelf, customizing products through toolkits requires higher efforts, time, and expertise from customers. To outbalance increased efforts, toolkits need to be designed in a way that makes the product design task fun and engaging. Based on marketing, human-computer interaction, and information systems research, toolkits can be designed as hedonic or utilitarian toolkits. We use focus groups to qualitatively analyze "visualization" and "detailed information" as toolkit design elements to generate hedonic or utilitarian experience, and their implications on toolkit users' emotional responses and perceptions. Our findings show that visualization and detailed information both help in enhancing users' realistic product understanding. We found that particularly visualization stimulates creativity and enjoyment in product design.

Individual contribution of Kathrin Füller: For this publication, I conducted the experiments (following the experiment idea presented in P4) and the focus groups with a subset of the experiment participants. Subsequently, I analyzed the qualitative data collected in the focus groups and derived guidelines for the design of toolkits for user innovation and design. Additionally, I have written all sections of the paper. My co-authors helped me in improving the paper by reviewing it and providing ideas for the presentation of the results.

1 Introduction

In the twentieth century, innovations have primarily been generated through in-house research and development. Nowadays, companies increasingly open up their innovation processes for external stakeholders such as customers or suppliers (Chesbrough 2003). In this context, customers are seen as one of the key sources of innovations (Chesbrough 2003; von Hippel 1988). Customers can provide input such as ideas, concepts, or product designs (Dahan/Hauser 2002). These customer inputs can be generated by companies by using different customer integration methods including idea competitions, toolkits for user innovation and design, or lead user workshops (Dahan/Hauser 2002).

Toolkits for user innovation and design allow companies to tailor products to individual customer preferences. This is particularly important as customer preferences have become increasingly heterogeneous in some markets. At the same time, customers' demand for unique and customized products has increased (Franke/Hader 2014; Franke et al. 2009). This is reflected by a steadily growing number of companies including Dell, General Mills, or Nike that provide toolkits on their websites allowing customers to design their own laptops, cereals, and running shoes (Franke et al. 2008). Toolkits are design interfaces that enable customers to customize products to their individual preferences in a trial-and-error process. The product configuration is transferred to the company's production system and delivered to the customer (Franke/Piller 2004).

From a customer perspective, the task of actively designing a product requires more effort, time, and expertise than simply buying products off the shelf (Franke/Schreier 2010). However, customers can also derive value in the form of pride and enjoyment from designing their own product (Schreier 2006). Therefore, toolkits need to fully engage customers into the design activity by providing a positive user experience that outbalances design costs. Yet, there is a paucity of research focusing on the toolkit interface between the user and the company, and the experience customers gain from self-designing their products (Franke/Piller 2004).. There is little guidance for companies on how to design for a positive experience in product design. Existing studies propose rather generic design elements including a trial-and-error process, a library of standard modules, or an appropriate solution space (Goduscheit/Jørgensen 2013; von Hippel 2001; von Hippel/Katz 2002). Therefore, we answer the following research question: What toolkit design elements constitute a positive user experience and what are the implications of the toolkit design elements on users' emotional reactions and perceptions? We take a qualitative research approach to systematically analyze toolkit design elements, and the emotional reactions (e.g., enjoyment, satisfaction) and perceptions (e.g., product understanding, decision support) they cause. Knowing about toolkit design elements and their implications, allows companies to design toolkits that elicit desired emotional reactions and avoid or mitigate undesired reactions.

Based on human-computer interaction (Hassenzahl/Tractinsky 2006), information systems (Van der Heijden 2004), and marketing research (Babin et al. 1994; Hirschman/Holbrook 1982), the differentiation in utilitarian and hedonic is taken as a theoretical lens for our study. In the context of an experiment, we implemented three toolkit interfaces (hedonic, utilitarian,

control) and conducted focus groups with participants of an experiment after using the toolkits to design a car. Our research has implications for designers of toolkits focusing on the user experience the toolkit is able to provide. We identify visualization as an important design element determining enjoyment, flow, playfulness, creativity, and realistic product understanding.

The remainder of the paper is structured as follows. First, we describe the theoretical background on toolkits as well as the concepts of customer and user experience. Second, we present our research approach. Third, we present our research findings and discuss their relevance for toolkit designers applying Garrett's 5 layer model "the elements of user experience" (Garrett 2006, 2010). Finally, we conclude with limitations and future research possibilities.

2 Theoretical Background

2.1 Toolkits for User Innovation and Design

Companies increasingly provide toolkits to their customers to transfer their preferences and ideas into real products (Schreier 2006). In practice, there is no generic toolkit design. Toolkits are very heterogeneous in terms of what customers can do (Franke et al. 2006). According to previous research, effective toolkits consider five aspects: an iterative trial-and-error process, an adequate solution space, user friendliness, module libraries, and an error free realization of the product configuration (Goduscheit/Jørgensen 2013; von Hippel 2001; von Hippel/Katz 2002). Trial-and-error processes facilitate customers in learning about their preferences by providing simulated feedback on their product configuration that can be iteratively evaluated and improved (von Hippel 2001; von Hippel/Katz 2002). A toolkit's solution space defines the user's design possibilities and limits the possible variations and combinations of product configurations that a user can make (Prügl/Schreier 2006; von Hippel 2001; von Hippel/Katz 2002). User friendliness describes how users perceive the interaction with the toolkit. Expenses in terms of perceived effort, time, and expertise influence the user's experience from interacting with the toolkit (Huffman/Kahn 1998; von Hippel 2001; von Hippel/Katz 2002). Module libraries contain commonly used elements and predefined solution items that users can choose from and incorporate into their product configuration. Further, toolkits need to allow an automatic and error free translation of the customer's final product configuration into the language of the company's production system (von Hippel 2001; von Hippel/Katz 2002).

An excessive variety of possible variations and combinations provided by toolkits results in high levels of perceived complexity that can overwhelm customers (Huffman/Kahn 1998). Especially novice toolkit users lack experience in designing their own product due to missing strategies for the customization process (Jeppesen 2005). This challenge can be mitigated by the provision of adequate information to support customers in successfully customizing the product to their specific preferences (Chang/Chen 2009). According to Chang/Chen (2009), extrinsic cues including ratings and discussions are in particular beneficial for experience products. In contrast, intrinsic cues provided through information from the retailer about

product specifications such as color, size, or functions are more compatible for search products (Chang/Chen 2009). Further, interactive 3D product visualization can be implemented to assist customers in examining search attributes (e.g., colors) (Chang/Chen 2009).

To sum up, previous mass customization and customer integration research provides some guidelines for the design of toolkits. However, these guidelines and toolkit design elements are rather general (Schreier 2006). Thus, there is little theoretical evidence on the appropriateness of particular toolkit design elements based on users' reactions that result from interacting with a toolkit (Chang/Chen 2009; Franke/Piller 2004; Franke/Schreier 2010). This calls for a systematic analysis of toolkit design elements that generate positive user experience (Franke et al. 2009; Franke/Schreier 2010).

2.2 Customer Experience and User Experience

Experiences can be defined as private and intangible events occurring in response to some stimulation such as a being exposed to a marketing campaign, or directly participating in activities (Nagasawa 2008).

Under the concept of customer experience, marketing research studies the comprehensive management of touchpoints of a customer with a company (Garrett 2006; Verhoef et al. 2009). Examples for touchpoints are a company's marketing campaigns, service personnel, or product. Positive experiences are reflected by positive emotions and behavioral intentions (e.g., willingness to pay, positive word-of-mouth) (Nambisan/Nambisan 2008). In contrast, negative experiences result in negative feelings of frustration or failure and are more likely to be avoided by customers in the future (Füller et al. 2011). Therefore purposefully creating and managing customer experience has been increasingly acknowledged by companies (Verhoef et al. 2009). In marketing, customer experience is distinguished in utilitarian and hedonic experience (Babin et al. 1994; Hirschman/Holbrook 1982). Utilitarian experience refers to consumer behavior in which pragmatic goals are in the foreground. For instance, shopping all items on a shopping list. Hedonic experience relates to multi-sensory and emotive benefits (e.g., enjoyment) that result from an activity (Babin et al. 1994; Hirschman/Holbrook 1982; Nambisan/Nambisan 2008).

In contrast to customer experience, the concept of user experience focuses on the appropriate design of a single, often digital touchpoint. According to the international standard on ergonomics of human-system interaction (ISO 9241-210), user experience is defined as *"a person's perceptions and responses that result from the use or anticipated use of a product, system, or service"* (Van der Geest et al. 2013, 93). In terms of user experience, human-computer interaction research initially concentrated on the instrumental (i.e., pragmatic, utilitarian) goals of systems including ease of use, usefulness, and achievement of behavioral goals in work settings. This narrow perspective on user experience was expanded by more non-instrumental (i.e., hedonic) aspects including joy of use, aesthetics, and mental stimulation (Hassenzahl/Tractinsky 2006). Similarly, information systems research distinguishes in utilitarian (or productivity-oriented) and hedonic (or pleasure-oriented) information systems (Van der Heijden 2004).

The design of a toolkit as a digital touchpoint determines the user experience the toolkit is able to provide. Given this differentiation in utilitarian and hedonic in marketing, human-computer interaction, and information systems research, a toolkit for user innovation and design can be designed in two ways: 1) as a utilitarian toolkit, or 2) as a hedonic toolkit.

3 Research Methodology

Taking a qualitative research approach, we investigated the impact of toolkit design elements on users' emotions and perceptions that result from using a toolkit for product design. To this end, we implemented three different toolkit interfaces (hedonic, utilitarian, control) similar to typical toolkits that can be found on the Internet. The CYLEDGE configurator database (http://www.configurator-database.com/) provides an overview of existing toolkits. Figure 22 illustrates our three toolkit interfaces which are described in the following.

Hedonic experience originating from interactions with virtual environments is related to mental stimulation, pleasure, and enjoyment (Nambisan/Nambisan 2008). Web sites reflecting more hedonic characteristics involve high resolution images and graphics as well as interesting and humorous product commentary (Childers et al. 2001). Interactive 3D product presentations can nurture playfulness as this design element allows users to inspect the virtual product and examine search attributes such as color and exterior design (Chang/Chen 2009; Kohler et al. 2011). Therefore, the hedonic toolkit provided instant visual feedback on the options through a mouse over function. Additionally, the toolkit provided an interactive visualization that showed the effects of selecting and combining different options (see Figure 24 A).

Utilitarian experience in contrast is related to cognitive and instrumental benefits that customers gain (Babin et al. 1994). Web sites incorporating more utilitarian characteristics provide customers with the ability to obtain in-depth product and price information (Childers et al. 2001). Hence, our utilitarian toolkit provided detailed information on the various product attributes and how their modifications affect the product's overall functionality (see Figure 24 B).

To control for the impact of the toolkit design elements visualization and detailed information, the control toolkit provided no visualization and no detailed information for the design activity. This toolkit illustrated in Figure 24 C) served as a baseline or worst-case scenario providing minimal support for participants to customize their car. This research design allowed us to systematically and separately investigate the influence of a single design element on the emotional reactions and perceptions of individuals.

3.1 Experiment Task and Design

Our qualitative analysis using focus groups was part of an experiment with 302 participants. Table 20 summarizes the demographics of the 302 participants.

Mean age	24.60 years
Gender	Male: 218 (72.2%); Female: 80 (26.5%); N.A.: 4 (1.3%)
Education	Students: 262 (86.8%); PhD students: 40 (13.2%)
Car owner	No: 183 Yes: 119

Table 20: Participant Demographics

Participants were randomly assigned to one of the three toolkits. The participants had to design a car as cars are common products that are easy to grasp and customize. Further, product and service components are included in a car which need to be adapted to customers' individual needs. Many car manufacturers provide toolkits to allow their customers to customize their cars.

The participants had to customize six different product attributes. For the engine, extras, services, and rims the participants could select from six options respectively. For the exterior color and the seat design, there were eight possible options respectively. The average time spent for customizing the car was 30 minutes. The experiment was conducted at a laboratory equipped with computers and separating walls between each workplace. The laboratory includes some older computers that require more time to load pages (e.g., show car in selected color). This allowed us to analyze the effect of page loading time on users' emotional reactions and perceptions.

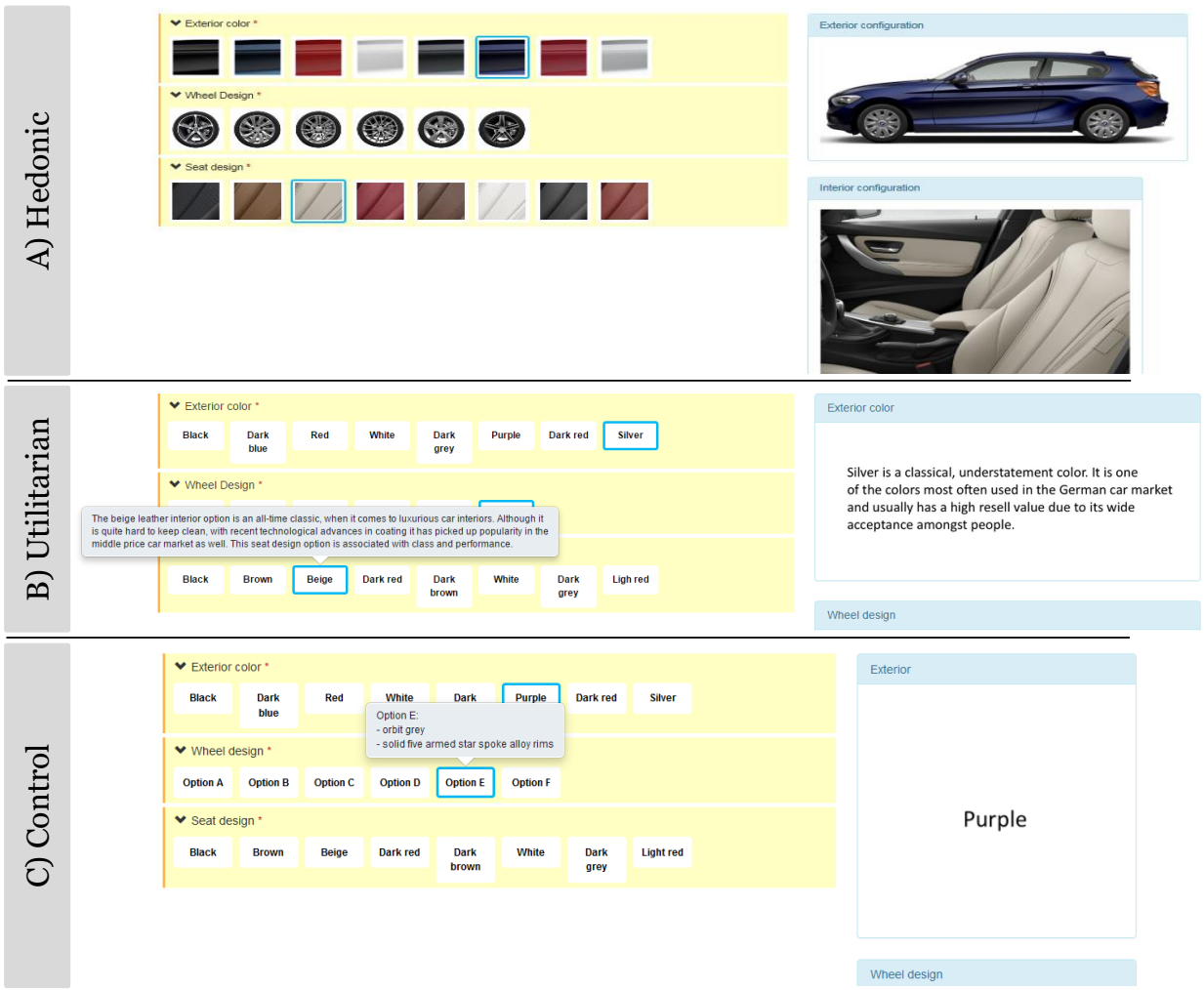

Figure 24: Screenshots of the Three Toolkit Interfaces

3.2 Focus Groups

After customizing a car in the experiment, we randomly selected four to six participants from each experiment session. Overall, from the 302 experiment participants, 64 subjects participated in 15 focus groups (5 hedonic, 5 utilitarian, and 5 control focus groups). We compensated the subjects with a reward of 10 €/hour or credit points in a course. The same person, a co-author of the paper, has moderated all focus groups. We used a semi-structured guideline for all 15 focus groups to ensure comparability of our findings. Participants were asked about the aspects of the design task and the toolkit that made the customization process most/ least enjoyable, why they experienced these aspects as most/ least enjoyable, what they want to see changed, and what kind of information they want to see added if they had the possibility to use the toolkit again. Data was collected from July to August 2014. We conducted the focus groups in German and translated a selection of illustrative quotes into English for the purpose of this publication. The focus groups lasted on average 11.39 minutes, and were voice recorded and transcribed. The collected data was analyzed using qualitative content analysis (Miles/Huberman 1994). Building on our interview guidelines, we iteratively developed a coding scheme. We coded ideas for improvements, toolkit design elements, and aspects that made the product design task most/ least enjoyable. Based on this coding, we extracted toolkit design elements and linked them to emotions and perceptions caused by

these design elements. We compared the findings from the different focus groups (hedonic vs. utilitarian vs. control) to examine whether there are differences in participants' perceptions and emotions due to the three different toolkit interfaces.

4 Results

4.1 Results of Hedonic Focus Groups

The participants evaluated the hedonic toolkit positively. It provided hedonic experience through visualization of the options and instant visual feedback of the product configuration. The focus group participants suggested improving the hedonic toolkit by using more advanced visualization techniques including 3D visualization, videos, animations, and a 360-degree view of the car. Further possibilities to foster a hedonic, multi-sensory experience are the selection of different backgrounds to view the car in different environments, e.g. car in the forest vs. car in the city. Apart from visually experiencing the car, participants desired to experience the car with other senses. Therefore, toolkits should also incorporate sounds*: "It would be great to hear the car, how the engine sounds."* Our hedonic toolkit design did not provide any detailed information. Yet, the hedonic toolkit users found that detailed descriptions, in particular of the functional car attributes, would be beneficial.

4.2 Results of Utilitarian Focus Groups

To generate a utilitarian experience, participants were provided with detailed information. The utilitarian toolkit users felt supported by this information, especially in customizing functional aspects such as the extras or the engine: *"The detailed information made the options transparent. One can clearly understand what one gets for selecting and buying an option".* However, the utilitarian focus group participants outlined the importance of an appropriate information amount and structure to improve utilitarian experience. Additionally, information on the customization progress through a progress bar, or information on finances by providing forecasts on running costs (e.g., taxes, insurances, fuel consumption) would be beneficial.

The utilitarian toolkit did not provide any visual support in the product design task. This was reflected by participants' feedback: *"The toolkit was useful and purposeful, but using the toolkit was not fun. I missed some pictures of the car."* To incorporate some more visual and multi-sensory experience, participants desired pictures, videos, sounds of the car, and 3D printers providing the customer with a prototype of the product before actually ordering the product.

4.3 Results of Control Focus Groups

The control toolkit did not provide detailed information and visualization of the product attributes and the options that could be selected. Positive feedbacks mentioned by the participants referred to the toolkit's ease of use and the fast customization process since the missing toolkit design elements visualization and detailed information prevented participants from clicking and playing around. However, the control group participants missed a visualization of the product as the following statements underline: *"With visualization it would have been easier to decide […]."; "I could not imagine anything of the car".* Similar

to the participants of the hedonic and utilitarian focus groups, the control focus group participants mentioned the necessity of detailed information and an adequate information amount and structure to support the product design task. Further, the users of the control toolkit desired the possibility to specify a prize limit, a forecasting of running costs, a bigger solution space, and a progress bar. Additional ideas to improve the control toolkit were a save and export function to show and discuss the final car configuration with friends and family as well as access to contact persons and retailers.

4.4 Cross-Focus Group Analysis

We compared the focus group results to identify similarities and differences. We observed similarities regarding the desire for visualization, a bigger solution space, and detailed information on the different options that can be selected and their costs. In all focus groups, participants outlined the importance of providing visualization. The participants that were provided with the hedonic toolkit for customizing the car mentioned that the visualization not only helped for customizing visual aspects (exterior color, seat design, rims), but also in understanding the functional product attributes (engine, extras, services): *"For example, the park distance control: When I saw the pictures I immediately knew "Ok, this is meant""; "One can clearly grasp and understand the options. This supports in […] deciding for the best option."*

Although provided with visualization, especially the hedonic focus group participants were creative about further enhancements of the product visualization. Participants recommended advanced visualization technologies including 3D visualization, 360-degree views, videos, and animations to experience the product. Such richer formats can make the product design task more real, involving, fun, and playful: *"To see how it is to get inside of the car. […] This is much more involving and makes the product much more real."* It is important to note, that participants mentioned real-life pictures and animations instead of computer-based imitations. However, many toolkits provided by companies on their websites include such imitations.

All participants acknowledged the importance of detailed information on the product attributes and the options that can be selected. This information is particularly important in terms of functional product attributes: *"Especially for the extras, the service packages and related contracts, reading on how the options work is important."* Providing detailed information to toolkit users is important as it allows users to learn about the product and to satisfy product-related informational goals: *"I most enjoyed reading the information on the technical product attributes and options of the car to inform myself about the current state of technology: from a technical or engineering perspective, what is possible? What are the latest technical innovations? […]."*

According to the participants, this detailed information should only be visible if desired by the toolkit user through a mouse over function or by clicking on an information button. Further, this information needs to be provided in an adequate amount and structure that supports users in eliciting relevant information for attribute evaluation and product design: *"The presentation of information is incredibly important. When I have to read a lot of running text, this is exhausting, boring."*

Further, in all focus groups (hedonic vs. utilitarian vs. control) we identified the need for clear depictions of the costs to enhance transparency on how the modifications of the product attributes affect the overall price of the product configuration. This allows participants to evaluate trade-offs between the desire for certain options and their willingness to pay for these options. This evaluation presents a challenge and nurtures playfulness: *"Precisely that is the interesting and fun thing about using a toolkit […]. I can start with designing my car, and if this configuration exceeds my budget I can iteratively adjust options until I reach a satisfactory configuration that is affordable and still satisfies my needs."*

Regarding information on the costs, the toolkit should be designed as an intelligent system that allows the user to specify a prize limit. The toolkit can indicate when the maximum budget is reached and recommends alternative options that are within the pre-defined budget. Alternatively, the toolkit can exclude very expensive options from the solution space. This avoids feelings of frustration: *"I would like to specify the budget I have, e.g. […]. Based on this input, the system can exclude too expensive options. This avoids frustration due to unaffordable options."*

However, we also found some different patterns across the focus groups. Especially participants that did not have visualization of the customized product felt rather insecure about their choices and desired more support for the customization process itself and information on the product configuration: "It was difficult to get a clear picture of the different options that can be selected. Due to the missing visualization and conception of the product in my mind, it was difficult to select suitable options. As a result I have not been sure about my selections and not very happy with my configuration." In order to get some more support, the utilitarian and control toolkit users wished to save, print, export, and prototype their product configuration to discuss it with experts, or family and friends before actually buying the product: *"It would be so cool and supportive to save the product configuration. Then I would see a friend who is an expert in this field. I would ask him whether he thinks this configuration suits me well. Or the possibility to save the configuration as a link […] would be super convenient."*

The discussions in the hedonic focus groups were more vivid than in the utilitarian or control focus groups. Thus, visualization enhances the toolkit's support for users to be creative and articulate their preferences. Several statements of the subjects underline this: *"The pictures helped in getting a clear understanding and imagination of the car"; "One can clearly grasp and understand the options. This supports in confidentially and quickly deciding for the best option."* Participants using a utilitarian or control toolkit were more frustrated and in a more negative mood than participants that used the hedonic toolkit: *"The missing visualization made the customization process very tedious and very abstract. There were no playful elements."*

Regarding the aspects of the customization process or the design elements of the toolkits that made the product design activity most enjoyable, we clearly identified visualization as a driver of fun, interactivity, and playfulness, while the type of product attributes had no influence. Some participants favored the design of the visual car attributes, and others most

enjoyed designing functional attributes of the car. This was independent of gender, but rather influenced by personal preferences and expertise: *"I am a very functional person. Therefore, the customization of the functional attributes was more interesting and meaningful to me. I do not care about the car's color"; "For me it was most interesting to select the extras and the engine. But that might be a personal thing"; "Customization of the exterior, color etc. was most satisfying for me, although there was no visualization."*

Another important factor influencing enjoyment of the product design activity is functionality, smoothly running systems, and fast page loading. We randomly provided some participants with a toolkit requiring longer page loading times. Therefore, the selection of an option was not immediately visualized, which was negatively evaluated by the toolkit users: *"It took quite some time to load pages and the selection of the options did not work immediately. That was very frustrating."* Table 21 summarizes the identified toolkit design elements, and the emotional reactions and perceptions they caused in our study.

Hedonic design element	**Implication**		**Illustrative quote**
Visualization (instant visual feedback, pictures)	Perception	Realistic product understanding	*"[…] One can clearly* ***grasp and understand*** *the options."*
		Clearness, transparency	*"With the picture showing the phone it was* ***clear*** *what extra or functionality was meant."*
		Imagination	*"I could get a* ***better imagination*** *by seeing the car visualized in the selected color."*
		Outcome directly visible and assessable, trial-and-error	*"I liked that the toolkit directly provided a* ***preview of the product*** *in the selected color. I could have a look and* ***assess whether I really like it****."*
		Decision support	*"One can clearly grasp and understand the options. This supports in* ***confidentially and fast deciding for the best option****."*
	Emotion	Enjoyment, playfulness, thrill	*"The visualization missed making the configuration very* ***tedious*** *and very abstract. There were no* ***playful elements****."*
		Satisfaction, uncertainty, ambiguity	*"Due to the missing visualization of the product, it was difficult to select suitable options. As a results I have not been* ***sure*** *about my selection and not very* ***happy with my configuration****."*
		Aversion	*"For the first time, I used a non-visual toolkit and that was an* ***extremely horrible experience*** *for me."*
3D visualization	Perception	Realistic product understanding, involving	*"To see how it is to get inside of the car. To feel more how it is, how high the car is... This is much more* ***involving and makes the product much more real****."*
360-degree view	Perception	Realistic product understanding	*"Allows the user to better experience the car. Get a better, a* ***more realistic understanding of the car*** *than when simply provided with descriptions or 2D pictures."*
	Emotion	Fun	*"Viewing the product from different angles makes the configuration more* ***fun****."*
Video	Perception	Virtual experience of the product	*"It would be nice to have a video, a short sequence of approximately 30 seconds,* ***illustrating how the extras work****. For instance, to* ***experience how park distance control works****."*
Animation	Perception	Virtual experience of the product	*"An animation that allows to open doors by clicking on the them and to* ***drive the car*** *would be great."*
Backgrounds	Emotion	Fun, enjoyment	*"It would be nice to view the car in different backgrounds, e.g. gar in the city, car in the forest, car at night. This would generate more* ***fun and joy****."*
Multi-sensory: sounds	Perception	Virtual experience of the product, product understanding	*"* ***See, hear, smell****, experience the car. An experience that may even* ***replace experiencing the car in reality, in a store****."*
Utilitarian design element	**Implication**		**Illustrative quote**
Detailed information	Perception	Clearness, transparency	*"The detailed information made the options* ***transparent****. One can* ***clearly understand*** *what one gets for selecting and buying an option."*
	Perception	Need for learning, intellectual stimulation, product understanding	*"I most enjoyed reading the information on the* ***technical product attributes*** *and options of the car to* ***inform myself*** *about the* ***current state of art/technology*** *- from a* ***technical or engineering perspective,*** *what is possible? What are the latest* ***technical innovations*** *? […]."*
	Perception	Decision support	*"The detailed information made the options transparent. One can* ***clearly understand what one gets for selecting and buying an option****."*
Information amount	Perception	Information overload	*"During the configuration process, the user should not be* ***flooded with information****. Too much information* ***distracts*** *the user from the design task and* ***interferes*** *with the configuration process."*
Information presentation format	Perception	Decision support, exhausting, boring	*"The presentation of information is incredibly important. When I have to read a lot of running text, this is* ***exhausting, boring****, and I cannot* ***absorb all relevant information*** *[…]."*
Comparison	Emotion	Playful	*"The comparison of product configurations - e.g. red car with white leather seats compared to a black car with [...] This makes the whole customization activity more* ***playful****."*
	Perception	Decision support, tool support	*"[…] A direct comparison of engine option A on the left and engine option B on the right makes the* ***comparison, evaluation, and selection of options easier****."*
Solution space	Emotion	Annoying, depressing	*"It* ***annoyed*** *me that I had few options."*
	Perception	Decision support, ease of use	*"The small solution space made the* ***selection of options*** *rather* ***easy****."*
Customer profile, pre-configurations	Perception	Decision support	*"It would be nice if the system asks - Are you a frequent car driver? [...] - In order to create a buyer profile and then* ***provide a preconfigured car****, or different* ***suitable preconfigured options****."*
	Perception	Emotional bonds	*"This builds* ***emotional bonds****. The toolkits* ***knows what I want and assists me*** *in getting what I want."*
Costs	Perception	Trade-off; trial-and-error process	*"I can* ***start*** *with designing my car, and if this configuration exceeds my budget I can adjust* ***iteratively*** *options* ***until*** *I reach a* ***satisfactory configuration that is affordable and still satisfies my needs****."*
	Emotion	Fun, playfulness, mental stimulation, challenge	*"To see how the different options affect the overall prize and to respectively configure a car that is within my budget is a* ***fun and playful experience****."; "Precisely that is* ***the interesting and fun thing about using a toolkit*** *and product customization. I can start with clicking together my car […]."*
		Frustration	*"I would like to specify the budget I have, e.g. […]. Based on this input, the system can exclude too expensive options. This avoids* ***frustration*** *due to unaffordable options."*
Specify price limit	Perception	Decision support	*"Allow user to specify a prize limit […]. Based on this input the system does not allow the user to* ***select certain options*** *(e.g. rim for 5.000 €)."*
3D printer	Perception	Product understanding, decision support	*"The user customizes the product and in the end the user receives a* ***3D prototype*** *as a small* ***physical version of the product configuration*** *to better* ***evaluate the product****."*
Save and export	Perception	Social feedback	*"I would like to save and print my configuration to* ***show it my friends […] to ask for opinions****."*
Access to contact persons, retailers	Perception	Social feedback, professional support and feedback, considerate decision-making	*"It would be so cool and* ***supportive*** *to save the product configuration. Then I would see a* ***friend*** *who is an* ***expert*** *in this field. I would ask him whether* ***he thinks this configuration suits me well****. Or the possibility to save the configuration [...]* ***share it with friends*** *would be* ***super convenient****."*
System: slow page loading	Emotion	Frustration	*"It took quite* ***some time to load pages*** *and the selection of the options did not work* ***immediately****. That was very* ***frustrating****."*

Table 21: Toolkit Design Elements and Caused Emotional Reactions and Perceptions

5 Discussion

In the following we discuss our findings with regard to the five layers of the model *"The elements of user experience"* by Garrett Garrett (2010) to illustrate the relevance and implementation of our findings for designers. The model is targeted for the design of websites, but is also applicable for other technical products. It consists of the five layers strategy, scope, structure, skeleton, and surface (Garrett 2006, 2010).

The *strategy*, the foundation of every user experience, takes business goals and user needs into consideration (Garrett 2006, 2010). According to our focus groups, user needs satisfied by using toolkits are the acquisition of product-related information, information about the state of the art, customization of a product for fun, and purchase of a unique, self-designed product.

In the next layer *scope,* functional specifications and content requirements of the system are derived from user needs and business goals (Garrett 2006, 2010). In the underlying research, these requirements define 1) the type of toolkit to be designed, 2) the corresponding selection of toolkit design elements, 3) the design of the solution space, and 4) the design of the module library.

Based on the user segment targeted or the resource constraints (e.g., time, budget) faced by the company, the toolkits can be designed as a utilitarian toolkit, a hedonic toolkit, or a hybrid toolkit including both hedonic and utilitarian design elements. Further, the solution space can be designed from small to large. Based on our qualitative research, there are different preferences of individuals to design functional or visual product attributes. Thus, the solution space of a toolkit should be adapted to the user's individual preferences. To this end, a hierarchically structured solution space can be implemented: Such a solution space firstly asks the user to select the model of the product, then requires the user to customize some mandatory (functional and visual) product attributes, and then asks if the user wants to customize some more optional (functional and visual) product attributes. Further, to support the product design task the module library should provide pre-configured products, information on frequently selected options, or examples for product configurations ordered by other users based on the user's characteristics (e.g., demographics).

The *structure* refers to the user's navigation through the website. Here, designers need to arrange information so that people can understand and use it. Decisions on the structure level need to consider how the user thinks and processes information (Garrett 2006, 2010). We found that detailed information enhances transparency and clearness of the options that can be selected, supports users in selecting the "best" option, and satisfies users' needs for learning, and mental stimulation. However, this information needs to be presented in an adequate amount and structure. Unstructured information increases perceived complexity; too much information can overwhelm users leading to feelings of frustration (Huffman/Kahn 1998). Thus, toolkits should provide basic information (e.g., advantages, disadvantages, costs) on the options that can be selected for the different functional and visual product attributes. This information should be presented with bullet points not as a running text to satisfy users'

utilitarian needs for product-related information acquisition and to assist toolkit users in absorbing relevant information for self-designing products. Information can also be provided in a drill down structure that offers further information for interested users without overwhelming other users. Further, information should be complemented with pictures and advanced visualization techniques to further illustrate the functionality of options. Additionally, sliders to allow users to interactively evaluate the effect of options on the price can be used. In addition to information provided by the toolkit itself (intrinsic cues), links to external websites providing additional information, blogs, discussion boards or user communities (extrinsic cues) should be provided to support user in successfully customizing products. This adds a social and collaborative aspect to the product design task.

The layer *skeleton* refers to the selection and arrangement of elements and controls (e.g., text input fields, boxes) the user will interact with. In terms of designing toolkits, the skeleton needs to clearly communicate choices available, and it needs to help the user to access relevant information of his or her choice (Garrett 2006, 2010). Based on our focus groups, toolkit users desire a progress bar on the top of the website, an overview on what has already been designed and selected and what still needs to be designed somewhere on the edge of the screen (e.g., on the left), and information on how selections influence the price of the product (e.g., on the bottom). Further, information should only be shown if requested by the user by clicking on an information button. It needs to be noted that particularly the utilitarian and control focus group participants asked for a progress bar as well as an introduction to the toolkit, the product attributes, and the solution space. A reason may be a negative effect of the utilitarian and control toolkit design on a flow or playful experience. In a flow or playful experience, individuals are fully absorbed into their task and forget about time and place (Csikszentmihalyi 1977). Thus, while the hedonic toolkit users enjoy the product design activity and are more likely to experience flow and playfulness, they are not interested about their customization progress.

Finally, the most concrete layer *surface* describes how the design supports the user and its sensory experience (Garrett 2006, 2010). In our qualitative research, we identified toolkit design elements and analyzed their implications on users' emotional reactions and perceptions. Based on our focus groups, both hedonic and utilitarian toolkit design elements can positively influence users' emotions (e.g., enjoyment) and perceptions (e.g., realistic product understanding, decision support). For instance, we found that visualization makes the product more tangible and helps users in getting a better understanding of the product. It needs to be noted that toolkit users prefer real-life pictures or videos instead of computer-based animations and imitations. When visualization was not present the participants of our study reported uncertainty and ambiguity concerning the options and their overall product configuration. They struggled in getting a realistic product understanding, being creative, and selecting options that suit their preferences best.

6 Conclusion

In our qualitative research, we identified toolkit design elements and their implications on users' emotional reactions and perceptions. This allows companies to apply toolkit design elements as a means to purposefully create and manage user experience.

We acknowledge that there are several limitations to our study. This study was conducted with students. Therefore, future research might replicate the study with other participants. Further, this study focused on the customization of a car, which presents a relatively expensive type of product. We found that users expect rich toolkit designs including innovative technologies especially for the design of expensive products. Moreover, the design of expensive products can cause huge price differences between the standard product and the customized product, which in turn may result in feelings of frustration. In addition, the willingness to customize and buy such expensive products online might be smaller compared to more affordable products. Thus, future research should study the appropriateness of toolkit design elements with regard to the price category of the product. Further, our analysis was based on 15 focus groups (64 participants). Given this qualitative, explorative approach, this research is only a first step to understand toolkit design elements and their implications (emotions, perceptions).

Our research has implications to theory and practice. Existing studies propose rather generic design elements including a trial-and-error process or an appropriate solution space (Prügl/Schreier 2006; von Hippel 2001; von Hippel/Katz 2002). We contribute to mass customization literature by providing an extended list of toolkit design elements and guidance on appropriate toolkit design based on users' emotional reactions and perceptions. Additionally, we broaden the body of knowledge by applying the concept of user experience to mass customization research. The findings of our research are also relevant for the design of other customer integration methods including lead user workshops, conjoint analysis, idea competitions, or idea communities. As our control focus groups show, customer integration methods can be designed in a way that hinders creativity. Thus, with our qualitative research we advance general understanding concerning the design of appropriate customer integration methods.

Existing user experience research primarily investigates user experience in terms of its effect on users' emotions, perception of the system (e.g., ease of use, usability), and the relationship between the user and the company (e.g., loyalty). We contribute to user experience research by including users' perceptions of a system in terms of tool support, decision support, and transparency as implications of positive user experience.

From a practical perspective, our research yields insights on the design of appropriate toolkits. We identify visualization as an important design element. It supports users in getting a realistic product understanding, in evaluating and selecting options, and articulating their preferences. Most importantly visualization leads to positive emotions and experiences, which are crucial to keep toolkit users engaged.

Publication 6: Knowledge Management in Customer Integration

Title:	Knowledge Management in Customer Integration: A Customer Input Ontology
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Abstract

Exchanging and analyzing customer input across different departments and software tools in a company is a prerequisite to successfully implement the co-creation of innovations with customers. Ontologies pose helpful tools to support knowledge representation and retrieval in a company. Prior research has developed ontology-based frameworks to manage idea generation and assessment in the early phases of the innovation process. However, these approaches do not address the holistic management of customer input across all phases of the innovation process. Based on a review of existing ontologies as well as types and characteristics of customer input, we develop the Customer Input Ontology. With competency questions we show how the ontology might be used to generate knowledge and value of obtained customer input in form of ideas, concepts, or feedback. The Customer Input Ontology supports knowledge management in customer integration since it provides a common language and format to collect and save customer input in a structured manner. Further, the Customer Input Ontology allows the tracking and reuse of customer input throughout different departments and innovation cycles.

Keywords: Open innovation, customer input, knowledge management, ontology

Individual contribution of Kathrin Füller: Together with my co-authors, I collected and analyzed relevant literature. Jointly, we identified types and characteristics of customer inputs and designed the Customer Input Ontology. Further, I have written all sections of the paper.

1 Introduction

To gather customers' preferences and knowledge in order to develop new products in line with customer needs, many companies nowadays open up their innovation processes and integrate their current and potential customers. In this open innovation approach, customers can take an active role as a resource of information, co-creator, co-developer, or tester in the innovation process (Nambisan/Baron 2007). Based on these roles, customers can provide input to the different phases of the innovation process by providing information on their needs and preferences, creating and evaluating ideas or concepts, or testing prototypes (Chesbrough 2003; Nambisan/Baron 2007).

However, the management of these customer inputs poses a challenge for companies. Customer input is highly unstructured information as it is generated and collected in different form. For instance, an idea might reach the company in audio, text, as a picture, figure, or video. Further, an idea can be expressed by the customer in different levels of detail (e.g. idea described in two sentences or two pages of text). Therefore, customer input is often not machine-readable and must be manually analyzed by employees. This approach for processing customer input is not only time-consuming but also inefficient and cost-intensive (Ziegler et al. 2008). Additionally, the proliferation of IT, such as the internet and software applications, allows companies to launch online platforms where customers can easily provide their input. With its "Innovation Jam" IBM received more than 46,000 ideas submitted by people from all over the world. This huge amount of customer input gets unmanageable (Jung et al. 2010). Therefore, co-creating innovations with customers is a knowledge-intensive process. However, solutions and languages for knowledge sharing, reuse, and integration across departments or stakeholders in innovation networks are missing (Song et al. 2013). Different guidelines and software tools used in different departments to manage customer information complicate communication and interoperability, and hinder the reuse of data (Franco et al. 2010).

Ontologies are helpful tools to support knowledge representation and retrieval. Thus, the co-creation of innovations with customers can be supported by ontologies that provide structure to unstructured data, making customer input machine-readable and automatically processable (Uschold/Gruninger 1996). Further benefits that can be expected from using ontologies include shared understanding of customer input, interdisciplinary communication, and reuse of customer input (Riedl et al. 2009). Reusing already created ideas, requirements, or concepts is viewed as a key factor to increase quality and productivity (Lim 1994; Orawski et al. 2013). Further, reusing customer input can decrease R&D costs in innovation projects, reduce time-to-market and market risks (Franco et al. 2010).

Previous research (Bullinger 2008; Riedl et al. 2009) has developed ontology-based frameworks to manage idea generation and evaluation in the early phases of the innovation process, but neither addresses the holistic management of customer inputs across all phases of the innovation process and departments in a company. To address this research gap, we develop a Customer Input Ontology to support the collection, storage, management, and reuse of customer input. We chose the ontology development approach by Noy/McGuinness (2001)

as it focuses on the reuse of existing ontologies which is a desirable attribute of ontology design. The Customer Input Ontology poses a meta model which can be used as a basis for future research (e.g. implementation of a software platform).

The paper is structured as follows: First, we provide some theoretical background information on customer integration and ontologies. Second, we describe our research methodology to design the Customer Input Ontology. Third, we present our findings and briefly illustrate the application of our ontology. Finally, the implications and limitations of the underlying research are discussed.

2 Theoretical Background

2.1 Customer Integration into Innovation Processes

Open innovation is a concept coined by Chesbrough (2006b); defined as *"a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology"* (Chesbrough 2006b, 1). Due to consumption and usage of products and services, customers possess great product and service related knowledge which is of importance for companies when developing new products or services. Therefore, companies are increasingly opening up their innovation processes for external stakeholders such as customers. Basically, customers can provide three types of input into the innovation process: decisions, information, and creation (Reichwald et al. 2004). Customers can assist companies in decision-making through the evaluation of ideas, concepts, and prototypes (e.g. rating product attributes according to their preferences). Further, customers are a source of information: need information covers customers' needs, demands, and preferences. This kind of information can be gathered by customer integration methods such as surveys or complaint analysis. Some customers also possess solution information on how to implement and realize a creative idea into a product or service. For instance, lead-user or focus group workshops can be applied to learn from customers about the solutions they encounter (Zogaj/Bretschneider 2012). In contrast, feedback information can be gathered by companies through complaint management or online consumer reviews (Mudambi/Schuff 2010). These types of input deliver post-purchase and consumption information and give directions for product improvements. Further, customers provide input by creating ideas, concepts, or prototypes. In this case, customers take the role of co-creators or co-designers in the innovation process (Reichwald et al. 2004).

2.2 Ontology

The term ontology is used with different meanings in different disciplines. In computer science, ontologies refer to an explicit formal specification of terms in a domain and relations among them (Gruber 1993). According to Borst (1997), an ontology is defined as a formal specification of a shared conceptualization. This definition implies that the conceptualization should express a shared view between actors rather than an individual view. Considering these definitions in the context of our research, the core of the Customer Input Ontology is the representation of customer inputs and their interrelationships to support customer integration

into innovation processes, including searching for, rating, tracking, grouping, or reusing customer input across departments or companies.

An ontology consists of a hierarchy of classes, attributes, allowed values which the attributes can take, and instances. Classes explicitly describe concepts in the domain of discourse (Noy/McGuinness 2001). Classes may have (sub)classes and can be arranged in an inheritance hierarchy. The (sub)classes of a class represent concepts that are more specific than the (super)class. As an example, Figure 25 illustrates the (sub)class "sales representative" which is derived from the (super)class "employee". Instances are concrete individuals of a class that adopt all structural and behavioural properties of a class. For instance, "Bob Miller" is an instance of the class "employee" (Bullinger 2008). Attributes are the properties or characteristics that classes can have. Attributes can take a set of allowed values. An example for an attribute of the class "employee" is "height". The attribute "height" of the class "employee" can have the value "185". Relations refer to associations or interactions between two or more classes. An "is employed relationship" indicates the relationship between the instance "Bob Miller" of the class "employee" and the class "company" (Bullinger 2008).

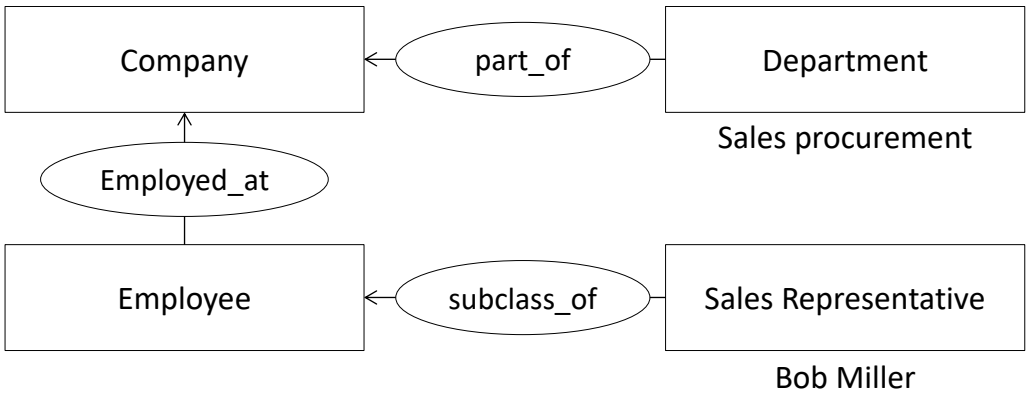

Figure 25: Illustration of Example
(Bullinger 2008)

3 Methodology

For the design of the Customer Input Ontology we conducted the following three steps:

1. Since creating ontologies from scratch is a tedious and costly work, reusing existing ontologies or ontology components that already have been evaluated is a widely accepted approach (Lonsdale et al. 2010). Therefore, to identify relevant ontologies that can be used for the design of the Customer Input Ontology, we conducted a structured review of literature on ontologies in the knowledge domain of innovation management (Webster/Watson 2002). The databases and keywords used for the literature search are described in section 3.1.
2. The design of an ontology includes the definition of classes and attributes. We conducted a second literature review (Webster/Watson 2002) to identify different types and characteristics of customer input, which the Customer Input Ontology needs to cover in its hierarchy of classes and sub-classes (see section 3.2).

3. Based on the steps 1 and 2 we designed the Customer Input Ontology. The selected modelling language and followed guidelines for ontology design are described in section 3.3.

3.1 Literature Review - Existing Ontologies for Innovation Management

As ontologies, innovation management, and customer integration are of interdisciplinary nature, we selected databases that allow access to research in different discipline. Using AND as well as OR combination of the keywords "customer", "innovation", "ontology" we searched in titles, abstracts, and keywords to identify relevant papers (Webster/Watson 2002). The initial search yielded 138 results. In a first screening process we read title and abstract of all obtained articles to identify their relevance for the design of the Customer Input Ontology. After removing duplicates and research papers that develop ontologies for purposes other than innovation management (e.g. ontology for fashion styling) we reduced the number of articles to 25. In order to reduce the set of articles to those that are actually relevant, we conducted a second screening process by reading the whole body of the paper. In this second screening process we excluded papers not capturing different types and characteristics of customer input in an ontology-based framework. Finally, we evaluated 8 papers as relevant for the underlying research. Presenting information about the databases used as well as the number of initially identified and finally included papers, Table 22 summarizes the literature search.

	IEEE	Google Book Library	SAGE Journals	Science Direct
Initial search results	31	32900	11	93
After 1st screening	11	3	4	7
After 2nd screening	2	3	1	2
Total (relevant, without duplicates)		8		

Table 22: Literature Review – Existing Ontologies for Innovation Management

3.2 Literature Review – Types and Characteristics of Customer Input

To determine the types and characteristics of customer input needed along the different phases of the innovation process, we conducted a second literature review. We searched different databases (search fields: titles, abstracts, keywords) using the keyword combination "customer AND (input OR feedback OR idea OR, concept)" to identify types and characteristics of customer input (see Table 23).

	ACM	IEEE	SAGE Journals	Science Direct
Initial search results	823	1673	810	973
After 1st screening	288	180	234	195
After 2nd screening	41	53	56	56
Total (relevant, without duplicates)		206		

Table 23: Literature Review – Types and Characteristics of Customer Input

3.3 Ontology Design

For modelling the Customer Input Ontology we selected Protégé, as Protégé can be adapted to build both simple and complex ontology-based applications. Further, Protégé fully supports the OWL and OWL 2 web ontology language and RDF specifications (Knublauch et al. 2004). The formal ontology design followed the ontology development approach by Noy/McGuinness (2001) as it focuses on the reuse of existing ontologies and provides an extensive guide for ontology design.

4 Findings

In the following, we present our findings structured according to the steps of our methodology.

4.1 Existing Ontologies for Innovation Management

In literature, there are many different ontologies that significantly differ according to their intended usage scenario, the formality of language, or the degree of generalizability. For instance, based on the intended application environment, an ontology can be classified on a continuum ranging from highly specific to most general representation (Bullinger 2008). Further, ontologies can be classified with respect to the degree of formality of a vocabulary and its meaning. An ontology can basically be highly informal (natural language, e.g. glossary), semi-informal (structured form of natural language, e.g. text version of coded ontology), semi-formal (ontology expressed in a formally defined language, e.g. Ontolingua), and formal (defined terms with formal semantics) (Uschold/Gruninger 1996).

Our Customer Input Ontology aims to model diverse types and characteristics of input that customers can provide to the innovation process in formal language. Therefore, to determine whether the ontologies or ontology parts are reusable for the design of our Customer Input Ontology, the 8 identified ontologies were analyzed with regard to the customer input and knowledge domain that they cover (see Table 24, column "description"), their intended application/generality as well as their formality (see Table 24). Only ontologies that 1) model types and characteristics of customer input, 2) that are rather general than too specifically tailored for a particular application, and 3) are implemented in a rigorously formal language, can potentially be reused for the design of the Customer Input Ontology. Based on these selection criteria, parts of the OntoGate (Bullinger 2008) and the Idea Ontology (Riedl et al. 2009) have been considered for our ontology design.

Ontology	Description	Application	Formality	Reference
OntoGate	A generically valid ontology of idea assessment and selection.	General	Formal	(Bullinger 2008)
Idea ontology	Represents ideas and covers further concepts to support collaborative idea development (e.g. rating ideas).	General	Formal	(Riedl et al. 2009)
Preference ontology	Focuses on the elicitation of customer preferences regarding cell phones.	Specific	Formal	(Cao et al. 2011)
Customer complaint ontology	An ontology-based approach for managing and maintaining multilingual online customer complaints.	General	Formal	(Jarrar et al. 2003)
Knowledge ontology module	Focuses on knowledge sharing and reuse in innovation networks.	General	Formal	(Song et al. 2013)
Ontology on customer needs	Presents an approach to automatically translate and represent customer needs.	Specific	Semi-formal	(Chen et al. 2011)
Swarm ontology	Presents an approach to tap into customers' collective intelligence and creativity.	General	Formal	(Baumoel et al. 2009)
Ontology for virtual innovation in construction	Presents an ontology for virtual innovation in construction powered by user driven innovation activities.	General	Semi-formal	(Christiansson et al. 2008)

Table 24: Summary of Existing Ontologies for Innovation Management

Some ontologies that we did not consider for the design of the Customer Input Ontology rather model the process of co-creating innovations with external sources instead of types and characteristics of input. For instance, the ontology on complaint management (Jarrar et al. 2003) covers the entire customer complaint management process. Additionally, in our literature review on customer inputs (see Table 22 and Table 23) we found that complaints can be defined as positive or negative customer feedback. Therefore, we subsume customer complaints under feedback in our Customer Input Ontology. Thus, we could not consider parts of the customer complaint ontology in the Customer Input Ontology. Also, we did not consider the swarm-ontology that presents an approach to build a swarm comprised of groups of customers so that the firm can benefit from customers' creativity and their contributions (Baumoel et al. 2009). With the knowledge module ontology, Song et al. (2013) aim to provide a technology solution for innovation networks to co-innovate with suppliers, customers, and other external partners. The proposed knowledge ontology module helps to integrate specific domain knowledge modules, such as design, manufacturing, or service knowledge. However, types and characteristics of input are not considered in this ontology and therefore it is not suitable for reuse in our Customer Input Ontology. The ontologies on customer statements (Chen et al. 2011) and customer preferences (Cao et al. 2011) focus on a specific knowledge domain and therefore could not be reused.

4.2 Defining Classes of the Customer Input Ontology

We synthesized the findings of our second literature review to the following list of customer inputs and corresponding characteristics that our Customer Input Ontology needs to model (see Table 25). According to our structured review of literature, customers can provide input in the different phases of the innovation process in form of information on their needs, preferences, and requirements. Further, customers can give feedback and create or evaluate ideas, concepts, and prototypes.

Customer input	Associated characteristics
Customer need **Customer preference** **Requirement**	• Quantity: Frequency with which a certain need or requirement is mentioned by customers (Bailey/Horvitz 2010) • Quality: Overall evaluation of customer input, e.g. need description • Validity: Validity, reliability, and correctness of customer input (Galitsky et al. 2009)
Feedback: Encompasses negative, positive, or neutral feedback, e.g. complaints.	• Quantity: Frequency with which a certain complaint is mentioned by customers • Validity: Validity, reliability, and correctness of customer input
Idea: An idea can be defined as an imagined product or service. **Concept:** A concept is an advancement of an idea. Not every idea evolves to a concept. A concept contains details of the innovation to be achieved, e.g. functional requirements, operation and revenue plans (Kasuga/Niwa 2006).	• Quantity: Frequency with which an idea is mentioned by customers (Bailey/Horvitz 2010) • Quality: A complex construct consisting of four distinct dimensions: novelty, feasibility, relevance and elaboration (Blohm et al. 2011b) • Novelty: Extent to which the customer input is new and unexpected • Feasibility: Ease with which an idea can be realized • Relevance: Extent to which an idea or concept satisfies the company's goals • Elaboration: Extent to which an idea is worked out in detail. The same attributes can be used to evaluate an idea or a concept. As a concept is a more detailed description of an idea, the attributes allow a more accurate evaluation compared to an idea.
Idea evaluation **Concept evaluation**	• Quantity: Number of idea assessments generated during idea evaluation • Validity: Results of cross validation check of idea assessment
Prototype	• Fidelity: The degree to which the virtual or physical prototype can accurately represent the utility and features of the real product (low/medium/high-fidelity) (Lim et al. 2006) • Completeness level: semi-finished, finished prototype
Prototype evaluation	• Quantity: Quantity of evaluation addressing the same prototype (Piller et al. 2004) • Validity: Results of cross validation check

Table 25: Types and Characteristics of Customer Input

4.3 Design of the Customer Input Ontology

Figure 26 shows our formal ontology design. In our Customer Input Ontology we reused the class “Participant” from Bullinger's (2008) OntoGate Ontology and its subclasses “Internal Participant” and “External Participant” as their attributes cover all critical elements to describe the internal or external origin of customer input. An internal participant (employee) selects and deploys a customer integration method to gather needed or desired customer input. Customers as external participants take part in this customer integration method. The class “Customer Integration Method” has been adapted from Bullinger's OntoGate Ontology. It encompasses the different methods and tools (e.g. idea competition, concept testing, or toolkits) that can be deployed by internal participants to generate and evaluate customer input. We adapted the attributes to our research by adding decision factors including duration and costs that allow internal participants to select appropriate customer integration methods (Füller et al. 2014a). This also facilitates the analysis of the customer integration project's effectiveness and efficiency (e.g. costs and duration in relation to quality and quantity of customer input generated).

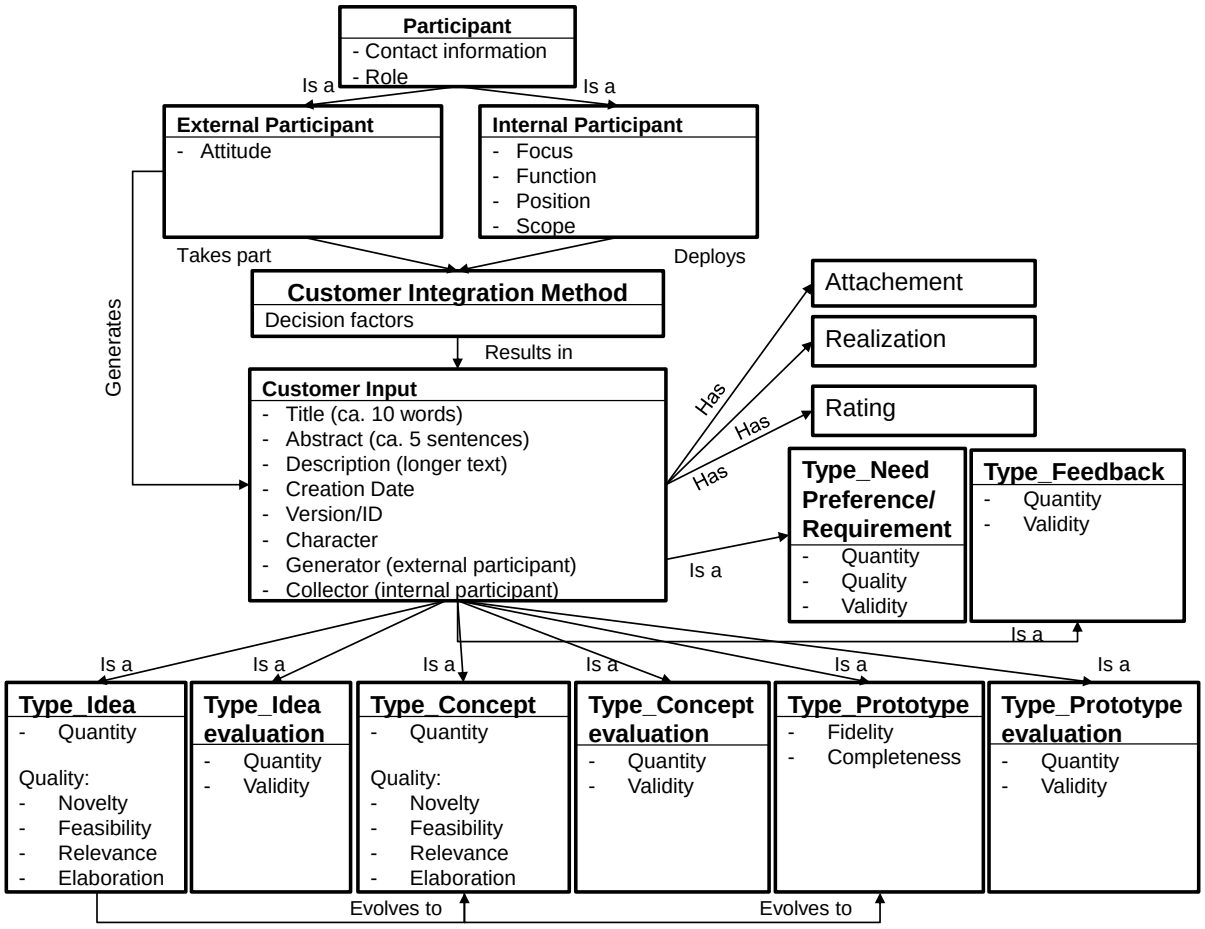

Figure 26: Customer Input Ontology

As an outcome of applying customer integration methods, the company receives different types and characteristics of customer input including ideas, idea evaluations, concepts, concept evaluations, or prototypes. These different types of customer input are modelled as sub-classes of the class “Customer Input”. The different characteristics a customer input can have are modelled as attributes of the different customer input types (as identified in section

"Defining Classes of the Customer Input Ontology"). Since companies often receive a huge amount of customer input through online platforms, it is necessary to compare and evaluate customer inputs. The attributes respectively characteristics of customer input can serve as criteria to evaluate customer inputs (see class "Rating"). Further, for the class "Customer Input" we reuse the attributes title, abstract, description, creation date, and version as well as the relationships (has attachment, has realization) from Riedl et al. (2009). This allows the generation and management of customer input of different form, length, and descriptions. The "has Attachment" relationship allows uploads of other resources (screenshots, audio files). Each customer input has a version number, which allows the different instances of the same idea to be tracked by the "is New Version Of" relationship. Further, we reuse the attribute character from the OntoGate Ontology (Bullinger 2008). The attribute character reveals the degree to which this input was expected: it can take the values continuous or discontinuous. Continuous input refers to inputs that are expected such as ideas originating from online brainstorming sessions or idea competitions, whereas discontinuous input is customer information received unexpectedly (e.g. reports on bugs, or complaints). Additionally, for the class "Customer Input" we defined the attributes generator and collector. Generator captures the origin of the customer input and can take the value external participant. The attribute collector refers to the internal participant(s) responsible for the customer integration project.

5 Illustration of Ontology Application

As proposed by Gruninger/Fox (1995), we derived a set of requirements in the form of competency questions that a knowledge base using the Customer Input Ontology should be able to answer. The questions have been defined from the perspective of an innovation manager responsible for the co-creation of innovations with customers. The questions also serve as test cases to evaluate our Customer Input Ontology. Similarly Riedl et al. (2009) used competency questions to evaluate their Idea Ontology. Based on the information (e.g. collector, generator, creation date) that the Customer Input Ontology requires the users to provide for customer input, the following competency questions can be answered with the Customer Input Ontology (see Table 26).

Competency Question	Customer Input Ontology
Which ideas have been realized?	Instances of the *customer input type idea* with a *"has realization"* relationship.
What are the last customer ideas generated and stored in the knowledge base?	Instances of the *customer input type idea* with the latest values for the attributes *creation date*.
What are the top 10 rated customer inputs?	Instances of the class *customer input* with a *"has rating"* relationship and the instances of *rating* having the ten highest values.
What is the customer feedback (e.g. complaints) obtained and stored in the knowledge base in the last two days?	Instances of *customer input type feedback* with *creation date* in the last two days.
Who are the five most valuable external participants as they provided highly rated (e.g. high quality) customer input in our customer integration initiatives?	Instances of the class *customer input* with a "*has rating"* relationship and the instances of the *rating* having a high value; viewing the value of the attribute *generator* of the customer input.
What are the most valuable internal participants responsible for customer integration initiatives resulting in a high amount of high quality customer input?	Viewing the value for the attribute *collector* of *customer inputs* with high values for the attributes *quality* and *quantity*.
What are the most successful customer integration methods?	Viewing the origin (*customer integration method*) of *customer inputs* rated with high *quality* and *quantity*.

Table 26: Competency Questions

The Customer Input Ontology offers a template to systematically capture information related to customer input including title, abstract, description, creation date, generator and collector. Therefore, the Customer Input Ontology allows innovation managers to structure unstructured customer inputs. This makes customer input computer-tractable.

6 Conclusion

Companies increasingly co-create innovations with external participants such as customers, acknowledging customers' product and service related knowledge and expertise. However, when integrating customers into innovation processes through the use of customer integration methods companies receive a huge amount of customer input (Zogaj/Bretschneider 2012). Solutions and languages to systematically store this information, and to share, reuse, and integrate knowledge across departments or stakeholders in innovation networks are missing (Song et al. 2013). To address this research gap this paper proposes the Customer Input Ontology.

Previous research basically differentiates customer input in need and solution information. By proposing a more detailed typology of types and characteristics of customer input, this paper contributes to open innovation research. This approach facilitates a more thorough investigation and usage of customer knowledge. The competency questions show how the ontology might be used to generate knowledge, use, and value of generated and received customer input in form of ideas, concepts, or feedback. To fully leverage the potentials of the Customer Input Ontology, further research might implement this ontology-based framework in a software platform to manage customer input.

From a practical perspective, the Customer Input Ontology provides practitioners with a shared and common understanding of the core concept of customer input. A common language is key to information sharing and to foster interoperability between tools (Riedl et al. 2009). By requiring the user to provide information on the input generator, collector, or creation date of the input in a unified manner across different departments of a company, the underlying research aims to solve the problems of cross-functional sharing and reusing of customer input. The stored information related to customer input allows companies to further analyze input and to identify success factors in customer integration. For instance, through automated analysis companies might identify creative external participants that provide high quality customer input, internal participants responsible for successful customer integration initiatives, customer integration methods that lead to invaluable customer input, or companies might track the life cycle and changes of customer input over time.

This research is subject to some limitations. The identified ontologies as well as types and characteristics of customer input in our literature review are obviously limited though the selection of the databases and keywords. Further, the Customer Input Ontology presents a first meta model for the management of customer input. Future research can formalize the classes and properties of the Customer Input Ontology and subsequently implement a prototype for a software platform to manage customer input across innovation cycles, departments, or companies.

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Publication 7: Knowledge Management in Customer Integration

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Abstract

Customers can take an active role in the innovation process and provide their input (e.g., ideas, idea evaluations, or complaints) to the different phases of the innovation process. However, the management of a huge amount of unstructured customer input poses a challenge for companies. Existing software solutions focus on the early stages of idea management, and neglect the interoperability of tools, sharing, and reuse of customer inputs across innovation cycles and departments. Following the design science approach, we address this research gap by designing and evaluating a prototypical software platform, the "Customer Input Management System". We derive functional and non-functional requirements that the software needs to meet from literature and by interviewing experts working in the fields of innovation management, product development, and marketing. The software provides practitioners with helpful functions for importing, exporting, tagging, and analyzing customer input to derive beneficial knowledge for innovation development.

Keywords: Open innovation, customer input, knowledge management

Individual contribution of Kathrin Füller: For this publication, I participated in the study design, data analysis, and interpretation. One of my co-authors collected the qualitative data for this paper by conducting a systematic literature review and semi-structured interviews. Further, the Customer Input Management System was implemented and evaluated by a co-author. My contributions include the study's idea of developing the system and guiding the overall research project including data collection and data analysis, and providing relevant literature. Further, I contributed by writing all sections of the paper.

1 Introduction

Companies often fail to deliver products that meet customer expectations (Matzler/Hinterhuber 1998). To overcome the challenge of better understanding market demand and customer needs, companies can assign their customers a more active role in the innovation process (Chesbrough 2003). Customers can participate in the innovation process by providing input in the form of information on their needs, ideas for new products or services as well as evaluations of ideas to support the company in deciding which ideas to pursue further. Later in the innovation process, customers can test and evaluate product and software prototypes to identify design flaws or missing functionalities (Dahan/Hauser 2002). Customer inputs can be obtained by companies through the application of different IT-based or face-to-face customer integration methods including online idea competitions, virtual concept testing, or focus groups (Dahan/Hauser 2002; Zogaj/Bretschneider 2012).

These sources often result in a huge amount of heterogeneous and unstructured data (Füller et al. 2015a), which presents companies with the challenge of managing and transferring customer input into useful and relevant knowledge for innovation development. Further, since customer integration methods can be expensive for the company to conduct and can also be cumbersome for customers to participate (Fähling et al. 2011), customer input needs to be shared across departments and innovation networks to facilitate reuse of customer input.

Despite the ongoing research on the integration of customers into innovation processes, there is a paucity of research focusing on how to manage customer input (Yang/Chen 2008; Zhang et al. 2011). There is a lack of suitable solutions and languages for knowledge sharing, reuse, and integration across departments (Song et al. 2013). There are different guidelines and software tools used in different departments to manage customer input. This complicates communication and interoperability, and hinders the reuse of data (Franco et al. 2010). Therefore, following the design science approach (Hevner 2007) this paper aims to develop and evaluate a software platform for the management of customer inputs in order to solve the challenge of unstructured information and the elicitation of beneficial knowledge for the innovation process. The software platform is called Customer Input Management System (CIMS) and will support the innovation management staff to import, store, evaluate, edit, filter, and reuse customer inputs. Additionally, the CIMS will provide the user with analysis tools to derive meaningful knowledge and competitive advantage.

The remainder of this paper is structured as follows. First, we present the theoretical background on knowledge management in customer integration. Second, the research methodology is described. Third, the findings from the literature review and the expert interviews are presented. Fourth, information on the design, implementation, and evaluation of the CIMS are provided. We conclude with implications and limitations of this research as well as possibilities for future research.

2 Knowledge Management in Customer Integration

We are living in a knowledge society in which the importance of knowledge is ever increasing (Nonaka 1994). The knowledge-based theory of the firm, an extension of the resource-based view, considers the resource "knowledge" as most strategically important for companies since knowledge is intangible, dynamic, and difficult for competitors to imitate (Grant 1996). Especially knowledge creation in form of innovation is key to organizational growth and competitiveness (Nonaka 1994). For companies to create innovations, customers as important external sources of knowledge need to be considered (Chesbrough 2003; Wilhelm et al. 2013). Research on customer knowledge management distinguishes in three customer knowledge flows: 1) *Knowledge for customers* on e.g., product range, required for the buying process; 2) *Knowledge about customers* to address them in personalized ways, 3) *Knowledge from customers* about products, and services to ensure continuous improvement (Gebert et al. 2002; Wilhelm/Gueldenberg 2014; Wilhelm et al. 2013). In this paper, we focus on the latter customer knowledge flow and the use of information systems implementations that facilitate companies in capturing, creating, and sharing customer knowledge in order to innovate (von Krogh 2012).

Existing information systems implementations to support companies' open innovation initiatives can be categorized in idea management systems, user feedback systems, and open innovation marketplaces (Leitzelman/Trousse 2011). Idea management systems allow companies to collect their customers' ideas, and subsequently, evaluate, analyze, and select ideas to pursue further. Tools dedicated to customer feedback such as the software solution by Kampyle help companies to trigger feedback invitations on their websites based on the user's behavior on the website (e.g., when the user is about to leave the website, abandons a transaction) (Kampyle LTD 2015). In contrast, open innovation marketplaces refer to crowdsourcing platforms that bring together solution seekers and innovators (Hrastinski et al. 2010; Leitzelman/Trousse 2011).

Hence, on a rather operational level customer integration research focuses on the application of information systems to gather customer input and co-create innovations with customers (Hrastinski et al. 2010; Wilhelm et al. 2013). However, administrative information systems to manage overflow of customer inputs are scarce. Further, research focuses on the early stages of the innovation process including idea generation and evaluation (Hrastinski et al. 2010). However, knowledge management systems need to be capable of capturing and sharing the valuable input that customers can provide along all phases of the innovation process (e.g., concepts, prototype tests).

3 Research Methodology

In previous research, we developed the Customer Input Ontology to provide a common understanding and interchange format of different types and characteristics of customer input across departments and companies (Füller et al. 2015a). Taking the Customer Input Ontology as a basis, we followed the design science paradigm, and the corresponding three cycle view to design, build, and evaluate an IT artifact that solves the challenge of managing customer input (Hevner 2007). The rigor cycle considers the integration of existing knowledge into the design of new IT artifacts as well as the advancement of general understanding through the design of IT artifacts. The relevance cycle includes requirements from the application environment which need to be considered in the design of IT artifacts in order to improve important and relevant business problems. The design cycle covers the iterative design and evaluation of IT artifacts (March/Smith 1995). In the following, we describe how we followed these three cycles to design, build, and evaluate the CIMS.

3.1 Rigor Cycle

In order to ensure rigor of our research, we conducted a literature review as recommended by Webster/Watson (2002). As the concepts of open innovation and knowledge management are studied in different disciplines, we selected databases that allow access to different research fields. We searched the databases IEEE, ScienceDirect, and EbscoHost with combinations of the keywords "knowledge management", "software" or "requirements", AND "open innovation" or "customer integration" to 1) learn about existing knowledge management tools specifically in the field of customer integration, their advantages, and disadvantages, and 2) to derive requirements for the design of a software platform that facilitates companies in managing customer inputs (see Table 27).

	IEEE		**ScienceDirect**		**EbscoHost**	
Keywords combinations	Identified	Relevant	Identified	Relevant	Identified	Relevant
“Open innovation” AND “knowledge management”	49	3	44	3	13	2
“Customer integration” AND “knowledge management”	59	2	14	1	2	0
“Open innovation” AND “requirements”	92	2	49	0	6	0
“Open innovation” AND “software”	166	2	111	2	18	0
Total (relevant without duplicates)			17			

Table 27: Overview of Identified and Relevant Papers

We initially found 623 papers through our keywords search. In the first screening process, we read title, abstract, and keywords of all 623 papers to evaluate their relevance. This first screening process resulted in 45 papers. In a second screening process we read all 45 papers and identified 17 papers that were relevant for the underlying research. In both screening processes, papers that answered the following questions have been evaluated as relevant: What kinds of customer inputs can be gained from customers? What kinds of processes and methodologies are used to organize customer inputs? What software and tools are used to organize customer inputs? How do companies turn customer information into knowledge that is useful and relevant for innovation development?

3.2 Relevance Cycle

To ensure the relevance of our research, we conducted expert interviews to elicit requirements from the application environment on the design of the CIMS. We conducted interviews with 12 experts working in the fields of innovation management, software and product development, sales, and marketing, where they experience the challenge of managing different types of customer input in everyday business (see Table 28). To ensure comparability between all 12 interviews, we used a semi-structured interview guideline (Gläser/Laudel 2009; Miles/Huberman 1994). Experts were asked about 1) the customer inputs that are collected in their company, 2) the customer integration methods used to obtain customer inputs, 3) the software solutions used to manage customer inputs, 4) the approaches and processes applied to derive business value from customer inputs, and 5) the requirements that they expect the CIMS to fulfil.

ID	Industry	Experience in this field (years)	Interview duration (minutes)	Position
I1	Health	7	17	Director sales & marketing
I2	Automobile	20	12	Vice president
I3	Online services	15	13	General manager/ founder
I4	Software	7	18	QA team leader
I5	Software	5	14	Director
I6	Semiconductor	3	17	Strategic planner
I7	Software	10	13	R&D group manager
I8	Software	3	14	Strategic planner
I9	Software	7	20	Senior developer
I10	Software	7	13	Product manager
I11	Semiconductor	15	15	Director marketing
I12	Fashion	20	17	Director customer experience

Table 28: List of Interviews

The interviews were carried out via phone or face-to-face meetings. Interview sessions lasted 15 minutes on average. When allowed, the interviews were voice recorded, transcribed, and checked for accuracy by the interviewee. In five interviews we manually took notes, as voice recording was not allowed. Data was collected from February to May 2015. The collected data was analyzed using qualitative content analysis (Gläser/Laudel 2009; Miles/Huberman 1994).

3.3 Design Cycle

Based on requirements and insights gained through the rigor and relevance cycle, we derived requirements for the design and evaluation of the CIMS. For instance, we found that the software platform needs to be implemented as a collaborative tool that fosters interoperability and allows different users to simultaneously use the tool. This can be achieved through ontology-based tools (Riedl et al. 2009) and an online service since application users are located in different locations. Finally, through a survey of 18 experts evaluated the CIMS with regard to the implementation of the requirements and its usefulness.

4 Results

In the following, we present the results of our literature review and the experts interviews. In the section "Approaches to Manage Customer Input in Practice" we provide information on the employed approaches in practice to manage customer input, the section "Requirements" describes the requirements for the design of the CIMS, section "Architecture of the Customer Input Management System" describes the architecture of the CIMS, and section "Evaluation of the Customer Input Management System" finally provides the evaluation results of the CIMS.

4.1 Approaches to Manage Customer Input in Practice

In our expert interviews we found that companies frequently discuss customer input in personal meetings. While this approach may be valuable to discuss, share, and evaluate customer input, it does not allow formal documentation, sharing, or reuse of customer input across departments.

Organizations appear to have little maturity in tool support for managing customer inputs. Standard office tools and tweaked solutions for special purposes (e.g., CRM or requirements management tools) seem to be predominant. The approach of managing customer inputs with Microsoft Office solutions raises problems of simultaneous work, tracking of changes, and versioning: *"We do not use specific software, we use Microsoft office tools like PowerPoint, SharePoint, and Excel. The data is stored in the emails and then they are transferred into Excel with our comments. The advantage here is mostly flexibility. The disadvantages are: not well organized, we search customer input with the search engine of Microsoft Windows, and there is data redundancy since many inputs are written in different places."* Some departments, create their own software solution to manage customer input. This knowledge management approach hinders interoperability, sharing, and reuse of customer input: *"We have an internal software to manage all customer requirements. This software was built*

internally to exactly suit the company's needs. However, it might limit the productivity in collecting and handling requirements."

The problem of interoperability of software solutions as well as knowledge sharing and reuse is further amplified by different departments using different software solutions to deal with different types of customer input. For instance, an expert working in software development mentioned the solution of AGM HP which allows the tracking of requirements, test of applications, and the status of projects. Another expert responsible for sales and marketing uses the software CRM Zoho. The purpose of Zoho is to track sales activities and customers in the sales cycle. Further, it allows companies to gather information relevant for sales and future sales opportunities.

In the expert interviews, we identified four main user groups: product developer, project manager, software developer, and marketing manager. Each user group has different usage intentions, corresponding needs, and required functionalities. This challenge can be solved by the CIMC through the implementation of role-based access control and the structured collection of different types of customer input in a unified format.

4.2 Requirements

Based on the literature review and the expert interviews, we derived requirements for the design of the CIMS. The requirements were categorized as functional and non-functional requirements (see Table 29). Functional requirements define what a system is supposed to do. In contrast, the non-functional requirements refer to e.g., security, or usability of a system (Sommerville 2012).

Functional requirement	Description	Source
Database	The software needs a knowledge base to store customer inputs, and to upload and attach corresponding documents.	(Zhang et al. 2011) Interviews I1, I2, I4, I5, I6, I9, I12
Documentation	Customer inputs can be modified by different stakeholders. A history and documentation might be helpful to understand the development path (e.g., who changed what and when).	Interviews I2, I5, I6
Data entry/ data import	Entering information and the import of data from external sources into the software platform is important (e.g., import of text files and emails; interface to IT-based customer integration methods such as idea competitions).	(von Krogh 2012) Interviews I1, I5, I8
Data search	The software must offer the possibility to search, filter, and fetch data from the database.	Interviews I1, I4, I8
Data export/ data sharing	The data can be exported and saved in different formats (e.g., CSV format) to be used in other software and tools.	Interview I6
Links/ tags	Inputs provided by different customers may concern the same content, product, or service. The software needs to link different customer inputs with each other.	(Carbone et al. 2012) Interviews I1, I5, I8
Input evaluation	To evaluate and filter relevant customer input, the system needs to assist the evaluation of customer input with different evaluation criteria.	(Blohm et al. 2011b) Interviews I1, I5, I8
Reporting and analysis tools	The software needs to visually present data and knowledge using charts and statistical tools. The system should incorporate structure analysis tools to analyze customer input and to identify success factors in customer integration.	(Carbone et al. 2012) Interviews I1, I2, I4, I6, I8, I12
Non- functional requirement	**Description**	**Source**
Security/ access control	The access of people to the data as well as the ability of an individual user to perform a specific task, such as view, create, or modify data needs to be controlled.	(von Krogh 2012) Interview I6
Collaboration/ interoperability	An ontology can serve as a basis to foster common understanding, interoperability between tools, and cross-enterprise collaboration.	(Riedl et al. 2009) Interviews I1, I2, I4, I5, I6, I9, I12
Intuitive and easy to use	The software should have an intuitive user interface that makes the software friendly to use and easy to understand.	Interviews I1, I10, I11

Table 29: Functional and Non-Functional Requirements

Compared to existing knowledge management systems, the CIMS needs to consider two major aspects which are defined by the requirements "Collaboration/ interoperability" and "Links/ tags" that enable company-wide or cross-company sharing and reuse of customer input as well as the tracking of evolution of customer input over time (e.g., from idea to concept to prototype).

4.3 Architecture of the Customer Input Management Systems

The architecture of the CIMS consists of 3 tiers: *Presentation Tier*, *Business Logic Tier*, and *the Data Tier*. *The Data Tier* describes the lowest layer which is also located on the server side. The data tier saves data securely. We used PostgreSQL as well as the Customer Input Ontology (Füller et al. 2015a) to derive the data schema. The ontology provides a common customer input data interchange format that supports interoperability between tools (Riedl et al. 2009). The Data Tier is considered to be highly important because it contains all data; if it gets lost or hacked, companies could lose valuable business data. To meet the requirement "Security/ access control" we limited access to the software though user accounts and passwords.

The Business Logic Tier is developed on the server side. The interaction with the frontend is implemented with AJAX and JSON. The interaction between the Business Logic Tier and the Data Tier is implemented with the Java Persistence API. In the Business Logic Tier, we implemented the functions and algorithms needed to meet the identified requirements. For instance, to meet the requirement "Links/ tags" we implemented a functionality to parse a text provided by customers to automatically suggest product related keywords to the user. Figure 27 (bottom right) shows the availability of this functionality through the user interface. This functionality can support the user in tagging customer inputs. The user only has to decide whether these keywords are relevant or not. Finally, these keywords can be used in business intelligence to derive knowledge from the database.

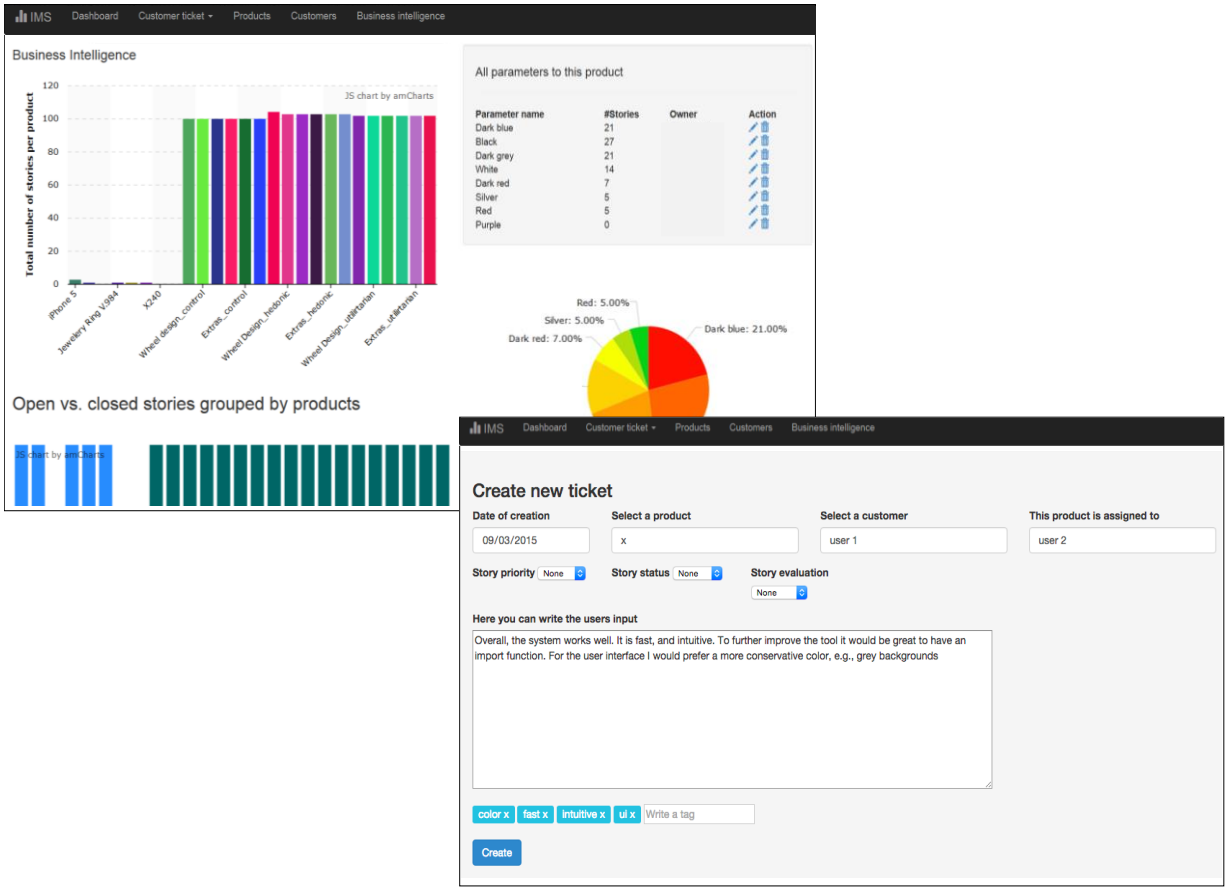

Figure 27: User Interface

The Presentation Tier refers to the user interface that allows the user to interact and query information from the CIMS. Figure 27 illustrates the user interface to the CIMS and some of the available functions. For instance, through the user interface users can insert and manually tag customer input. This function meets the requirement "Links/ tags" and is illustrated in Figure 27 (bottom right). To meet the requirement "Reporting and analysis tools", users can analyze and graphically/ visually present data (see Figure 27, top left).

4.4 Evaluation of the Customer Input Management System

In order to see whether our software meets the requirements and to get a good understanding of the weaknesses and strengths of the software, we evaluated the CIMS in two steps: 1) we imported large amounts of customer input obtained through previous research projects to test import, search, edit, and data analysis functions; 2) we shared the link to our web-based software with experts and asked them to evaluate the software by giving feedback through an online survey. We contacted the experts that we have interviewed and additional potential users of the CIMS working in the fields of project management, software development, product development, and sales and marketing. In total, 18 experts evaluated the CIMS with regard to four evaluation components. The survey consisted of four items for each of the evaluation components *purpose and strategy* (Cronbach's Alpha: 0.85), *content and functionality* (Cronbach's Alpha: 0.60), *navigation and interaction* (Cronbach's Alpha: 0.73), as well as *media design and presentation* (Cronbach's Alpha: 0.80) (see Table 30) (Heidmann/Ziegler 2002). The items have been adapted from existing items for the evaluation of websites and applications (Heidmann/Ziegler 2002; Oppenheim/Ward 2006; Webb/Webb 2004; Finstad 2010). *Purpose and strategy* refers to whether the software platform helps the company to reach its goals in customer input management (e.g., derive meaningful knowledge for innovation development). *Content and functionality* covers questions concerning the mere supply of content and functionalities. In the evaluation domain *navigation and interaction*, we asked the experts whether the navigation concept allows easy and intuitive navigation. *Media design and presentation* refers to the design of the user interfaces (e.g., visual design, use of graphics/ charts) (Heidmann/Ziegler 2002). A seven-point Likert scale anchored with one as "Strongly Disagree" and seven as "Strongly Agree" has been used.

To analyze the survey data, the positively formulated items in the survey (e.g., "This software will help me […]") were scored as [score – 1], and the negatively formulated items (e.g., "I don't think this software […]") were scored as [7 – score]. This aligned all scores in one direction, removing the positive/ negative keying of the language in the instrument (Finstad 2010). After recording, each individual item had a range of 0-6. To calculate the percentage of satisfaction with regard to an evaluation component, we divided the sum of participants' scores for each evaluation component by the number of items (= 4 items to measure each evaluation component) multiplied with the maximum possible score (= 6), and then multiplied by 100 (see formula (1)) (Finstad 2010).

$$S[\text{in } \%] = \frac{\sum((\textit{mean positive item} - 1) + (7 - \textit{mean negative item}))}{\textit{number of items} \times 6} \times 100\% \qquad (1)$$

For instance, the evaluation component *purpose and strategy* was calculated as in formula (2).

$$S[\text{in } \%] = \frac{((4.95-1)+(7-3.1))+((5.1-1)+(7-2.84))}{4\times 6}\times 100\% = 67\% \quad (2)$$

The result for the overall satisfaction for all four evaluation components with the CIMS after the first development and evaluation iteration was 70.4%.

We can conclude that the evaluation component navigation and interaction has the highest satisfaction rate with 78%. In contrast, content and functionality has the lowest satisfaction with 67.5%. In the next development and evaluation iteration, this evaluation component can be particularly focused. For instance, the tagging system can be improved by integrating text mining tools to automatically search and find important keywords in customer input (e.g., complaints, online reviews, textual descriptions of customer ideas). To this end, open source libraries such as Weka can be applied. Further, IT-Security should be improved by applying the role-based access control approach to ensure data privacy. Additionally, the CIMS could be improved by integrating more advanced analysis and visualization tools. Charts and graphical illustrations of data result in high transparency and better understanding of the data in the knowledge base. This will be of great value for companies in terms of deriving relevant knowledge for innovation development (e.g., customer integration methods that yield a high amount of high quality customer input, responsible employees that manage customer integration initiatives that result in relevant customer input, identification of areas of knowledge deficits about customers, identification of frequent complaints concerning a product). Finally, future and more advanced versions of the CIMS could include tooltips, videos for training, and a start page presenting available functions and features.

Evaluation component	Items	Score (mean)
Purpose and strategy	• This software will help me derive meaningful knowledge for the innovation process in my team.	4.95
	• I think that this software does not cover the needs of all stakeholders involved in the innovation process.	3.1
	• Using this software reduces working time and increases the effectiveness of my team.	5.1
	• I do not think this software might add any business value to my company.	2.84
	Satisfaction with evaluation component purpose and strategy	*67%*
Content and functionality	• I could interpret meaningful and helpful knowledge from the charts in the software.	4.61
	• I have spent a lot of time to understand how to use the functions in the system.	3.1
	• The smart tagging feature for customer inputs to identify keywords from a given text is very efficient.	5.61
	• The software does not cover security and privacy issues; I do not feel safe to use it in the company to store data.	3.67
	Satisfaction with evaluation component content and functionality	*64.5%*
Navigation and interaction	• The interaction with the software was straightforward; I did not find difficulties with the interaction.	5.5
	• The navigation is not clear enough; I have spent much time to find what I am looking for.	3.1
	• The input-autocomplete function helped me to browse the content from the website.	5.95
	• I reached the error page very often although I executed the functions correctly with valid inputs.	1.55
	Satisfaction with evaluation component navigation and interaction	*78%*
Media design and presentation	• This system has clear forms and is easy to understand.	5.27
	• The application uses different names for the same functionalities which make it confusing to understand the differences.	2.45
	• I find the data presentation in the charts very clear and understandable.	4.95
	• I think that the design of the web application is not comfortable enough.	2.56
	Satisfaction with evaluation component media design and presentation	*72%*

Table 30: Survey to Evaluate the Customer Input Management System

5 Conclusion and Future Research

The emergence and proliferation of modern information technologies has brought forward a notable number of IT-based customer integration methods (Dahan/Hauser 2002; Zogaj/Bretschneider 2012). With this development, the variety of customer input in different form (e.g., video, audio, text) and level of detail and elaboration is increasing (Zhang et al. 2011). Despite the ongoing research on the integration of customers into innovation processes, there is a paucity of research focusing on how to store, structure, retrieve, and reuse customer input to derive meaningful knowledge for innovation development and competitive advantage (Yang/Chen 2008; Zhang et al. 2011). Using the design science approach, our research addresses this gap by designing, implementing, and evaluating the CIMS, a software platform for managing customer inputs.

Our research is subject to some limitations. First, the requirements for the design of the CIMS are limited on the databases and keywords used for the literature search as well as the opinions of the 12 interviewed experts. The majority of the experts is from the software industry, which might also influence the identified requirements. Similarly, the evaluation results are based on a relatively small sample of 18 experts. Further research should evaluate the impact of the CIMS on interoperability, customer knowledge sharing and reuse in a long-term field study. The CIMS is only a first prototype and is not yet ready for productive use in practice. Further versions of the CIMS can incorporate role-based access control as well as text mining and sentiment analysis to automatically tag customer input, and identify relevant customer reviews and opinions from social networks or online reviews from amazon.com.

The paper contributes to theory by providing insight into the roles/ stakeholders, and challenges of customer input management. For instance, companies face huge amounts of customer input that needs to be evaluated and analyzed. However, companies lack in time and other resources to manage customer input manually. The underlying research provides insight into the state of research as well as the approaches currently used in practice for knowledge management in customer integration. Our research shows that the applied approaches are rather immature and hinder formal documentation, interoperability, and knowledge sharing and reuse across departments or innovation networks. From a practical perspective, this paper introduces a software platform that allows companies to capture different types of customer input along the whole innovation process. The CIMS supports companies in structuring, storing, analyzing, sharing, and reusing customer input. The evaluation of the system through a survey of experts showed that the system is capable of managing huge amounts of data. The experts found that the system is easy and intuitive to use.

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Appendix - List of Author's Publications

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