Three Essays on the Design of Crowdsourcing Projects

vorgelegt von

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an der Fakultät VII - Wirtschaft und Management

der Technischen Universität Berlin

zur Erlangung des akademischen Grades

Doktorin der Wirtschaftswissenschaften

- Dr. rer. oec. -

genehmigte Dissertation

Promotionsausschuss:

Vorsitzender:Prof. Dr. Knut Blind
Gutachter 1: Prof. Dr. Søren Salomo
Gutachter 2: Prof. Dr. Katharina Hölzle

Tag der wissenschaftlichen Aussprache: 7. Dezember 2021

Berlin 2021

Acknowledgements

I would like to express my heartfelt gratitude to multiple people, without whom writing this dissertation would not have been possible. I am immensely grateful to all those who dedicated their precious time and effort in supporting and nurturing me throughout my academic journey.

Foremost, I would like to begin by thanking my academic supervisor and mentor, Prof. Dr. Søren Salomo for his continual guidance and encouragement throughout my journey. His extensive knowledge, expertise and wisdom in the field of innovation management was particularly inspiring and insightful. I am extremely grateful for his unwavering enthusiasm and dedication to share his knowledge and provide me with constructive feedback at every step of the process. Additionally, I would like to extend my appreciation to my co-author, Felix Pinkow who made working stimulating and enjoyable. Collaborating with him has been a pleasant journey.

I am immensely grateful to my parents and family for always believing in me and supporting each one of my endeavors. I am fortunate for their unconditional love and support. Without their relentless encouragement and motivation through both the good and challenging times of my thesis, this would not have been possible. I would like also like to thank my friends for their valuable advice as well as motivating me to complete this journey.

Further, I would like to express my deepest gratitude to my partner for being extremely empathetic and understanding throughout. Thank you for being my pillar of strength and reassuring me every step of the way. I appreciate your constant support especially through the tough times of my academic research. Your patience cannot be underestimated.

Last but not the least, I am highly indebted to my supervisor Gero Corman, for his unparalleled support, enthusiasm and profound belief in my work throughout.

Executive Summary

This thesis comprises three manuscripts rooted in the design and operationalization of crowdsourcing contests for innovation. This thesis responds to the many calls for research regarding the 'lack of standardization' and the need for a 'comprehensive guideline' to better structure and manage crowdsourcing projects. The primary objective of this study is to explore how crowdsourcing campaigns can be designed effectively to engage potential crowd contributors and capture relevant information.

The first research paper, *'Understanding Crowdsourcing Projects: A Review on the Key Design Elements of a Crowdsourcing Initiative'* reviews the state-of-the-art in the crowdsourcing literature to develop a comprehensive understanding of designing crowdsourcing projects for innovation. A systematic literature review was conducted in three of the most prominent scholarly databases in management research; EBSCO Business Source Complete, Web of Science and ABI/Inform. Based on the findings, a concept-centric approach was developed to present a summary of the findings and map the various design elements identified in the literature to the four fundamental crowdsourcing dimensions as guided by the theoretical background. In total, 20 relevant design elements were extracted from the literature. Based on these major findings, this paper provides a novel conceptual configuration to design and operationalize crowdsourcing projects. In particular, a morphological approach was used to structure and present an integrated overview of the various crowdsourcing design options. In doing so, this study is one of the first attempts to present an elaborate conceptual framework representing the critical design decisions in the context of crowdsourcing design. Furthermore, from a practical perspective, this study seeks to serve as a comprehensive guideline for practitioners, offering valuable insights to make more

informed decisions.

The second research paper titled *'A Morphological Approach towards Crowdsourcing Project Design: A multiple Case Study'* empirically investigates how crowdsourcing projects are designed and operationalized in practice. Moreover, this paper adopts an innovation barrier perspective coupled with signaling theory to explore how crowdsourcing campaigns can be designed effectively to capture relevant innovation. To this end, this study draws on a multiple case study to investigate the various design complexities and interdependencies involved in developing effective crowdsourcing campaigns. In particular, a *'clinical'* research approach was used to examine three crowdsourcing projects set in an established firm environment, providing a detailed account on the rationale behind the different design decisions taken along the crowdsourcing process. Based on the findings, a decision-centric approach is proposed to structure crowdsourcing campaigns into main decision dimensions, which together provide a comprehensive basis for delineating decision elements. Complementing some of the major findings in the extant literature, the results of this study highlight that the underlying task is the most central decision parameter in the overall campaign design because it relates closely to the objective of the campaign and more importantly influences subsequent decisions. Consequently, the cases indicate a strong hierarchy and interdependencies between certain design choices, such that some task related decisions influence subsequent design parameters. Extending current research, the results also suggest the innovation ambition of the seeker to be an additional, critical decision element in the context of crowdsourcing project design. Furthermore, from a practical standpoint, the findings of this paper have significant ramifications for practitioners to effectively design and operationalize crowdsourcing projects.

The third and final research paper, *'Designing Crowdsourcing Contests for Ideation: Investigating the Relationship between Task Complexity, Specificity, Innovation Ambition and Crowdsourcing Performance'* seeks to explore how certain design characteristics of the underlying task influence potential solvers to contribute in ideation contests. Since solver participation is crucial to the success of crowdsourcing initiatives, this study investigates the central role of the task description and its impact on solvers' decisions

to participate and develop solutions. This study builds on the propositions suggested in the previous paper, and seeks to understand the relationship between the delineation of the underlying task and crowdsourcing performance. Drawing on the underlying premises of signaling theory and the social exchange theory, this paper argues that potential contributors perceive the crowdsourcing task through a portfolio of signals, and thereby decode these signals to determine the associated costs and benefits of participation. In particular, three central components of the task are assessed, which are the task specificity, the task complexity and the communicated innovation ambition of the seeking firm. Drawing on a rich dataset of 392 ideation challenges in the timeframe of 2010 to 2020, this paper investigates the impact of these three task attributes on crowdsourcing performance in terms of the ratio of the total number of submitted solutions to the total number of interested solvers per challenge. The findings of this paper suggest that all of the three examined components of the task have an impact on solvers' decisions to participate in innovation contests. As such, the manner in which the task is delineated and communicated significantly influences how solvers perceive the task, and hence their decision to contribute. From a managerial perspective, crowdsourcing firms can leverage the results of this study to delineate the task, such that it has a positive impact on crowdsourcing performance.

Finally, this thesis concludes with a comprehensive synthesis and discussion of the three research papers and outlines further implications for research and management.

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List of Abbreviations

Autonomous Guided Vehicle (AGV)

Computer-Aided Design (CAD)

Intellectual Property (IP)

Intellectual Property Rights (IPR)

Information Technology (IT)

Key Performance Indicator (KPI)

Non-Disclosure Agreement (NDA)

Non-Governmental Organization (NGO)

Research and Development (R&D)

User Experience (UX)

Question and Answer (Q&A)

Chapter 1

Introduction

When I was initially given the responsibility to drive crowdsourcing in the context of a large automotive firm, I searched for direction and guidance in research and popular literature on how to best approach the design of such campaigns - all I found was fragmented literature on very specific aspects, mostly not related to each other. From a conceptual perspective, the literature on crowdsourcing was mostly phenomenon-driven, lacking attempts for a conceptual rooting. This deficit motivated me to dig deeper and pursue my research in the context of effective crowdsourcing campaign design. To this end, my thesis aims at providing a comprehensive approach to understand the primary design facets of crowdsourcing campaigns, rooting this in theory, and finally seeking relevant interdependencies between design facets to better understand the opportunities embedded in such an open innovation approach. Further, by offering an approach to conceptualize the various design complexities and interdependencies, my thesis seeks to provide a detailed account on how crowdsourcing projects can be effectively operationalized, such that firms can capture value from such initiatives.

1.1 Relevance of Crowdsourcing in the Context of Innovation

In today's challenging and competitive business environment, innovation is a core strategic activity in the development of new products to create value and maintain a competitive edge (Salomo, Talke, & Strecker, 2008). In particular, advancing technologies, shorter product life cycles, and rapidly evolving customer demands make it essential for organizations to innovate (Chesbrough, 2003; Gassmann, 2006). However, internal efforts alone to initiate innovation processes are becoming increasingly insufficient, which in turn, has led to fundamental changes in the way organizations innovate and bring new products and services to market (Chesbrough, 2003; Enkel, Gassmann, & Chesbrough, 2009). As a result, Enkel et al. (2009) further highlight that many organizations are compelled to shift their focus from exclusive internal research and development (R&D) to cooperation with external partners. This paradigm shift is deeply embedded in the open innovation model, initially coined by Chesbrough (2003), which encourages organizations to access valuable knowledge beyond the firm's traditional boundaries (Chesbrough & Crowther, 2006). Furthermore, Chesbrough (2003) points out several 'erosion factors' such as the increasing mobility of skilled workforce, the growing presence of venture capital and the convergence of technologies and markets, that have urged organizations to look beyond the traditional way of innovating. In this context, the open innovation paradigm offers organizations the opportunity to overcome internal innovation barriers by unleashing valuable knowledge from outside the firm's corporate boundaries. Such increased interaction with external partners in the context of innovation has been shown to be an effective complement to more closed R&D model (Herzog, 2011).

Among the many existing approaches to engage in open innovation, such as strategic alliances and co-creation, crowdsourcing for innovation has gained considerable traction especially since it has emerged as a powerful tool in the innovation processes of organizations. Complemented by the emergence of the Web 2.0 that has enabled

organizations, individuals and societies to connect and collaborate easily (Vukovic, 2009; Zhao & Zhu, 2014b), crowdsourcing has become a popular problem solving approach, attracting firms to access an external pool of expertise, knowledge, and creativity to address internal challenges at substantially lower costs (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Jeppesen & Lakhani, 2010). In recent years, many organizations have resorted to crowdsourcing-based business models to respond to advancing technologies, evolving market trends, and to accelerate overall innovation capabilities (Kohler, 2015). In fact, a recent industry report indicates that over the past decade, 85% of the most renowned global brands have integrated crowdsourcing initiatives into their innovation processes (eYeka, 2015).

As initially introduced by Howe (2006), the underlying notion of crowdsourcing is that an organization outsources a task to a large, undefined, external group of individuals in the form of an open call. Since the term was first coined, crowdsourcing has evolved into a complex, multidisciplinary phenomenon with applications in a variety of domains, such as computer science, public health, disaster and crisis management, information technology, software testing, business and management (Afuah & Tucci, 2012; Brabham, 2008; Gao, Wang, & Barbier, 2011; Hossain, 2015; Zogaj, Bretschneider, & Leimeister, 2014). In the context of this thesis, I specifically focus on innovation contests, also known as broadcast search or tournament-based crowdsourcing (Afuah & Tucci, 2012; Terwiesch & Xu, 2008). Such innovation contests are typically used to solve complex, challenging innovation problems by addressing a large network of potential external contributors (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Jeppesen & Lakhani, 2010). Individuals that are interested in developing solutions have the opportunity to self-select into participating and compete with other contestants to generate solutions. Ultimately, the best solution(s) are selected and rewarded by the seeking firm, typically in the form of monetary rewards (Afuah & Tucci, 2012; Blohm, Zogaj, Bretschneider, & Leimeister, 2018).

The primary benefit of such innovation contests lies in the opportunity to mobilize external knowledge that is otherwise dispersed and to gain access to expertise and

competencies beyond the corporate boundaries of an organization (Blohm, Leimeister, & Krcmar, 2013). A well-known example of an innovation contest is the Goldcorp Challenge, when Goldcorp announced a $575,000 award to anyone who could locate the gold deposits in the Red Lake in Ontario. 110 potential sites were identified by participants across the globe, yielding a total of 8 million ounces. The company estimated that the challenge saved three years of exploration time, and increased revenues by about 170% (Brabham, 2008; Wilson, 2013). Other popular examples of enterprises using crowdsourcing contests for innovation include, Procter & Gamble to grow their product portfolio (Ozkan, 2015), Netflix to improve their movie recommendation system (Villarroel, Taylor, & Tucci, 2013), and Merck to identify promising chemical compounds for future testing (Boudreau & Lakhani, 2013).

Despite the growing significance and widespread adoption of crowdsourcing contests in practice, our understanding of the overarching design and configuration of such initiatives remains rather limited. Although crowdsourcing has received significant attention in academia over the past decade, extant research has primarily adopted a micro-approach, focusing on individual aspects of crowdsourcing design, such as the motivation of crowd members to participate (Leimeister, Huber, Bretschneider, & Krcmar, 2009; Zhao & Zhu, 2014a), certain attributes of the underlying task (Nakatsu, Grossman, & Iacovou, 2014; Zheng, Li, & Hou, 2011), and communication and feedback mechanisms (Piezunka & Dahlander, 2019; Schäfer, Antons, Lüttgens, Piller, & Salge, 2017). To this end, the current literature on crowdsourcing lacks a comprehensive perspective on crowdourcing design. In a recent study, Neto & Santos (2018) point out that an integrative, conceptual framework representing the important design facets has yet to be established. Amrollahi (2015, p.2) further argues that the "crowdsourcing literature lacks a comprehensive guideline through which practitioners can initiate and manage their crowdsourcing projects." This highlights the central role of the design aspect of crowdsourcing projects. Since designing a crowdsourcing campaign entails multifold interrelated decisions, a thorough understanding of the key design decisions, and more importantly, how these decisions interact to influence the outcome of the project is essential for managers when initiating such projects. The central research

questions derived from this gap in the crowdsourcing literature therefore are: Which key decisions must crowdsourcing managers consider during the design process of a crowdsourcing initiative? In particular, how do these decisions influence the performance of the project? Hereby, the goal of this thesis is to address these questions by developing an integrative, macroscopic overview of the various design facets involved in crowdsourcing campaigns, highlighting key interdependencies and design recommendations, such that managers can make more informed decisions when operationalizing such projects.

The three research articles presented in this thesis seek to address the aforementioned deficits and contribute to advancing the crowdsourcing literature in several ways: the first paper in this thesis reviews the state-of-the-art in the crowdsourcing literature to present a novel approach to conceptualize the overall design of crowdsourcing campaigns. Next, the second research paper explores various design complexities involved in developing effective crowdsourcing campaigns, and seeks to investigate the key interdependencies between these design-related decisions. Finally, the third research study goes one step further to empirically assess the central role of certain task-related decisions on crowdsourcing performance. In addition to the contribution to crowdsourcing literature, the results of this thesis also have significant practical ramifications, providing valuable insights for practitioners and managers engaging in crowdsourcing projects.

1.2 Research Context and Research Questions

Research on crowdsourcing has gained tremendous interest and momentum in recent years with applications in a variety of domains (Afuah & Tucci, 2012; Brabham, 2008; Gao et al., 2011; Hossain, 2015; Zogaj et al., 2014). In particular, crowdsourcing contests for innovation have become an integral part of the innovation processes within organizations (Blohm et al., 2018; Boudreau & Lakhani, 2013; Kohler, 2015; Terwiesch & Xu, 2008). However, from a design perspective, much research has focused on examining the impact of individual design parameters on the participation behaviour of

individuals in innovation campaigns. These parameters include the motivation of crowd members to participate (Brabham, 2010; Leimeister et al., 2009; Zhao & Zhu, 2014a), certain aspects of task design (Nakatsu et al., 2014; Zheng et al., 2011), duration of the contest and size of the network (Ayaburi, Lee, & Maasberg, 2020; Muhdi, Daiber, Friesike, & Boutellier, 2011; Boudreau, Lacetera, & Lakhani, 2011), and intermediary-based crowdsourcing models (Colombo, Buganza, Klanner, & Roiser, 2013; Diener & Piller, 2013; Leicht et al., 2016). Although these aspects are highly relevant in the context of designing a crowdsourcing campaign, the current literature lacks a comprehensive integrative perspective on the different key design facets and decisions involved in designing and operating crowdsourcing projects (Amrollahi, 2015; Neto & Santos, 2018; Zheng et al., 2011). As a result, our comprehension of the various design complexities and interdependencies involved in developing effective crowdsourcing campaigns remains limited thus far.

A second shortcoming is that extant research has primarily focused on the solver perspective, examining the different factors that motivate external individuals to engage in innovation contests. While the participation of individuals is detrimental to the success of crowdsourcing initiatives, limited attention has been paid to the seeker perspective of crowdsourcing design. Designing a crowdsourcing project encompasses various interrelated design decisions depending on the nature and type of the innovation problem to be solved. Adamczyk et al. (2012) highlight that the design of an innovation contest must be tailored for its individual purpose, and therefore seeking firms must consider the different design parameters when configuring crowdsourcing projects. More importantly, these various design choices combined play a significant role in providing the necessary information to external individuals, who subsequently interpret this information, to submit solutions to innovation challenges. Pollok et al. (2019a) further argue that crowdsourcing firms can influence the perceived uncertainty and hence the participation of solvers by taking certain decisions during the design phase of the contest. In this context, adopting a seeker perspective to develop a profound understanding of these different design parameters is a crucial aspect that deserves more attention.

Third, although extant research has investigated different factors that motivate the crowd to participate in innovation contests (Acar, 2019; Ghezzi, Gabelloni, Martini, & Natalicchio, 2018; Lee, Chan, Ho, Choy, & Ip, 2015; Leimeister et al., 2009; Zhao & Zhu, 2014a), surprising little is known about how certain decisions taken when articulating the problem statement play a role in motivating solvers to contribute in innovation contests. In a recent review on crowdsourcing, Ghezzi et al. (2018) point out that "one of the main issues in crowdsourcing is to define the structure of the innovation problems to be broadcast to the pool of solvers." To this end, limited prior studies have empirically investigated how certain attributes of the task contribute to solvers' decisions to participate and submit solutions in innovation contests (Ghezzi et al., 2018). As a result, our understanding of the impact of certain decisions taken when delineating and communicating the problem statement on crowdsourcing performance remains limited.

Despite the significance and increasing prevalence of innovation contests in practice, organizations continue to face many managerial challenges in effectively executing such projects and capturing adequate value (Boudreau & Lakhani, 2013; Jeppesen & Lakhani, 2010; Sieg, Wallin, & Krogh, 2010). On the one hand, the seeking firm must motivate the crowd to develop solutions (Acar, 2019; Zhao & Zhu, 2014a; Zheng et al., 2011), and on the other hand, the crowdsourcing firm must ensure that it can implement and capture value from the crowdsourced solutions (Blohm et al., 2013; Ghezzi et al., 2018). Therefore, when setting up and planning crowdsourcing initiatives, firms must consider these two central aspects, which in turn, requires crowdsourcing managers to make informed decisions that account for these aspects. As such, the scope of the design of a crowdsourcing challenge refers to the complete set of decisions managers must address when designing a crowdsourcing contest. In this context, the aim of this thesis is to overcome these shortcomings and close the research gap of a lacking framework for crowdsourcing project design by offering an approach to systematically conceptualize the overall design of crowdsourcing campaigns. In doing so, this study seeks to contribute towards a better understanding of the key design parameters, and more importantly, how crowdsourcing projects can be effectively designed and managed, such

that firms can capture value from such projects. This thesis consists of three self-standing research papers rooted in the design and operationalization of innovation contests, each of which seeks to respond to the research deficits outlined above.

The first research paper focuses on establishing a comprehensive overview of the various crowdsourcing design parameters. This paper responds to the many calls for research regarding the 'lack of standardization' and the need for a 'comprehensive guideline' to better structure and manage crowdsourcing projects (Amrollahi, 2015; Ghezzi et al., 2018; Neto & Santos, 2018; Zheng et al., 2011). Based on a systematic literature review, this paper develops a novel conceptual configuration to present an integrated overview of the 20 key design elements that are crucial to crowdsourcing project design. In particular, a morphological analysis is used to facilitate the possibility of choosing different combinations for each design parameter, best suited to the goals of the problem to be crowdsourced. Corresponding to the lack of a comprehensive framework and guideline, this paper seeks to address the following research questions:

Research Question 1a: Which design decisions must crowdsourcing managers take during the design process of a crowdsourcing initiative in order to both motivate the crowd to develop solutions, and to ensure that the solutions can be implemented and provide value to the crowdsourcing firm?

Research Question 1b: What are the attributes that managers can choose from within these design-related decisions?

The second research paper builds on the previously established morphological framework to empirically investigate the configuration of crowdsourcing projects in practice. In particular, this paper adopts a 'clinical' case study approach to get first-hand insights about the rationale behind the key decisions made taken when setting up crowdsourcing campaigns. Adopting a seeker perspective, this paper further explores the various design complexities and more importantly, highlights some key interdependencies that emerge, such that certain decisions taken early on influence subsequent design parameters. Addressing the lack of research from the lens of the seeking firm, a decision-centric approach is proposed to better structure crowdsourcing

campaigns into the main decision dimensions, which together provide a comprehensive basis for delineating the different decisions elements. As such, this paper seeks to address the following research questions:

Research Question 2a: Which different design decisions of a crowdsourcing project need to be considered for gaining a more comprehensive understanding of crowdsourcing campaigns?

Research Question 2b: What interdependencies exist between these design-related decisions?

The third research papers builds on some of the major propositions of the previous paper, and thereby seeks to explore the central role of the task description in solvers' decisions to contribute and develop solutions. Since solver participation is critical to the success of crowdsourcing initiatives (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Ghezzi et al., 2018), this paper investigates the relationship between the delineation of the underlying task and crowdsourcing performance. Drawing on a rich dataset of 392 ideation campaigns, this paper seeks to better understand how certain signals provided through the task description influence solvers decisions to engage in innovation contests. In particular, three central components of the task are assessed, which are the task specificity, the task complexity and the communicated innovation ambition of the seeking firm. In doing so, this study addresses one of the most prominent gaps in the literature, in terms of how crowdsourcing firms can attract and motivate the crowd to develop solutions. To bridge this gap, the following research questions are answered:

Research Question 3a: How can innovation problems be delineated in order to improve solver participation in crowdsourcing contests?

Research Question 3b: How do certain characteristics of the task influence solvers' decisions to submit solutions?

Combined, the three research papers contribute to a profound understanding of the key design parameters of a crowdsourcing campaign. Further, by offering an approach to conceptualize the various design complexities and interdependencies, this thesis seeks

to provide a thorough account on how crowdsourcing projects can be effectively designed and managed, such that firms can capture value.

1.3 Research Methods and Empirical Setting

To address the aforementioned research questions, this doctoral thesis employs a combination of research methods. In the context of the first research paper, a systematic literature review was conducted to identify and analyze the various design facets of a crowdsourcing initiative. Since the primary objective of this study was to develop a profound understanding of the different aspects that contribute to the design and operationalization of crowdsourcing projects in practice, a systematic literature review is an appropriate research method for extracting and synthesizing the literature to develop a comprehensive understanding and overview of a given field of research (Webster & Watson, 2002). Moreover, it allows for a structured analysis of previous work done in a field, by evaluating and assimilating extant research using a concept-centric approach. Through this analysis, 20 key design elements were extracted and organized into a conceptual framework. In particular, a morphological framework was used to present a concrete, holistic overview of the key design facets. This provides the possibility of choosing different combinations for each design parameter, best suited to the goals of the problem to be crowdsourced. Hereby, this paper responds to the various calls for research on a lacking framework and answers the central research questions of which key design elements must be considered in the context of crowdsourcing project design, and more importantly, highlights the different attributes that managers can choose from within these design-related decisions.

To address the second research question of how crowdsourcing campaigns are operationalized in practice, a multiple case study research approach was used to empirically investigate three distinct crowdsourcing projects. In particular, a 'clinical' case study method was used to better understand what design options were chosen for each project, their interdependencies, and most importantly, to inform us about the

rationale behind the different design decisions taken when setting up a crowdsourcing project. To explore the different decisions made and the fundamental interdependencies between different decisions, experienced managers across the three projects were interviewed to gather first-hand information about the projects. Using such a case study approach is particularly suitable for research in new areas, with the underlying objective to explore a phenomenon in its natural setting to enrich and build theory (Eisenhardt, 1989). Moreover, this provided the opportunity to dig deeper into the individual cases to enhance the overall understanding of how crowdsourcing projects are designed in reality. The template analysis technique was used to identify themes, patterns, similarities and differences across the cases, and to structure content that was generated from the conducted interviews (King, 2012). Building on the previously established morphological framework, the different configurations of the cases are illustrated to show potential interdependencies. Finally, propositions are developed based on the key findings derived from the interviews. In doing so, this study addresses the central research question of which different design decisions of a crowdsourcing project need to be considered for gaining a more comprehensive understanding of crowdsourcing campaigns.

The third and final research article adopts a quantitative research approach to empirically explore the relationship between the delineation of the problem statement and its impact on crowdsourcing performance. Building on the propositions developed in the previous study, three fundamental design aspects of the underlying task are examined: task complexity, task specificity, and the innovation ambition of the seeking firm. Drawing on a rich dataset of 392 ideation campaigns conducted on InnoCentive, one of the leading crowdsourcing intermediary platforms worldwide, the goal of this study is to investigate the impact of the three aforementioned crucial design facets on crowdsourcing performance. This study focuses on ideation challenges, which primarily focus on generating ideas to problems, without solvers having to develop concrete prototypes. In order to collect information on the three primary (independent) variables of interest, the complete challenge statements were used. Further, crowdsourcing performance (dependent variable) is measured in terms of the ratio of the submitted solutions to the total number of interested solvers per challenge. In particular, a

hierarchical regression was conducted to test the research hypotheses and to investigate the impact of the three design attributes of the task on crowdsourcing performance. Using such an approach allows to iteratively add variables of interest and to determine their distinct effect on the dependent variable. Through employing various hierarchical regression models, the independent variables of interest can be assessed in terms of the additional amount of variance explained through gradually adding them in the statistical analysis. Hereby, this study seeks to answer the underlying research questions of how innovation problems can be delineated in order to improve solver participation in crowdsourcing contests, and more specifically, how certain characteristics of the task might influence solvers' decisions to submit solutions.

Table 1.1 provi des a brief overview of the three research papers, each of which address the research deficits previously outlined. The table below further highlights the respective research questions addressed, the methodology employed to collect and analyze the data, and the key contributions of each of the papers.

Research Paper	I	II	III
Title	Understanding Crowdsourcing Projects: A Review on the Key Design Elements of a Crowdsourcing Initiative	A Morphological Approach towards Crowdsourcing Project Design: A multiple Case Study	Designing Crowdsourcing Contests for Ideation: Investigating the Relationship between Task Delineation and Crowdsourcing Performance
Research Gap	Lack of a conceptual integrative framework that represents the crucial design elements of a crowdsourcing project	Limited understanding of the complexities and interdependencies between the key crowdsourcing design facets	Lack of empirical evidence of the impact of certain task-related design decisions on solver motivation to contribute ideas
Research Questions	• Which decisions must firms take during the design process of a crowdsourcing initiative in order to motivate the crowd to develop solutions and to ensure that the solutions can add value to the firm? • In particular, what are the attributes that managers can choose from within these design decisions?	• Which different design decisions of a crowdsourcing project need to be considered for gaining a more comprehensive understanding of crowdsourcing campaigns? • What interdependencies exist between these design-related decisions?	• How can innovation problems be delineated in order to improve solver participation in crowdsourcing contests? • In particular, how do certain characteristics of the task contribute to solvers' intrinsic and extrinsic motivation to submit solutions?
Methodology	• Qualitative • Systematic Literature Review	• Qualitative • Multiple Case Study Design	• Quantitative • Regression Analysis (hierarchical ordinary least squares)
Key Contributions	• 20 key crowdsourcing design elements identified and extracted through the systematic literature review • Morphological approach to synthesize and organize the key findings and design facets from the literature review • Provides an integrative overview and serves as a comprehensive guideline for crowdsourcing campaign design	• Develops a decision-centric approach to conceptualize the overall design space in crowdsourcing campaigns • Uses first-hand data to understand the rationale behind the various design choices • Indicates a certain hierarchy and highlights key interdependencies between the design elements	• Investigates the relationship between task delineation and contest performance • Examines the impact of three task-related design elements on campaign performance (task complexity, specificity and innovation ambition) • Highlights design complexities and provides suggestions to design ideation contests
Submission	• Accepted and presented at the IPDMC, 2020 • Accepted at Creativity and Innovation Management	• Submitted to Technological Forecasting and Social Change	• Accepted and presented at the Open and User Innovation Conference, 2021

Table 1.1: Submission Status

1.4 Structure of the thesis

This thesis is organized into five chapters as indicated below in Figure 1.1. The first chapter provides an introduction to crowdsourcing in the context of innovation and outlines the research motivation and scope of this thesis. Further, the chapter presents a review on the core literature, defines the research questions addressed in the respective research papers, and outlines the overarching structure of the thesis. Chapters two through four comprise the three individual research papers, which is the core of this thesis. Finally, chapter five concludes with a discussion of the major findings in each research paper, highlights the key theoretical and managerial implications, and provides avenues for further research.

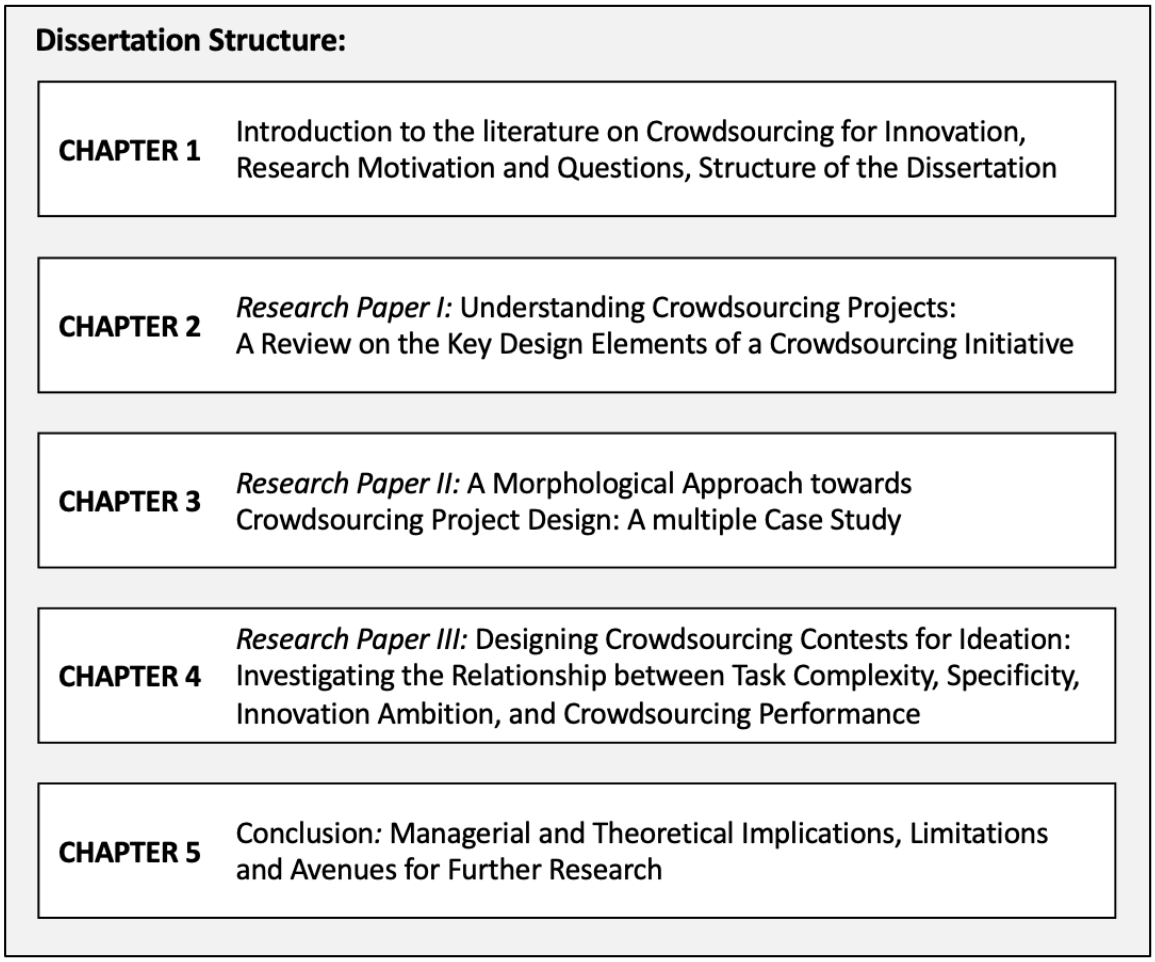

Figure 1.1: Overarching structure of the thesis

Chapter 2

Understanding Crowdsourcing Projects: A Review on the Key Design Elements of a Crowdsourcing Initiative (Paper I)

This is the accepted manuscript of Karachiwalla, R., and Pinkow, F. (2021) - Understanding crowdsourcing projects: A review on the key design elements of a crowdsourcing initiative. Creativity and Innovation Management, 1-22.

Published version available under: https://doi.org/10.1111/caim.12454

Abstract

Crowdsourcing has gained considerable traction over the past decade, and has emerged as a powerful tool in the innovation process of organizations. Given its growing significance in practice, a profound understanding of the concept is crucial. The goal of this study is to develop a comprehensive understanding of designing crowdsourcing projects for innovation by identifying and analyzing critical design elements of crowdsourcing contests. Through synthesizing the principles of the social exchange theory and absorptive capacity, this study provides a novel conceptual configuration that accounts for both the attraction of solvers and the ability of the crowdsourcer to capture value from crowdsourcing contests. Therefore, this paper adopts a morphological approach to structure the four dimensions (i) task, (ii) crowd, (iii) platform, and (iv) crowdsourcer into a conceptual framework, to present an integrated overview of the various crowdsourcing design options. The morphological analysis allows the possibility of identifying relevant interdependencies between design elements, based

on the goals of the problem to be crowdsourced. In doing so, the paper aims to enrich the extant literature by providing a comprehensive overview of crowdsourcing, and to serve as a blueprint for practitioners to make more informed decisions when designing and executing crowdsourcing projects.

Keywords: *Crowdsourcing contest, literature review, morphological framework, open innovation, social exchange theory, absorptive capacity, crowdsourcing design*

2.1 Introduction

Innovations are considered a cornerstone of achieving and maintaining competitive advantage (Salomo et al., 2008). However, the ways how organizations innovate experienced fundamental changes in the last two decades. Enkel et al. (2009) highlight that many organizations are compelled to shift their focus from exclusive internal research and development (R&D) to cooperation with external partners. This understanding is rooted in the open innovation paradigm coined by Chesbrough (2003). The concept of open innovation assumes that knowledge is widely distributed, and organizations seeking external knowledge for their own innovation purposes engage in open innovation practices (Chesbrough & Bogers, 2014). Chesbrough and Bogers (2014) thereby explicitly highlight that the rise of the Internet contributes to an ongoing paradigm shift in innovation.

The emergence of Web 2.0 has enabled enterprises, people and societies across the globe to connect and collaborate easily (Vukovic, 2009; Zhao & Zhu, 2014b). In this context, crowdsourcing has emerged as an effective problem solving approach, attracting firms to tap into a global pool of expertise, knowledge and creativity at substantially lower costs (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Jeppesen & Lakhani, 2010; Vukovic, 2009). Over the past decade, many organizations have benefited from crowdsourcing-based business models to solve internal problems, adapt to rapidly evolving customer needs, shorten product lifecycles, and to increase overall innovation efficiency (Brabham, 2008; Kohler, 2015).

Since the term was first coined by Howe (2006), crowdsourcing has emerged as a complex, multidisciplinary concept with applications in a wide variety of domains, including computer science, public health, disaster and crisis management, information technology, engineering, business and management (Afuah & Tucci, 2012; Brabham, 2008, 2009; Hossain, 2015; Gao et al., 2011). Crowdsourcing for innovation primarily refers to innovation contests, also called tournament-based crowdsourcing or broadcast search (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Terwiesch & Xu, 2008).

Innovation contests are typically used to solve innovative, challenging, or creative problems in the form of an open call to large network of potential contributors (Afuah & Tucci, 2012; Blohm et al., 2018; Boudreau & Lakhani, 2013; Jeppesen & Lakhani, 2010). In such contests, contributors self-select into participating, and compete with each other to generate the best solution(s). Consequently, the best solution(s) are awarded by the seeking firm, typically in the form of monetary awards (Afuah & Tucci, 2012; Blohm et al., 2018). The primary essence of such contests lies in mobilizing knowledge and expertise that is otherwise distributed among the crowd, to obtain novel solutions beyond the traditional boundaries of an organization (Blohm et al., 2013).

Despite the widespread adoption of crowdsourcing and the many advantages it offers, there are many managerial challenges in running crowdsourcing contests, and consequently many companies do not use the crowd effectively (Boudreau & Lakhani, 2013). In particular, managers are concerned about executing crowdsourcing challenges at reasonable costs, that deliver appropriate solutions which are ultimately implementable in their organizations (Acar, 2019; Afuah & Tucci, 2012; Boudreau & Lakhani, 2013). Addressing these managerial challenges, the plethora of literature on crowdsourcing evolves around two central aspects. On the one hand, a crowdsourcer must, in the first place, motivate the crowd to develop solutions (Acar, 2019; Zhao & Zhu, 2014a; Zheng et al., 2011), and, on the other hand, the crowdsourcing firm must ensure that it can implement and capture value from the crowdsourced solutions (Blohm et al., 2013; Ghezzi et al., 2018).

Therefore, when setting up and planning a crowdsourcing initiative, crowdsourcing firms must consider these two central aspects, which requires crowdsourcing managers to make informed decisions that account for both aspects. In the course of this study, we define these decisions, that relate to both crowd motivation or engagement, and capturing value, as design-related decisions. The scope of the design of a crowdsourcing challenge thus refers to the complete set of decisions managers must address when designing a crowdsourcing contest. In this context, crowdsourcing research often focuses on individual crowdsourcing design elements, such as the motivation of crowd members (Leimeister et

al., 2009; Zhao & Zhu, 2014a), task design (Nakatsu et al., 2014; Zheng et al., 2011), and communication and feedback mechanisms (Camacho, Nam, Kannan, & Stremersch, 2019; Piezunka & Dahlander, 2019; Schäfer et al., 2017). However, these studies have primarily focused on addressing single or specific design elements, without developing an integrated picture of the overall crowdsourcing system. As a result, there is still a lack of standardization for designing crowdsourcing projects, and a conceptual framework representing the important elements has yet to be established (Neto & Santos, 2018; Zheng et al., 2011). Amrollahi (2015, p.2) also points out that the "crowdsourcing literature lacks a comprehensive guideline through which practitioners can initiate and manage their crowdsourcing projects." As emphasized in the context of innovation contests by Adamczyk et al. (2012), the design of a contest must be tailored for its individual purpose. As such, from a practical standpoint it is crucial to have a comprehensive and standardized blueprint, which allows to efficiently address the elaborated managerial challenges when setting up crowdsourcing contests.

The central research question derived from this gap in crowdsourcing literature therefore is: Which design decisions must crowdsourcing managers consider during the design process of a crowdsourcing initiative in order to both motivate the crowd to develop solutions, and to ensure that the solutions can be implemented and provide value to the crowdsourcing firm? In particular, what are the attributes that managers can choose from within these design-related decisions? In consideration of the two central managerial challenges, attracting the crowd and capturing value from crowdsourced solutions, we seek to answer this call for research through synthesizing existing research results on crowdsourcing design. This paper is organized as follows. First, we elaborate on two major theoretical considerations that conceptually relate to the derived managerial challenges and that outline the central dimensions along which design-related decisions must be taken. To identify the concrete design-related decisions, we conducted a systematic literature review in order to capture a comprehensive overview of the current state of research in the field of crowdsourcing. As a result, a decision-centric overview of design elements for crowdsourcing contests for innovation is developed, discussed, and promising avenues for future research based on the findings

are presented.

2.2 Conceptual Background

2.2.1 Defining Crowdsourcing Contests for Innovations

As proposed originally by Howe (2006), the underlying premise of crowdsourcing is that an organization outsources a task to a large, undefined, external group of individuals in the form of an open call. In the context of crowdsourcing for innovation, the crowd typically solves problems through creating prototypes, contributing ideas in ideation contests, or developing intellectual property for crowdsourcing firms. Thereby, the individual solvers who decide to develop a solution compete with each other. Since its emergence, research on crowdsourcing has identified a range of elements defining the process of crowdsourcing for innovations. A common denominator in the vast majority of crowdsourcing literature is that the crowdsourcing environment encompasses four fundamental dimensions, that Hosseini et al. (2014) classify as the four fundamental pillars of crowdsourcing: the crowdsourcing firm, the crowdsourced task, the crowd, and the system or platform used to connect the crowd and the crowdsourcing firm (Afuah & Tucci, 2012; Brabham, 2008, 2009; Estellés-Arolas & González-Ladrón-de Guevara, 2012; Kazman & Chen, 2009; Pedersen et al., 2013; Vukovic, 2009).

Assuming this classification of the crowdsourcing environment, many of the characteristics of crowdsourcing challenges that have already been identified in the extant crowdsourcing literature can be subsumed under these four pillars, or dimensions, of crowdsourcing. For instance, the task dimension includes certain characteristics such as the task specificity and the degree of the idea elaboration (Leimeister et al., 2009), or the task definition (Blohm et al., 2018). The crowdsourcing firm is characterized, for instance, by factors contributing to the quality assurance concerning the received solutions (Blohm et al., 2018), or how firms evaluate the submitted ideas from the crowd (Muhdi et al., 2011). The crowd, in turn, can be characterized by the type of target

group the crowdsourcer seeks to address (Leimeister et al., 2009), which determines the specific skills and knowledge the crowd requires to develop solutions (Blohm et al., 2018). Against this backdrop, the four fundamental pillars of crowdsourcing are considered a robust classification of the crowdsourcing environment, encompassing four distinct dimensions that allow to clearly distinguish and categorize a vast majority of more specific characteristics of crowdsourcing. In the following, we will use these four dimensions to derive their linkage to the stated two central managerial challenges for conducting crowdsourcing challenges.

2.2.2 Motivating and Encouraging the Crowd

The fundamental mechanism that enables successful crowdsourcing initiatives is the participation of individual crowd members. Therefore, crowdsourcing firms must convince the crowd to develop solutions by conveying the task to be solved through a suitable platform. Thereby, the crowdsourcing firm and the solvers engage in an exchange process - the solvers put effort into developing solutions and expect to receive rewards for their efforts. This exchange process reflects the basic notion of the social exchange theory introduced by Blau (1964). The exchange process hereby "refers to voluntary actions of individuals that are motivated by the returns they are expected to bring and typically do in fact bring from others" (Blau, 1964, p. 91). In a crowdsourcing context, potential solvers screen the task provided by the crowdsourcing firm and evaluate both the expected benefits and the related costs.

In fact, previous research on crowdsourcing participation primarily focuses on factors motivating the crowd to participate. Individuals may be motivated to develop solutions based on intrinsic motives such as altruism, working on an interesting project, being creative, or demonstrating their skills (Afuah & Tucci, 2012; Garcia Martinez, 2017; Schäper, Foege, Nüesch, & Schäfer, 2021). These intrinsic motivators illustrate that crowdsourcing is not exclusively an economic relationship and exchange process (Allon & Babich, 2020). Solvers may enjoy the very process of developing solutions merely based on the required creativity and the individual autonomy to solve the given

problems (Garcia Martinez, 2017). While intrinsic motivation plays a central role for crowdsourcing participation, crowdsourcing firms also offer extrinsic motivation by providing monetary rewards for the best solution(s) (Afuah & Tucci, 2012). Solvers who provide solutions hence provide knowledge and ideas in return for an expected outcome, which can be either monetary or non-monetary (Afuah & Tucci, 2012). Ye and Kankanhalli (2017) acknowledge the central role of motivators for the crowd to engage in this exchange process, but highlight the lack of research on possible deterrents of participation, and thus introduce the social exchange perspective to the context of crowdsourcing. More specifically, individuals who develop solutions also face costs in terms of required time and effort. Ultimately, individuals only engage in developing solutions when they expect a positive net reward from a cost-benefit analysis (Ye & Kankanhalli, 2017), which is reflecting the central notion of the social exchange theory (Blau, 1964).

Hereby, the description of the task to be crowdsourced provides the relevant information for solvers to create solutions, and conveys potential motivators and costs. This constitutes the central interdependence required for a social exchange process - the outcome (the solutions developed by the crowd) depends on both (i) the crowdsourcing firm through providing a sufficiently detailed task description and defining solution requirements, and (ii) the knowledge and skills of the crowd to interpret the task and to develop solutions. This interdependence is a fundamental requirement of social exchange (Cropanzano & Mitchell, 2005). We build on the argumentation provided by Ye and Kankanhalli (2017) and seek to identify the factors in a crowdsourcing contest that determine the benefits and costs of the participating solvers which must be considered during the design phase of a crowdsourcing campaign. In particular, this highlights that the crowdsourced task must be sufficiently delineated in order to provide adequate information to potential solvers. Applying the social exchange perspective further emphasizes that managers must not only take extrinsic motivators, in terms of monetary awards, into consideration, but must deliberately determine which potential intrinsic motivation, and which costs, the task description conveys to the crowd. This theoretical perspective thereby captures and motivates three of the fundamental pillars of

crowdsourcing, that are the communication of the crowdsourced task, which provides the required information for the cost-benefit analysis, and thus conveys motivational and cost factors to the crowd through a chosen crowdsourcing platform.

2.2.3 Capturing Value from Crowdsourced Ideas and Solutions

Besides the elements that support attracting potential solvers to develop solutions, firms must also take into account that the crowdsourced solutions ultimately should provide value to the firm (Cappa, Oriani, Pinelli, & Massis, 2019). Malone et al. (2010) raise the central question of why crowdsourcers engage in crowdsourcing projects in the first place, emphasizing the need to define how solutions can eventually be utilized to provide value. Recent crowdsourcing research therefore increasingly focuses on the absorptive capacity of organizations in the context of crowdsourcing (e.g. Afuah & Tucci, 2012; Boons & Stam, 2019; Gassenheimer, Siguaw, & Hunter, 2013; Ruiz, Brion, & Parmentier, 2020).

In its core, absorptive capacity relates to an organization's ability to recognize the value of external information, the assimilation of said value, and the implementation and application to commercial ends (Cohen & Levinthal, 1990). In the context of crowdsourcing, absorptive capacities can include the platform that is used to connect the crowdsourcer and the crowd, filtering processes that enable the crowdsourcer to exclude weak solutions quickly, establishing information exchange processes between the crowd and the crowdsourcer, and attracting a critical mass of contributors (Blohm et al., 2013). Furthermore, gaining crowdsourcing experience and thereby creating knowledge on how to conduct crowdsourcing projects ultimately can positively affect the absorptive capability for future crowdsourcing projects and knowledge exchange processes (Pollok, Lüttgens, & Piller, 2019b).

These approaches to build absorptive capacities to capture value from crowdsourcing demonstrate that this is primarily the task of the crowdsourcing firm. Given the solutions provided by the crowd are contingent on the description of the crowdsourcing task, the crowdsourcer can already account for creating absorptive capacities during the design phase of a crowdsourcing contest. As such, defining certain success metrics to evaluate

solutions (Ford, Richard, & Ciuchta, 2015), estimating the costs of required resources such as personnel (Muhdi et al., 2011), and deliberate risk management (Liu, Xia, Zhang, Pan, & Zhang, 2016) can positively contribute to crowdsourcing success. These exemplary issues facilitate to receive solutions that ultimately can provide value to the crowdsourcing firm. We hereby emphasize the importance of the early design phase of a crowdsourcing contest to determine whether a firm can benefit from the received solutions. Moreover, this consideration goes beyond the scope of the introduced exchange process between the crowd and the crowdsourcer. Crowdsourcing firms have to determine internal organizational factors, that are not directly linked or perceived by the crowd, but that contribute to the ability to capture value. For instance, firms must determine the internal costs of executing a crowdsourcing campaign, and subsequently determine whether the expected benefits of the solutions exceed the internal costs. This cost-benefit analysis is a prerequisite for firms to ultimately capture value from crowdsourcing. This second theoretical perspective relates to two of the mentioned pillars of crowdsourcing, which are the crowd, in terms of decisions related to which type of crowd to attract, and to the crowdsourcing firm, in terms of internal organizational capacities that enable the firm to capture value.

2.2.4 Theoretical Framework and Contributions

While these distinct theoretical perspectives, the social exchange theory and absorptive capacity, have been investigated separately in the context of crowdsourcing, we aim to integrate these perspectives from both a theoretical and practical point of view. On the one hand, this integration allows to provide design-related implications for crowdsourcing managers to make more informed decisions when designing and executing crowdsourcing projects for innovation by offering a decision-centric blueprint for crowdsourcing challenge design. On the other hand, the synthesis of the different theoretical perspectives - social exchange theory and absorptive capacity - constitutes a novel conceptual approach in crowdsourcing literature. As indicated above, only this integrative perspective allows to address all four fundamental dimensions of crowdsourcing, and thereby captures the two main challenges for crowdsourcing managers to attract and motivate the crowd, and

capture value from crowdsourcing.

Amidst the plethora of literature on crowdsourcing, this conceptual paper is positioned in the context of crowdsourcing contests for innovation. Since Hosseini et al. (2014) elaborate on a general perspective on the four dimensions of crowdsourcing, their categorization seeks to maintain a rather multidisciplinary perspective. With this paper, we refine and enhance the conceptual understanding of crowdsourcing contests, adopting the perspective of the crowdsourcing firm. The central contribution of this perspective to the extant literature is twofold. First, the elaboration of design-related decisions along the four crowdsourcing dimensions contributes to a unitary understanding of the process of designing a crowdsourcing contest. Future research can thus benefit from this refined understanding as further insights on crowdsourcing can be clearly positioned within this framework, resulting in more coherent research designs. Second, the novel conceptual approach emphasizes that in order to advance our understanding of crowdsourcing for innovation, research results must be discussed in the context of all four dimensions. As Ghezzi et al. (2018) outline, there is still need for further research on both the mechanisms that allow firms to effectively integrate solvers' ideas, and practices that enable firms to increase solver participation through intrinsic and extrinsic motivational factors. While investigating factors that impact the extrinsic or intrinsic motivation of the crowd, not relating these factors to the ability of firms to effectively utilize the crowd to create value, or vice versa, fails to address fundamental managerial concerns. This paper therefore provides a groundwork for discussing specific findings in the broader context of the crowdsourcing environment. Furthermore, by adopting a decision-centric approach to conceptualize crowdsourcing project design, this paper highlights the overall design space opportunities available to firms engaging in crowdsourcing for innovation. Since planning and framing a crowdsourcing contest is rather cost-intensive, it is of particular importance to cautiously define all fundamental aspects and decision to be taken (Paik, Scholl, Sergeev, Randazzo, & Lakhani, 2020). This study, therefore, contributes to this central managerial challenge by providing an integrative overview on the different possible campaign configurations for a crowdsourcing initiative.

2.3 Research Methodology

Building on the four pillars of crowdsourcing proposed by Hosseini et al. (2014), we review existing literature and broadly classify previous research into the following four dimensions: 1) the task to be crowdsourced; 2) the crowd; 3) the platform; 4) and the crowdsourcer. Next, individual design elements corresponding to each of the four dimensions are extracted and analyzed. The introduced theoretical background provides further guidance to structure the reviewed literature. Against this backdrop, for example, the motivation of the crowd to participate in a crowdsourcing initiative could be intrinsic, extrinsic or both. In order to consolidate the findings from the literature, a morphological framework considering the different design elements is proposed. The morphological approach accommodates multiple alternative configurations since it allows the possibility of choosing different combinations of attributes for each design element.

This paper uses a systematic literature review as the research method to identify and analyze the different design elements of a crowdsourcing project. A systematic literature review is a structured analysis of previous work done in a field, by evaluating and assimilating extant research using a concept-centric approach (Webster & Watson, 2002). Since prior research has explored individual, specific elements of a crowdsourcing project, a systematic literature review is an appropriate research method for extracting and synthesizing the literature to develop a comprehensive overview of a given field of research. We followed the four essential stages of a systematic literature review (i) plan the review, (ii) conduct search, (iii) extract data, and (iv) report results, as proposed by Okoli & Schabram (2010).

2.3.1 Systematic Review

The first stage of a systematic literature review is to meticulously plan the research strategy. This comprises defining the research questions to be addressed and outlining the search strategy, including identifying appropriate databases, defining search terms, and setting selection criteria for the search. As discussed in the previous section, the goal of

this paper is to develop a profound conceptual understanding of crowdsourcing projects by answering the central research question of which key elements of a crowdsourcing project can be identified in consideration of a holistic perspective on crowdsourcing contests for innovations. In particular, this study aims to develop a comprehensive overview of all aspects that need to be considered when designing a crowdsourcing contest.

Databases: As a preliminary step, suitable databases for the search process were selected. EBSCO Business Source Complete is a leading scholarly business database, with content from over 10.000 well established academic journals. Since the focal point of this paper is to better understand crowdsourcing projects in the business context, this database seemed appropriate. As a second source, the Web of Science database was selected because of its breadth of interdisciplinary research literature from over 30.000 peer-reviewed scientific journals. As a third source, the ABI/Inform was used, since it offers a plethora of research literature on business trends, corporate strategy and management theory, which are relevant for this paper.

Search Terms: In order to get a complete overview of prior work done in the field, we intentionally chose broad keywords. Since this study focuses on exploring crowdsourcing in the context of sourcing innovations, the search terms included *crowdsourc** or *crowd sourc** restricted to business and management literature. This restriction was made in order to exclude other forms of crowdsourcing, such as crowdsourcing for software engineering, and to account for the scope of this study considering the focus on crowdsourcing contests for innovation. In line with Snyder (2019), we developed pre-defined criteria to determine which articles to include in the final analysis from the initial pool of articles that have been identified through searching for the keywords. These criteria include (i) articles that focus on crowdsourcing in the business or management context (not NGO, social context, or non-business organizations), (ii) articles that focus on crowdsourcing innovation contests, (iii) articles must include design elements of the crowdsourcing concept, (iv) primary focus on articles from high quality academic journals (peer-reviewed), and (v) articles within the time frame 2006 (when the term was first coined) until 2021, and (vi) articles written in English.

Conduct Search: As a preliminary step, the keywords *crowdsourc** and *crowd sourc** were used in all three selected databases, applying the following first level criteria: articles published in the time frame January 2006 and April 2021; and articles published in English. This resulted in a total population of 22.178 results. A broad search was intentionally conducted at first, in order to generate a wide range of results, and to get an overview of prior work done in the field. Since this study focuses on understanding crowdsourcing projects in the business and management context specifically, the search was narrowed down by applying the following second level criteria: articles focused on crowdsourcing in the business or management fields; and articles published in academic or scholarly journals. In doing so, the population of articles was reduced to 1.859 articles. The significant reduction in articles shows that there has been comparatively little crowdsourcing research in the business and management context. As a final step, the following third level criteria were applied: articles that focus particularly on innovation contests or tournament-based crowdsourcing; and articles that include at least one dimension or design element. During this step, the relevance of the articles was determined by reading the abstract, introduction, and conclusion, and in some cases by examining the paper. Our search resulted in a total of 94 articles that we identified as eligible for further review, which is accordingly illustrated in the table below.

Database	**First Level Criteria**	**Second Level Criteria**	**Third Level Criteria**
Business Source Complete	3.811	802	38
Web of Science	10.813	477	32
ABI/Inform	7.554	580	24
Total	**22.178**	**1.859**	**94**

Table 2.1: Database Search Results

After removing duplicate papers, a total of 55 articles were left. In order to identify additional relevant articles, a backward and forward search was conducted (Webster & Watson, 2002). In this step, relevant conference papers were additionally included. This yielded another 11 journal and conference articles, resulting in a final pool of 66 articles.

2.3.2 Data Extraction

In this stage, data was extracted from the final pool of articles to identify the different elements of a crowdsourcing initiative. Building on the 'four pillars of crowdsourcing' proposed by Hosseini et al. (2014), the existing literature was first classified and coded into the following four fundamental dimensions of crowdsourcing: 1) the task to be crowdsourced; 2) the crowd; 3) the crowdsourcer; 4) and the platform. For each of the articles, the main findings and corresponding design elements were recorded.

Since the four selected dimensions are relatively broad and contain multiple elements within them (for instance, the task dimension includes different elements such task delineation, task modularity, task granularity), many articles address more than one dimension. It is worth pointing out that a relatively permissive approach was adopted when classifying the literature, meaning that even articles that vaguely related to any crowdsourcing design elements were initially considered. The purpose in doing so was to ensure that the review took into account different findings previously suggested in the literature, in order to develop a comprehensive and cohesive picture of the key design elements of crowdsourcing.

2.3.3 Descriptive Results

Including the final pool of 66 articles, figure 2.1 illustrates the number of publications per year as a result of the systematic literature search. The distribution shows that the number of studies related specifically to crowdsourcing contests for innovation is relatively low, in contrast to the literature in the crowdsourcing field in general. In the first years since the coined was termed, most studies focused on exploring the general crowdsourcing concept and its potential applications in other fields. However, in the past few years, there has been an increasing number of publications per year with regards to crowdsourcing contests, which indicates the growing relevance of crowdsourcing for innovation in the business and management context.

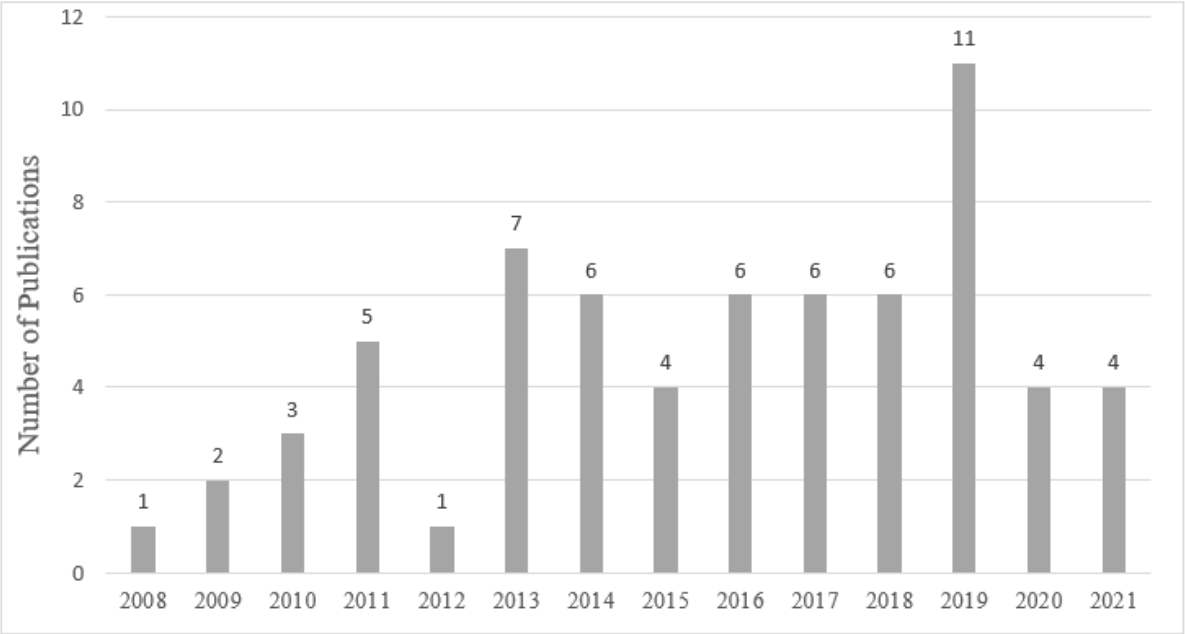

Figure 2.1: Publications per year (Journal and Conference Articles).

As previously mentioned, the articles in the final pool were coded based on the four fundamental dimensions of crowdsourcing. Papers that dwelled upon any of the design elements corresponding to the four dimensions were included. For each of the selected articles, the main findings and corresponding design elements were recorded.

Consistent with prior research, the results show that the task to be crowdsourced is one of the most critical factors influencing the overall success of crowdsourcing projects (Afuah & Tucci, 2012; Blohm et al., 2018; Ghezzi et al., 2018; Gillier, Chaffois, Belkhouja, Roth, & Bayus, 2018; Nakatsu et al., 2014; Zheng et al., 2011). Since the nature and complexity of the task has a significant impact on elements in the other dimensions such as crowd participation, incentive design, and intellectual property mechanisms, effective task design is crucial for crowdsourcing projects. The results of the literature review also demonstrate that the crowdsourcer dimension is highly important for the success of crowdsourcing contests. Since the crowdsourcer is responsible for initiating and operating the project, several key decisions need to be made. For instance, how to manage risk, allocate resources, evaluate and implement crowdsourced ideas. From the crowd perspective, the success of any crowdsourcing project largely depends on the knowledge and diversity, motivation and size of the

crowd. Therefore, crowdsourcing firms must consider the characteristics of the crowd when designing a crowdsourcing project. The platform dimension seems to have received relatively less attention. However some prior studies point out that the decision to set up an own platform, versus contract an intermediary is an important decision for crowdsourcing firms (Ford et al., 2015; Thuan, Antunes, & Johnstone, 2016).

2.4 Literature Synthesis and Analysis

In this section, the results of the literature review are presented and discussed. The first sub-section essentially summarizes prior work related to design elements for innovation contests. Subsequently, the individual design elements are analyzed and discussed in more detail.

2.4.1 Literature Synthesis

A concept-centric approach is used to present a summary of the relevant findings (Webster & Watson, 2002). More specifically, table 2.2 maps the various design elements identified in the literature to the four fundamental dimensions as guided by the introduced theoretical background. As previously mentioned, articles that explicitly dwelled upon any of the design elements corresponding to the four dimensions were coded and included in the context of this study. In the concept matrix below, studies corresponding to each of the design elements are also highlighted. In total, 20 design elements were extracted.

Dimensions	Design-Elements	Sources
Task	Task Delineation (10)	Afuah & Tucci, 2012; Allahbakhsh et al., 2013; Gillier et al., 2018; Hetmank, 2013; Jespersen, 2018; Lee et al., 2015; Muhdi et al., 2011; Natalicchio et al., 2017; Schenk & Guittard, 2011; Thuan et al., 2016
	Task Specificity (13)	Afuah & Tucci, 2012; Christensen & Karlsson, 2019; Colombo et al., 2013; Ghezzi et al., 2018; Hetmank, 2013; Jespersen, 2018; Leimeister et al., 2009; Nakatsu et al., 2014; Natalicchio et al., 2017; Pollok et al., 2019a; Ren et al., 2021; Schenk & Guittard, 2011; Zheng et al., 2011
	Task Granularity (10)	Afuah & Tucci, 2012; Garcia Martinez, 2017; Ghezzi et al., 2018 Lee et al., 2015; Liu, Xia, Zhang, Pan, & Zhang, 2016; Muhdi et al., 2011, Natalicchio et al., 2017; Rouse, 2010; Zhao & Zhu, 2014a; Zheng et al., 2011
	Task Modularity (6)	Afuah & Tucci, 2012; Blohm et al., 2018; Liu, Xia, Zhang, Pan, & Zhang, 2016 Nakatsu et al., 2014; Natalicchio et al., 2017; Pee et al., 2018,
	Solution Requirements (8)	Afuah & Tucci, 2012; Blohm et al., 2018; Ford et al., 2015; Ghezzi et al., 2018 Koh, 2019; Mazzola et al., 2018; Steils & Hanine, 2016; Zheng et al., 2011
	Task Allocation (10)	Afuah & Tucci, 2012; Blohm et al., 2018; Boudreau & Lakhani, 2013; Christensen & Karlsson, 2019 Geiger & Schader, 2014; Hetmank, 2013; Jeppesen & Lakhani, 2010 Leimeister et al., 2009; Piezunka & Dahlander, 2015
	Contest Duration (4)	Ayaburi et al., 2020; P.-Y. Chen et al., 2021; Leimeister et al., 2009 Muhdi et al., 2011
Crowd	Motivation & Incentives (21)	Acar, 2019; Afuah & Tucci, 2012; Blohm et al., 2018; Brabham, 2010; P.-Y. Chen et al., 2021; de Beer et al., 2017; Frey et al., 2011; Garcia Martinez, 2017, Ghezzi et al., 2018; Görzen, 2021; Hanine & Steils, 2019 Jeppesen & Lakhani, 2010; Lee et al., 2015; Leimeister et al., 2009 Li & Hu, 2017; Mazzola et al., 2018, 2020; Pee et al., 2018 Schenk & Guittard, 2011; Zhao & Zhu, 2014a; Zheng et al., 2011
	Knowledge Diversity (8)	Afuah & Tucci, 2012; Blohm et al., 2018; Boons & Stam, 2019; Ford et al., 2015; Frey et al., 2011; Natalicchio et al., 2017; Steils & Hanine, 2016, Thuan et al., 2016
	Size (2)	Afuah & Tucci, 2012; Boudreau et al., 2011;
Platform	Ownership (9)	Blohm et al., 2018; Colombo et al., 2013; Diener & Piller, 2013; Ford et al., 2015; Leicht et al., 2016; Schenk et al., 2019; Thuan et al., 2016, Zhao & Zhu, 2014a; Zogaj et al., 2014
Crowdsourcer	Solution Evaluation (9)	Afuah & Tucci, 2012; Blohm et al., 2013, 2018; L. Chen et al., 2020; Geiger & Schader, 2014; Ghezzi et al., 2018; Mack & Landau, 2020, Muhdi et al., 2011; Piezunka & Dahlander, 2015
	Implementation Potential (5)	Afuah & Tucci, 2012; Blohm et al., 2013; Ford et al., 2015; Lüttgens et al., 2014; Muhdi et al., 2011
	Feedback & Communication(11)	Blohm et al., 2013, 2018; Camacho et al., 2019; Chan et al., 2021; Jian et al., 2019; Leimeister et al., 2009; Muhdi et al., 2011; Piezunka & Dahlander, 2019; Schäfer et al., 2017; Wooten & Ulrich, 2017; Zheng et al., 2014
	Incentives & Awards (11)	Afuah & Tucci, 2012; Blohm et al., 2018; Boudreau et al., 2011; Geiger & Schader, 2014; Lee et al., 2015; Leimeister et al., 2009; Mazzola et al., 2018; Muhdi et al., 2011; Schenk & Guittard, 2011; Zhao & Zhu, 2014a; Zheng et al., 2011
	Resource Planning (9)	Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Ford et al., 2015; Jeppesen & Lakhani, 2010; Lüttgens et al., 2014; Muhdi et al., 2011; Thuan et al., 2016; Vukovic, 2009
	Risk Management (10)	Afuah & Tucci, 2012; de Beer et al., 2017; Ford et al., 2015; Ghezzi et al., 2018; Liu, Xia, Zhang, Pan, & Zhang, 2016; Liu, Xia, Zhang, & Wang, 2016; Nakatsu et al., 2014; Natalicchio et al., 2017; Kannangara & Uguccioni, 2013; Sauerwein et al., 2016
	Legal & Intellectual Property Management (4)	Blohm et al., 2018; de Beer et al., 2017; Foege et al., 2019; Mazzola et al., 2018
	Brand Image & Trust (3	Blohm et al., 2013; Garcia Martinez, 2017; Liu, Xia, Zhang, Pan, & Zhang, 2016
	Success Metrics (2)	Blohm et al., 2013; Ford et al., 2015

Table 2.2: A Morphological Framework of crowdsourcing design elements

2.4.2 Literature Analysis

Task

The task or problem to be crowdsourced is one of the most important aspects of a crowdsourcing initiative. The task is usually the first point of contact between the crowdsourcer and the crowd, based on which solvers decide to self-select into participating or not (Afuah & Tucci, 2012; Steils & Hanine, 2016). Based on an analysis of prior literature, seven essential design elements related to the task dimension are identified and their relevance for the design phase is illustrated in table 2.3.

Task Dimension	**Design-related Relevance**
Task Delineation	Problem and task articulation
	Facilitate interpretation of crowdsourced task
Task Specificity	Defines the scope and solution space of the task
	Determines whether the task requires local or distant knowledge
Task Granularity	Defines the complexity of the task
	Conveys the required skills to solve the task and thereby impacts crowd motivation to engage in solving the task
Task Modularity	Decomposition of tasks into sub-tasks (if applicable)
	Illustrate interdependence of sub-tasks, which can increase the task complexity
Solution Requirements	Criteria that a solution must fulfill
	Guide solvers during solution development
	Indicate the evaluation procedure by the crowdsourcer
	Indicate expectations on intellectual property rights
Task Allocation	Specifies the target group contingent on required expertise and skills
Contest Duration	Timeframe defining the deadline to submit solutions
	Depends on the defined complexity of the task

Table 2.3: Design-related elements in the task dimension.

Task Delineation. The delineation of a task refers to how well the crowdsourced problem is described and formulated (Afuah & Tucci, 2012). A well-articulated problem statement is one of the most fundamental steps in the crowdsourcing process. Prior

research suggests that the formulation of the problem statement has a direct impact on the quality of the solutions received (Allahbakhsh et al., 2013; Gillier et al., 2018; Hetmank, 2013; Jespersen, 2018; Lee et al., 2015; Thuan et al., 2016). Well-delineated problems are easier to understand and interpret, but on the other hand, problems that are not clearly described can increase the chances of being misinterpreted (Afuah & Tucci, 2012; Muhdi et al., 2011; Natalicchio et al., 2017; Schenk & Guittard, 2011). In order to formulate a well-delineated problem statement, the following characteristics should be considered in more detail.

Task Specificity. Task specificity refers to the scope of the problem to be solved. It could range from highly specific tasks to open-ended tasks for which no particular problem solving approach or solution is known (Jespersen, 2018; Leimeister et al., 2009; Nakatsu et al., 2014; Ren et al., 2021). Jespersen (2018) argues that highly specific tasks reduce the solution space and often lead to an incremental nature of solutions submitted. On the other hand, unstructured, open-ended tasks foster creativity and could lead to the discovery of new knowledge. In particular, tasks with a rather broad scope may attract more solvers, but in turn leads to higher firm efforts considering the evaluation of a more heterogenous pool of solutions (Christensen & Karlsson, 2019).

The specificity of the task reflects whether the company searches for solutions that are 'local' or 'distant' from its exiting knowledge base (Afuah & Tucci, 2012; Jespersen, 2018). For instance, if a company searches for improvements to an existing technology, it is conducting a local search, but on the other hand, if a company is searching for new technologies that it is unfamiliar with, it is conducting a distant search (Afuah & Tucci, 2012). Pollok et al. (2019a) suggest that in order to attract an optimal number of solutions, the seeker should have sufficient domain knowledge to formulate a comprehensive problem statement, but at the same time, not be too specific such that the problem solving space is overly constrained. Given that the task briefing should contain all the necessary information needed by the solvers to develop a solution (Colombo et al., 2013; Schenk & Guittard, 2011; Zheng et al., 2011), tasks with highly confidential information are not ideal for crowdsourcing because sensitive components

are made unavailable to the solvers, which in turn may affect the quality of the solutions (Afuah & Tucci, 2012; Ghezzi et al., 2018; Hetmank, 2013; Nakatsu et al., 2014; Natalicchio et al., 2017). Therefore, it is highly important to distinguish between crowdsourcing specific problems for which a pre-defined solution or approach exists, and open-ended problems for which creative, innovative solutions are needed.

Task Granularity. Task granularity refers to the degree of complexity of the problem to be solved. Rouse (2010) distinguishes three classifications of tasks to be crowdsourced: *simple tasks*, *moderate tasks*, and *sophisticated tasks*. Simple tasks refer to those of low complexity that do not require specific skills or expertise, while sophisticated tasks on the other hand, are more complex in nature, and demand certain competencies and substantial domain knowledge. Moderate tasks refer to tasks that involve a moderate level of skill and knowledge.

Zheng et al. (2011) further define two components of task complexity: *analyzability* and *variability*. Analyzability refers to the difficulty of the knowledge search process in developing the solution. Variability refers to the amount of new knowledge required to solve a problem. Similarly, Natalicchio et al. (2017) highlight that task complexity is represented by the number of knowledge components involved in the problem.

Prior studies suggest that the complexity of the task strongly influences the motivation of the crowd to participate in crowdsourcing contests (Ghezzi et al., 2018; Lee et al., 2015; Zhao & Zhu, 2014a; Zheng et al., 2011). For instance, a complex task often requires a higher level of specific knowledge and skill, and is more likely to satisfy an intrinsic need to further develop one's competences (Garcia Martinez, 2017). However, as the task complexity increases, the level of involvement, effort and cognitive skills needed to solve the problem also increase, and therefore solvers need to be incentivized appropriately. During the task design phase, it is crucial to assess the level of complexity of the task, and the effort required to solve it (Lee et al., 2015; Liu, Xia, Zhang, Pan, & Zhang, 2016). Afuah & Tucci (2012) highlight that since highly complex problems can often be difficult to delineate, they increase the chances of being misinterpreted (Lee et al., 2015; Muhdi et al., 2011). Therefore, crowdsourcing companies should take into account the level of

complexity and ease of delineation when deciding to crowdsource a problem.

Task modularity. Task modularity refers to the decomposition of the task into smaller sub-tasks. While not all tasks can be decomposed, it is important to point out that modularity is effective only when there is a low degree of interdependence among the task components (Afuah & Tucci, 2012; Natalicchio et al., 2017). Modular tasks with a low level of interdependence can be easier to delineate, and hence easier for the solvers to interpret. It also provides the opportunity for individuals to work on sub-tasks for which they have high levels of expertise and skills (Afuah & Tucci, 2012). However, for problems that require a high level of interaction among the task components, decomposing the problem can increase the overall complexity, since different knowledge components need to be combined to develop the solution. Furthermore, such tasks require individuals to collaborate and share knowledge (Pee et al., 2018). As a result, any missing information or lack of knowledge for any of the sub-tasks can negatively influence the quality of the solution. Some prior studies suggest that task decomposition is more appropriate for collaborative crowdsourcing that leverages collective intelligence (Afuah & Tucci, 2012; Blohm et al., 2018; Nakatsu et al., 2014), than tournament-based crowdsourcing for which individuals compete individually to develop the best solutions (Liu, Xia, Zhang, Pan, & Zhang, 2016). Therefore, when delineating the problem, crowdsourcing firms should take into consideration the degree of interactions between the sub-tasks when deciding whether to decompose it or not.

Solution Requirements. Solution Requirements refer to the criteria that must be fulfilled in developing a solution. Defining the contribution requirements is considered to be one of the most crucial steps because its influences the solvers decision to participate (Afuah & Tucci, 2012; Blohm et al., 2018; Zheng et al., 2011). Seekers should ensure that contribution requirements are explicitly defined because they serve as a guide for solvers to develop solutions (Steils & Hanine, 2016). Furthermore, the contribution requirements stated in the project briefing serve as an indicator for how the solutions will be evaluated and assessed by the seeker. Some studies suggest providing examples to improve the quality and effectiveness of solutions (Ghezzi et al., 2018; Koh, 2019).

Afuah and Tucci (2012) further highlight that firms must take into account the potential for integrating solutions into the company's existing value chain. This becomes especially relevant for organizations that search for 'distant' solutions beyond their current trajectories. On the other hand, integrating 'local' alternative solutions which are incremental in nature are relatively less complicated. Therefore, to benefit from crowdsourcing initiatives, it is important to consider the implementation potential when delineating the problem and defining requirements (Ford et al., 2015).

Prior research also indicates that firms must clearly indicate the expectations regarding intellectual property rights in the problem statement, because this has a significant impact on participation in crowdsourcing contests (Mazzola et al., 2018; Steils & Hanine, 2016). Intellectual property arrangements should be defined based on the level of complexity of the problem and expected solution requirements (Mazzola et al., 2018).

Task allocation. Task allocation refers to allocation of the task to a specific group of individuals in the crowd, depending on the expertise required to solve the problem. For instance, crowdsourcing companies can target contributors with specific knowledge that may be better suited to develop a solution (Blohm et al., 2018; Leimeister et al., 2009). Blohm et al. (2018) highlight that crowdsourcing firms can target crowd contributors based on specific skills, demography, and performance in prior contests.

While tournament-based crowdsourcing leverages the diversity of the crowd to solve problems (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Jeppesen & Lakhani, 2010), it can also result in a lot of 'crowding' from low-quality and irrelevant solutions (Piezunka & Dahlander, 2015). Therefore, targeting crowd contributors with the appropriate knowledge and expertise could be an effective approach to reduce the 'noise', and generate higher quality solutions (Blohm et al., 2018; Christensen & Karlsson, 2019; Geiger & Schader, 2014; Hetmank, 2013).

Contest Duration. Contest duration refers to the timeframe during which solvers can actively submit solutions. When designing a crowdsourcing project, it is important to consider the contest duration, since this could affect the overall quality of solutions (Ayaburi et al., 2020; Leimeister et al., 2009). In a study of twelve crowdsourcing projects

for idea generation, Muhdi et al. (2011) find that most of the ideas were submitted within the first four weeks of the contest being online. However, it is important to point out that these findings could differ with the nature of the problem. For instance, for problems with a higher level of complexity and specific solution requirements, solvers may need more time and effort to develop high quality solutions (Ayaburi et al., 2020). P.-Y. Chen et al. (2021) find that although a higher contest duration increases the amount of solvers and thus the likelihood of receiving high-quality solutions, they also report a decrease in the attraction of high-quality contestants. Ultimately, it is crucial for managers to take into account the difficulty of the problem, the specificity of the solution requirements, and the level of skill and expertise required when defining the duration of the contest.

Crowd

The Crowd refers to the people that participate in a crowdsourcing activity. The crowd is one of the most important actors in the crowdsourcing system (Zhao & Zhu, 2014a). The success of any crowdsourcing initiative largely depends on the ability to attract and motivate a crowd to develop solutions (Ford et al., 2015). Based on a literature analysis, three crucial characteristics of the crowd are identified and the central points are summarized in table 2.4.

Crowd Dimension	**Design-related Relevance**
Crowd Motivation	Indication of incentives for the crowd to participate in the contest
	Conveys monetary and/or non-monetary incentives
	Incentives should consider emerging costs (time and effort) for the crowd to develop solutions
Knowledge Diversity	Crowdsourcer needs to specify the required knowledge diversity
	Determines the crowd to be targeted
Crowd Size	Crowdsourcer needs to determine the amount of required solvers
	Address an open crowd or selected participants (experts) contingent on required knowledge diversity

Table 2.4: Design-related elements in the crowd dimension.

Crowd Motivation and Incentives. Crowd motivation refers to the motivation of the crowd to participate in innovation contests. Many previous studies have investigated the motivation aspect of crowdsourcing (Acar, 2019; Brabham, 2010; Frey et al., 2011; Garcia Martinez, 2017; Leimeister et al., 2009; Pee et al., 2018; Zhao & Zhu, 2014a; Zheng et al., 2011). Since incentives are an inherent component of tournament-based crowdsourcing (Blohm et al., 2018; Leimeister et al., 2009), a thorough understanding of what motivates the crowd is important for crowdsourcing firms when designing incentive mechanisms. The award money, as a central extrinsic motivator, increases both the number of solutions and the solution quality (P.-Y. Chen et al., 2021). However, as Leimeister et al. (2009) explore different incentives that motivate individuals to participate in ideas competitions, they find that incentives providing direct compensation (extrinsic) are not the only motivating factor. Other forms of motivation such as appreciation and learning through interaction with knowledge experts and mentors (intrinsic) are also important. Similarly, Brabham (2010) identifies four primary motivators for participation in crowdsourcing initiatives: the opportunity to make money, the opportunity to develop one's skills, the opportunity to take up full-time work, and the love of community. Hanine & Steils (2019) state that negative feelings must be avoided, for instance through transparency and encouraging a positive and respectful climate. In particular, perceived fairness of a crowdsourcing contest increases the likelihood of crowd participation (Mazzola et al., 2020). Görzen (2021) complements these findings on perceived feelings, and reports that a meaningful task can stimulate positive mood among solvers which positively impacts the creativity of solutions, and as such task meaningfulness is considered an indirect motivator (Görzen, 2021).

Prior research has further linked the nature and complexity of the crowdsourced problem with the motivation of solvers to participate (Afuah & Tucci, 2012; Garcia Martinez, 2017; Ghezzi et al., 2018; Li & Hu, 2017; Pee et al., 2018; Zheng et al., 2011). For instance, Pee et al. (2018) demonstrate that participants that are motivated to develop competence, focus on high-commitment tasks while those motivated by the 'love of community' focus on tasks that require interaction between solvers. Zheng et al. (2011) state that tasks that are ill-structured and poorly delineated may have a negative

influence the motivation to participate. On the other hand, well-structured tasks with high level of autonomy have a positive influence on participation in crowdsourcing contests (Garcia Martinez, 2017; Lee et al., 2015).

Another crucial aspect that plays a significant role in participant motivation is the treatment of intellectual property. Stringent intellectual property arrangements could significantly discourage participation in crowdsourcing contests (Mazzola et al., 2018). Prior studies indicate that intellectual property decisions are typically dependent on the complexity and stage of development of the problems (de Beer et al., 2017; Mazzola et al., 2018). Crowdsourcing firms should consider the negative influence on participation when designing intellectual property arrangements. For instance, one possible way to motivate solvers that have to fully transfer rights is to offer significantly higher monetary rewards (Mazzola et al., 2018).

While prior research suggests that both intrinsic and extrinsic motivation is important in crowdsourcing contests (Zhao & Zhu, 2014a), crowdsourcing firms must take into account the nature and complexity of the problem when designing incentives. For problems with a higher complexity that require more time and effort, financial incentives are particularly important (Afuah & Tucci, 2012; Blohm et al., 2018; Jeppesen & Lakhani, 2010; Schenk & Guittard, 2011; Zhao & Zhu, 2014a). Managers should also find ways to incentivize solvers that are intrinsically motivated to develop competencies and learn from experience. For instance, (Leimeister et al., 2009) show that solvers that are motivated to develop their skills appreciate feedback from experts. Therefore, incorporating feedback mechanisms can be very helpful to foster learning and competence development.

Knowledge Diversity. Knowledge diversity refers to the range of knowledge, skills and expertise of the crowd members. The required knowledge to solve a problem is closely related to the complexity of the task, which is represented by the number of knowledge components involved in the problem (Ford et al., 2015; Natalicchio et al., 2017; Thuan et al., 2016). Some tasks such as software testing require highly specialized knowledge (Afuah & Tucci, 2012; Blohm et al., 2018), whereas other generic problems rely on the

heterogeneity of the crowd (Steils & Hanine, 2016). Boons & Stam (2019) argue that the ability to combine and integrate 'related' (specific domain knowledge) and 'unrelated' (other domain knowledge) perspectives are key in generating high quality, novel solutions. Similarly, Frey et al. (2011) highlight that individuals with knowledge in diverse areas, are better able to combine knowledge and make connections. While knowledge diversity plays an important role in crowdsourcing contests, making the distinction between problems that require specific knowledge versus generic problems is essential for crowdsourcing companies to benefit from crowdsourcing initiatives.

Crowd Size. Crowd size refers to the number of solvers participating in a crowdsourcing contest. Crowd size is an important element of a crowdsourcing initiative, since it has a direct impact on the quantity and quality of solutions received. Afuah and Tucci (2012) highlight that since knowledge and expertise are widely dispersed among the crowd, a larger solver base increases the possibility of receiving higher quality solutions. Boudreau et al. (2011) point out that in tournament-based crowdsourcing contests in which few winning solutions are selected, the larger the number of participants, the less likely it is for individual contestants to win, which in turn reduces the effort exerted by individuals in developing solutions. However, for problems that draw on multiple knowledge domains and that do not have a specific problem-solving approach, this effect is reversed. In other words, a large (diverse) crowd could lead to better performance for problems with greater knowledge uncertainty. On the other hand, for problems in which a specific knowledge domain is required and predefined solutions exist, targeting professionals with the appropriate skills and expertise could be a more effective approach. Therefore, managers should take into account the nature of the problem when deciding whether to address an open crowd (unlimited contestants), or to target individuals with specific expertise to develop solutions.

Platform

The Platform refers to the interface through which a firm broadcasts the problem to be solved, and the design-related considerations are indicated in table 2.5.

Platform Dimension	Design-related Relevance
Platform	Connects crowdsourcer and crowd
	Considers the costs associated with developing an own platform or using existing (external) crowdsourcing platforms as intermediary
	Depends on existing crowdsourcing experience
	Platform specifies the size of the network of potential solvers

Table 2.5: Design-related elements in the platform dimension.

Organizations can either develop their own crowdsourcing platform or use third-party (intermediary-based crowdsourcing) platforms. While many renowned enterprises (including Dell, SAP, Google, LEGO, Procter & Gamble) have successfully developed their own crowdsourcing platforms (eYeka, 2015), it is important to take into account the costs of setting up, operating and managing such platforms (Ford et al., 2015; Schenk et al., 2019). Blohm et al. (2018) further highlight that developing scalable platforms with appropriate governance mechanisms can be very challenging for firms with no prior experience in crowdsourcing. Another crucial aspect is the access to a large crowd with diverse skills and expertise. The success of any crowdsourcing initiative largely depends on the ability to attract and motivate a crowd to develop solutions (Ford et al., 2015). This is especially relevant for tournament-based crowdsourcing for challenging, innovative problems.

Over the past decade, the market for crowdsourcing intermediaries has grown significantly (Diener & Piller, 2013). Some well-known examples include InnoCentive, NineSigma, IdeaConnection, and Yet2. These intermediaries have a large global network of experts and professionals in diverse fields, and play a mediating role by connecting the seeker firm with external solvers via their own web-based platform (Diener & Piller, 2013; Leicht et al., 2016). Since crowdsourcing intermediaries differ in expertise (Colombo et al., 2013; Diener & Piller, 2013), firms must select the right one, based on the nature and complexity of problem to be solved.

Recent developments indicate that many organizations have turned to intermediary-based crowdsourcing to broadcast innovation problems. Intermediaries

play a key role in managing the crowdsourcing process (Zogaj et al., 2014), including formulating the problem statement, broadcasting the task to their solver community, pre-selecting appropriate solutions and providing feedback to solvers. Furthermore, intermediaries support seeker firms by providing advice, managing intellectual property and associated risks, and tracking overall crowdsourcing performance (Colombo et al., 2013; Diener & Piller, 2013; Leicht et al., 2016). Prior research suggests that using intermediaries can significantly decrease development costs and other risks associated with crowdsourcing, therefore making it an attractive problem-solving approach for firms (Ford et al., 2015; Zhao & Zhu, 2014a). Therefore, the choice between establishing an internal platform versus using an external intermediary is a crucial decision in the crowdsourcing process (Ford et al., 2015; Schenk et al., 2019; Thuan et al., 2016; Zhao & Zhu, 2014a).

Crowdsourcer

The Crowdsourcer refers to the organization seeking to solve a task through crowdsourcing. The crowdsourcing firm is responsible for designing the overall contest starting from formulating the problem statement, to attracting solvers, and finally evaluation and implementation of crowdsourced ideas. Based on a review of prior literature, nine design elements corresponding to the crowdsourcing firm are extracted and illustrated in table 2.6.

Crowdsourcer Dimension	**Design-related Relevance**
Solution Evaluation	Internal evaluation process of received solutions
	Determine how to deal with a large number of solutions
Implementation Potential	Determine how to transform solutions into valuable information
	Establish criteria to determine the technical and economic feasibility of solutions
	Top management commitment
Communication & Feedback	Create communication channels to communicate with the crowd
	Determine adequate communication forms and flows
	Create feedback structures and channels

Incentives & Rewards	Define potential intrinsic motivators that are conveyed through the nature of the task
	Provide external motivators (e.g. monetary rewards)
	Align rewards with required effort and time the crowd needs to develop solutions
	Consider amount of potentially winning solution(s)
Resource Planning	Assess internal expertise and experience on crowdsourcing
	Determine all associated costs (financial, time, personnel)
	Allocate sufficient resources in advance
	Create informal organizational roles (gatekeepers, champions)
Risk Management	Identify potential uncertainties (e.g. receiving only inferior solutions)
	Identify sources of potential threats to intellectual property (IP) that may be exposed through the crowdsourcing contest
	Consider data protection / data privacy
Legal & IP management	Determine the legal terms and conditions, and IP rights arrangements
	Determine the ownership of the IP created through the crowdsourced solutions
Brand Image & Trust	Consider marketing-related aspects of crowdsourcing
	Determine the influence crowdsourcing firm's brand on the perception of the crowd with regards to the task
Success Metrics	Assess the overall success of a crowdsourcing contest
	Recognize failures and encourage learning

Table 2.6: Design-related elements in the crowdsourcer dimension.

Solution Evaluation. Solution Evaluation refers to how firms assess the solutions developed by the crowd. In tournament-based crowdsourcing, participants typically compete with each other to generate solutions to a defined problem. Crowdsourcing firms then screen and evaluate the set of solutions received to select the best one(s), which are ultimately rewarded (Geiger & Schader, 2014).

While crowdsourcing provides the opportunity to tap into diverse knowledge that is distributed among the crowd, it can also lead to a state of 'crowding', in which

organizations received a large number of solutions (Mack & Landau, 2020; Piezunka & Dahlander, 2015). Since organizations have limited resources, evaluating large sets of solutions can be tedious and increase the overall transaction cost of crowdsourcing (Afuah & Tucci, 2012; Blohm et al., 2013). Piezunka & Dahlander (2015) further highlight that as crowding increases, firms tend to limit their attention to solutions that are familiar and within the local knowledge domain. Consequently, when crowding occurs, organizations tend to filter out solutions that include distant knowledge that could be potentially relevant. Therefore, in order to benefit from the diversity (local and distant solutions), firms should establish clear evaluation criteria through which relevant solutions are selected. Defining clear guidelines for solution requirements in the problem statement can be helpful for solvers to develop solutions that better meet the expectations of seeking firms (Afuah & Tucci, 2012; Blohm et al., 2018). Previous studies also indicate that different evaluation tools and methods can be used when assessing crowdsourced ideas (Blohm et al., 2018; Geiger & Schader, 2014; Ghezzi et al., 2018; Muhdi et al., 2011). Blohm et al. (2018) point out that in tournament-based crowdsourcing, manual assessment is crucial because automated tools could potential overlook relevant contributions. To reduce the transaction costs from crowding, firms can integrate peer assessment techniques in the contest design, in which other crowd contributors can also rate the quality of contributions. As such, the jury may be composed of the end-users of the solution, who can judge the value of solutions based on their own needs and requirements (Afuah & Tucci, 2012). In this context, L. Chen et al. (2020) find that when the crowd itself can vote for the winning solutions, the overall motivation to participate in a contest can be increased. For solutions that primarily will be used by the crowdsourcing firm, and not by other end-users, the firm must employ internal evaluators with sufficient knowledge (Afuah & Tucci, 2012). As such, internal experts that have sufficient domain knowledge should be involved in evaluating ideas received from crowdsourcing contests, if the firm evaluates the received solutions internally.

Implementation Potential. Implementation potential refers to the ability to utilize the solutions received by the crowd. Crowdsourcing contests often generate an overwhelming

number of solutions, and therefore organizations must be prepared to effectively transform relevant solutions into valuable information for the company (Afuah & Tucci, 2012; Blohm et al., 2013). Prior studies suggest that in order to benefit from crowdsourcing initiatives, firms must develop distinct capabilities to integrate and transfer externally developed solutions (Afuah & Tucci, 2012; Ford et al., 2015). Firms need to carefully assess the technical and economic feasibility of crowdsourced solutions. Blohm et al. (2013) further highlight that solutions received by the crowd may need to be modified and tailored to fit the exact internal needs of the company.

Muhdi et al. (2011) stress the importance of a concrete implementation plan to better manage and transfer crowdsourced ideas either into existing projects or to initiate new projects. Communication of crowdsourcing project results to other business units within the organization can also increase the potential for implementation (Blohm et al., 2013). Finally, the support and commitment from the top management is instrumental for overcoming internal resistance towards externally developed solutions, making the transformation of crowdsourced ideas faster and easier (Ford et al., 2015; Lüttgens et al., 2014).

Communication and Feedback. Communication and feedback refer to how crowdsourcing firms communicate with the crowd at different stages of the contest. Many studies affirm that communication and feedback to solvers is a critical component, which can significantly influence the quality of solutions received (Blohm et al., 2013; Camacho et al., 2019; Chan et al., 2021; Jian et al., 2019; Leimeister et al., 2009; Piezunka & Dahlander, 2019; Schäfer et al., 2017; Wooten & Ulrich, 2017).

Schäfer et al. (2017) distinguish three types of communication flows in crowdsourcing contests: unidirectional (suggestion boxes), bidirectional (e-mail) and multidirectional (forums, wikis). The authors further outline which communication flow is best suited for different stages of the contest. The study revealed that unidirectional and multidirectional communication are most valuable before the contest, and bidirectional communication during and after the contest (Schäfer et al., 2017). Communicating with crowd members during the runtime of the contest increases the

chances of high-quality submissions (Blohm et al., 2018; Zheng et al., 2014) because in some cases, solvers may require additional information about the problem to develop appropriate solutions (Jian et al., 2019; Schäfer et al., 2017). A further feedback mechanism that firms can employ is creating peer-feedback structures, such that members of the crowd can provide feedback to other members (Chan et al., 2021). In fact, both peer-and firm-feedback encourage and motivate solvers to improve solutions, which in turn leads to high-quality ideas (Chan et al., 2021). While in-process communication is important, feedback after the contest, especially when solutions are rejected, are particularly important (Piezunka & Dahlander, 2019; Schäfer et al., 2017). For solvers that are intrinsically motivated to learn and develop competencies (Leimeister et al., 2009), providing constructive feedback can play a critical role in participation in future contests (Piezunka & Dahlander, 2019).

In order to benefit from crowdsourcing initiatives, crowdsourcing firms should establish appropriate communication tools for different stages of the crowdsourcing process. Additionally, firms should allocate time to communicate and answer questions from solvers (Muhdi et al., 2011). Trained moderators to provide constructive feedback at appropriate phases of the contest can highly influence the participation and success rates of crowdsourcing projects (Camacho et al., 2019).

Incentives and Rewards. Incentives and rewards refer to the remuneration that solvers receive in exchange for winning solutions. As previously discussed, incentives are one of the most critical components in tournament-based crowdsourcing (Blohm et al., 2018; Leimeister et al., 2009). While prior research indicates that both intrinsic and extrinsic motivation influence participation in crowdsourcing contests (Lee et al., 2015; Zhao & Zhu, 2014a; Zheng et al., 2011), the nature and complexity of the problem plays an critical role when designing effective incentive structures. For problems with a higher complexity that require participants to invest substantial time and effort, financial incentives are particularly important (Afuah & Tucci, 2012; Blohm et al., 2018; Schenk & Guittard, 2011; Zhao & Zhu, 2014a). Furthermore, for problems that require solvers to transfer intellectual property rights, firms must ensure that the rewards are

sufficiently high (Mazzola et al., 2018).

While intrinsic motivators such as passion or personal achievement cannot be directly controlled (Geiger & Schader, 2014; Leimeister et al., 2009), crowdsourcing firms should try to incorporate elements that promote learning and competence development in incentive mechanisms. For instance, the possibility to communicate and receive feedback from experts or potential collaboration opportunities to further develop promising solutions (Leimeister et al., 2009).

Tournament-based crowdsourcing is typically associated with success-based remuneration, which means that only successful contributions are rewarded (Geiger & Schader, 2014). As a result, the higher the number of potential contributors, the smaller the chance of winning for individual contributors. This could potentially discourage solvers from investing time and effort into developing solutions, which in turn could negatively influence the performance of the contest (Boudreau et al., 2011). Therefore, instead of following the 'winner takes it all' approach, crowdsourcing firms should consider distributing awards among the top contributors (Blohm et al., 2018; Muhdi et al., 2011).

From a managerial perspective, designing appropriate incentive structures are very important for the success of crowdsourcing projects. Crowdsourcing firms must take into account the nature and complexity of the problem crowdsourced, the type of intellectual property arrangement, and the different intrinsic and extrinsic motivators when defining awards and incentives.

Resource Planning. Resource planning refers to management of resources (time, human capital and financial capital) in a crowdsourcing project. Prior crowdsourcing literature suggests that when making the decision to crowdsource, one of the most important factors that must be considered is whether an organizational has sufficient internal expertise to solve the problem (Thuan et al., 2016). Organizations typically engage in crowdsourcing initiatives when they do not possess the required expertise or knowledge (Afuah & Tucci, 2012). Another critical factor that influences the decision to crowdsource is the cost of running crowdsourcing projects. While many studies argue

that crowdsourcing can significantly reduce development costs (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Jeppesen & Lakhani, 2010; Vukovic, 2009), some studies suggest that dedicated budgets are required to effectively carry out crowdsourcing projects (Ford et al., 2015; Thuan et al., 2016). Therefore, crowdsourcing firms must consider the different transaction costs involved, for instance, the cost to develop a platform (or hire an intermediary), the cost of internal human resources, and the cost of incentivizing the crowd (Ford et al., 2015).

Managing crowdsourcing initiatives are similar to managing projects. Allocating sufficient resources and defining a concrete project plan with clear milestones is important (Ford et al., 2015; Muhdi et al., 2011) . Furthermore, competent managers with crowdsourcing experience are critical for the success of crowdsourcing projects (Ford et al., 2015). Lüttgens et al. (2014) recommend that in addition to getting the strong commitment from the top management, creating informal organizational roles such as gatekeepers and champions, can be particularly beneficial in overcoming organizational resistance and barriers in crowdsourcing projects. Therefore, from a resource perspective, it is crucial for firms to weigh the costs and benefits when deciding whether to crowdsource or not, and to ensure the commitment of employees to effectively support and manage crowdsourcing initiatives.

Risk Management. Risk management refers to the management of uncertainties in the context of crowdsourcing projects. Although most previous research has focused on the different benefits of crowdsourcing, it is equally important for firms to consider the potential risks involved in crowdsourcing projects. One of the most prominent risks in crowdsourcing projects is the possibility of receiving inferior solutions of low quality (Liu, Xia, Zhang, Pan, & Zhang, 2016; Liu, Xia, Zhang, & Wang, 2016; Kannangara & Uguccioni, 2013). Since crowd members are not confined to employment contracts, firms may not have effective control over the quality of the output (Kannangara & Uguccioni, 2013). However, by defining the problem explicitly, providing clear solution requirements and addressing an appropriate crowd, organizations can reduce the risk of receiving poor quality solutions.

Another critical risk in crowdsourcing initiatives is the loss of intellectual property and knowhow. Crowdsourcing projects run the risk of revealing too much information when delineating a problem, which could negatively impact competitive advantage (Ford et al., 2015; Kannangara & Uguccioni, 2013). Prior studies suggests that tasks with highly confidential information are not ideal for crowdsourcing (Afuah & Tucci, 2012; Ghezzi et al., 2018; Nakatsu et al., 2014; Natalicchio et al., 2017). Therefore, crowdsourcing firms should be cautious when defining problem statements, and ensure that no sensitive information is revealed. Including non-disclosure agreements (NDAs) could also be effective when working with external crowds (de Beer et al., 2017).

Other risks related to information and data security include violation of personal data and malicious activity on crowdsourcing platforms (Sauerwein et al., 2016). To ensure platform security, performing penetration tests to evaluate the vulnerability of the system can be an effective measure.

Similar to any other projects, crowdsourcing projects also involve risks. Therefore, organizations must carefully assess potential risks, and define measures to mitigate them, before embarking on crowdsourcing initiatives.

Legal and Intellectual Property Rights Management. Legal and Intellectual Property Rights (IPR) Management refer to the legal terms and conditions and intellectual property mechanisms in crowdsourcing projects. IPR arrangements can significantly impact the participation and performance in crowdsourcing contests (de Beer et al., 2017; Foege et al., 2019; Mazzola et al., 2018), therefore firms need to carefully decide which intellectual property treatment to use when designing crowdsourcing projects.

de Beer et al. (2017) distinguish four different approaches to manage intellectual property in crowdsourcing projects based on the degree of ownership and the potential to reduce liabilities associated with crowdsourced solutions. The degree of ownership refers to the degree to which organizations acquire intellectual property rights of crowdsourced solutions. In the case of high degree of ownership, seekers have exclusive control over the intellectual property, but in the case of low degree of ownership, the solvers retain exclusive rights, which means that the IPR can be licensed out to other parties. Reducing liabilities

refers to the degree to which organizations protect themselves from liabilities associated with crowdsource solutions, for instance, third-party intellectual property which may possibly be embedded in the solutions.

Mazzola et al. (2018) highlight that firms should also consider the complexity and the stage of development of the crowdsourced problem when deciding the degree of ownership. For problems with higher complexity or those related to the later stages of development, seeking firms generally prefer to have a high degree of ownership since the potential value generated in larger. In such situations, crowdsourcing firms should ensure that contributors are adequately compensated (Blohm et al., 2018; Foege et al., 2019). From a solver perspective, when IPR arrangements are too stringent, individuals are less motivated to participate in crowdsourcing contests because they are not always willing to give up ownership (de Beer et al., 2017; Mazzola et al., 2018). Since crowds are not protected by employment regulations, a fair and balanced approach to manage intellectual property is important (de Beer et al., 2017). Therefore, firms should prioritize in which circumstances retaining exclusive control can be beneficial and define appropriate remuneration (Foege et al., 2019).

By defining explicit terms and conditions, including non-disclosure agreements, and outlining appropriate intellectual property arrangement in the problem statement, firms can ensure widespread participation as well as protect themselves from legal contamination (de Beer et al., 2017).

Brand Image and Trust. Crowdsourcing provides the opportunity for firms to gain visibility and advertise their brand. The Lego Ideas Platform is an excellent example of creating a strong brand image and enhancing customer loyalty through crowdsourcing. With an established online community of almost one million members, Lego actively works together with the crowd to convert promising ideas into tangible products. Through its crowdsourcing platform, Lego has attracted an increasing number of loyal customers and fans, who are enthusiastic about developing new Lego products (PD., 2018).

Another related aspect is developing a sense of trust among solvers (Blohm et al., 2013; Garcia Martinez, 2017; Liu, Xia, Zhang, Pan, & Zhang, 2016). When solvers

associate with the brand, they may be more motivated to develop solutions. Therefore, when designing crowdsourcing projects, firms should ensure a sense of trust and perceived fairness. Not only does this encourage participation, but also provides the opportunity to create a strong brand image.

Success Metrics. Success metrics are important to evaluate the overall performance and effectiveness of crowdsourcing initiatives. Crowdsourcing firms should develop specific metrics to track the success of crowdsourcing outcomes (Blohm et al., 2013; Ford et al., 2015). While it is clear that not every crowdsourcing project may result in high quality solutions, establishing success criteria can be helpful for organizations to recognize failures and foster learning (Ford et al., 2015).

2.5 A Morphological Framework on Crowdsourcing Contest Design

In this section, the results of the literature analysis are consolidated to present a concrete, holistic overview. In particular, a morphological framework is developed to better structure and investigate the different design elements in a crowdsourcing project. The morphological approach was first popularized by Zwicky (1969) to "study the more abstract structural interrelations among phenomena, concepts, and ideas" (Ritchey, 2013, p. 3). A morphological analysis is essentially a systematic approach to structure and analyze multi-dimensional problems by identifying and investigating possible relationships or configurations in the system (Ritchey, 2013). This approach is an alternative to other quantitative modeling methods and is particularly useful when organizing and synthesizing qualitative aspects to determine different possible outcomes.

The development of a morphological framework typically begins by identifying important 'dimensions' of the overall system. Consequently, the dimensions can be further broken down into sub-dimensions (in this case elements and sub-elements). For each dimension (and sub-dimension), possible 'values' or attributes are identified and structured into a matrix, known as a morphological box (Ritchey, 2013). By organizing

the different design parameters and possible options in a morphological box, it presents an integrative, visual representation of the overall solution space (Ritchey, 2006). In other words, the box seeks to uncover different possible solutions to a problem by allowing multiple alternative configurations rather than providing a single solution (Ritchey, 2006). This allows the possibility of choosing different combinations of options for each design parameter, best suited to the goals of the problem.

A morphological framework is specifically chosen for this study because it provides a cohesive, integrative picture of the findings in the literature. Table 2.7 presents the morphological framework developed in the context of crowdsourcing contest design. The matrix comprises the four fundamental pillars of crowdsourcing: the task, the crowd, the platform, and the crowdsourcer (Hosseini et al., 2014). For each dimension, corresponding design parameters (16 elements and 12 sub-elements) are identified through a rigorous systematic literature review. Consequently, for each parameter, possible 'values' or attributes are outlined. By assigning options to each parameter, the morphological box serves as a well-structured framework with different potential configurations, allowing managers to make well informed decisions when designing crowdsourcing contests.

Dimensions	Elements	Sub-Elements (if applicable)	Attributes			
Task	Task Delineation	Task Specificity	Low	Moderate	High	
		Task Granularity	Simple	Moderate	Complex	
		Task Modularity	Decomposed	Undecomposed		
		Solution Requirements	Bounded	Unbounded		
	Task Allocation		Performance based	Demographic based	Skill based	Open
	Contest Duration		Short	Medium	Long	
Crowd	Motivation		Intrinsic	Extrinsic	Both	
	Knowledge Diversity		Related	Unrelated	Both	
	Size		Small	Medium	Large	
Platform	Ownership		Own Platform	Intermediary Platform		
Crowdsourcer	Solution Evaluation		Expert Evaluation	Peer Evaluation	Both	
	Implementation Potential	Technical Feasibility	Low	Moderate	High	
		Economic Feasibility	Low	Moderate	High	
	Feedback & Communication		Uni-directional	Bi-directional	Multi-directional	All
	Incentives & Awards		Financial	Non-Financial	Both	
	Resource Planning	Financial Resources	Low	Moderate	High	
		Time Resources	Low	Moderate	High	
		Personnel Resources	Low	Moderate	High	
	Risk Management	Solution Quality Risk	Low	Moderate	High	
		Loss of IP Risk	Low	Moderate	High	
		Platform & Security Risk	Low	Moderate	High	
	Legal & IP Management		Passive	Prudent	Persuasive	Possessive
	Brand Image Impact		Low	Moderate	High	
	Success Metric		Quantitative	Qualitative	Both	

Table 2.7: A Morphological Framework of crowdsourcing design elements

2.6 Discussion

Crowdsourcing contests are a promising and innovative approach in the field of open innovation to tap into a global pool of widely distributed external knowledge. In consideration of the fundamental phase of designing a crowdsourcing contest, this paper

sought to answer the question which design-related factors organizations must consider. Existing literature informs practitioners about specific factors that help to succeed with crowdsourcing a task to an external crowd. However, the lack of a theory-based yet practicably applicable framework on crowdsourcing renders efective crowdsourcing contest design to be very time-consuming. Therefore, by applying a decision-centric view we provide a systematic review on design-related elements that help guiding practitioners and future research.

2.6.1 Theoretical Implications

From a theoretical perspective, this study responds to the calls for further research regarding the 'lack of standardization' and the need for a 'comprehensive guideline' to better understand and manage crowdsourcing projects (Amrollahi, 2015; Neto & Santos, 2018). By synthesizing two distinct theoretical perspectives on crowdsourcing, social exchange theory and absorptive capacity, we provide an integrative conceptual approach that pursues the goal to determine which factors contribute to executing successful crowdsourcing contests.

While many studies focus on the crowd participation motivation, and as such on the expected benefits (e.g. Acar, 2019; Zhao & Zhu, 2014a; Zheng et al., 2011), the crowdsourcing firm must also consider which costs it signals to the crowd by delineating the task (Ye & Kankanhalli, 2017). We draw on the principles of the social exchange theory to elaborate which potential costs the crowd perceives, and argue that only when individual crowd members perceive a positive expected net gain from a cost-benefit analysis based on the information conveyed through the task description, they engage in developing solutions. Thereby, we add to extant literature that the identified design elements cannot be considered sequentially, but our results indicate that they are closely related. While a crowdsourcer must determine internal factors such as deciding on the evaluation process or a deliberate risk management, these factors impact the way how the crowdsourcer can describe the task, and thereby convey the costs and benefits to the crowd in terms of time and effort versus intrinsic and extrinsic motivation.

Bayus (2013) shows that some firms are able to establish own crowdsourcing platforms and communities over time, and thus establish long-term relationships with potential solvers who provide solutions to several crowdsourced tasks over time. This consideration adds to the idea of social exchange to develop a lasting relationship between two parties (Blau, 1964), and our results indicate that crowdsourcing is a learning experience for firms as well. While crowdsourcers may initially utilize intermediary platforms to connect to the crowd, they gain experience in executing crowdsourcing contests and may establish their own platform over time. However, this implies that the crowdsourcer can benefit, or capture value, from the received solutions.

Thus, we add an absorptive capacity perspective in order to account for the value that organizations aim to create through crowdsourcing contests. Bloodgood (2013) emphasizes that capturing value is a fundamental issue that impacts the decision how to solve problems, with crowdsourcing being one approach. Thus, effective crowdsourcing requires certain organizational capabilities to capture value. We accounted for this consideration by integrating an absorptive capacity perspective to our research design. First, absorptive capacity is built through deliberate internal planning, referring to the crowdsourcer dimension in our morphological approach. Second, while the absorptive capacity primarily emerges from internal processes of the crowdsourcer, it impacts the manner in which the task is communicated to the crowd. As such, crowdsourcers must be aware that building absorptive capacity should be part of the design process of a crowdsourcing contest, as it impacts the crowdsourced task and contributes to defining the solution space for the task. Thus, the concept of absorptive capacity is implicitly included in the task dimension, since task-related design decisions may emerge or be based on internal decisions that aim to create the ability to capture value from the submitted solutions. This finding extends previous research that investigated the task-related elements from the perspective that the task description and delineation not only conveys the motivation to engage in crowdsourcing and provide high-quality solutions, but also determines whether crowdsourcers can ultimately benefit from these solutions.

2.6.2 Managerial Implications

From a practical perspective, this paper provides several valuable insights for practitioners and managers undertaking crowdsourcing projects. In recent years, crowdsourcing contests have become an increasingly popular innovation management practice to leverage the knowledge and wisdom of external crowds. In spite of its widespread adoption in practice, it is important to point out that not all crowdsourcing initiatives are an immediate success, and therefore, a thorough understanding of the underlying dynamics is crucial. This study specifically aims to bridge this gap, by presenting an integrative account of the key design elements of a crowdsourcing contest. By adopting a morphological approach, this paper provides different configurations of crowdsourcing projects, allowing managers to choose alternative solutions for each design parameter. The findings of this study aim to serve a comprehensive guideline and blueprint through which managers can effectively carry out crowdsourcing contests, and use this guideline as a checklist. Using the morphological approach presented in this study allows practitioners to consider elements that relate to both the crowd's motivation to engage in the crowdsourcing contest and the internal management of crowdsourcing. There are two central managerial implications that we derive from this study.

First, attracting the crowd requires a comprehensive perspective on the crowd's perception on associated costs and benefits for solving a task. While the crowdsourcing firm can explicitly determine the extrinsic motivation in the form of monetary rewards, the intrinsic motivation is more difficult to assess. However, intrinsic motivation plays a fundamental role, and the crowdsourcer can emphasize certain issues in the task description that relate to intrinsic motivation, such as promising feedback to submitted solutions (Hanine & Steils, 2019). While motivation is one aspect that the crowd considers for participation in crowdsourcing, another aspect is the related cost in terms of time and effort required to develop the solution. The crowdsourcer must make sure to provide adequate benefits, such that contingent on the task complexity, the rewards and incentives must be adapted accordingly. This requires that the crowdsourcing firm is

aware of the complexity of the task and the potential expectations of the crowd. Sourcing specific knowledge to a complex problem might be more costly than sourcing diverse knowledge to a rather simple problem. This consideration must be addressed during the early design phase of a crowdsourcing contest, in order to attract the right crowd members to develop high-quality solutions.

Second, crowdsourcing firms must define the factors that determine whether crowdsourcing a specific task ultimately can provide value to the firm. It may be particularly difficult for the crowdsourcer to determine the internal workload associated with conducting a crowdsourcing campaign (Hanine & Steils, 2019). Thus, a first step is to explicitly consider the related internal costs of resources, such as personnel. Moreover, the crowdsourcer must decide whether the required knowledge sourced from the crowd should be local or distant to the firm, since the resulting crowdsourcing design is contingent on this requirement (Jespersen, 2018). Consequently, the second requirement is to ensure that the firm can capture adequate value from the crowdsourced solutions. Thus, from a general perspective, capturing value comprises both the decisions taken in terms of the internal organizational processes associated with crowdsourcing, and the decisions related to how the task is delineated and communicated to the crowd.

2.7 Limitations and Future Research

As with any systematic literature review, this paper is not without limitations. Although the morphological approach presents a structured overview of the potential design configurations, we acknowledge that it does not capture potential relationships or interdependencies between individual design options. While this is a relevant aspect, we perceive these interdependencies to be beyond the scope of the current study due to the chosen morphological approach. Since designing a crowdsourcing campaign entails multifold interrelated decisions, future research is encouraged to explore the interrelationships among the various design elements, since certain decisions taken might confine the decision opportunities for other elements. In particular, further research

should investigate whether there is a certain hierarchy between design choices such that certain decisions taken early on consequently influence other decisions, and thereby limit the decision space of other design elements.

A further limitation is related to crowd motivation. While crowd motivation as a central factor for crowdsourcing is accounted for in this study, there are more potential advancements that can be made to the suggested morphology. We suggest that it could be interesting to investigate how the crowdsourcer can foster rewards that correspond to the intrinsic motivation of individuals to participate in crowdsourcing. For instance, how crowdsourcers can implement rewards in the design phase of a crowdsourcing contest that relate to aspects of social recognition as a central intrinsic motivator (Hanine & Steils, 2019). This requires the crowdsourcer to understand the crowd composition and what determines prestige within crowd communities. These rather subjective factors perceived by the crowd, e.g. prestige within communities, cannot be directly designed by the crowdsourcer and thus are not included in the morphology. Although we are well aware that such scoping decisions also go along with excluding potentially relevant but more indirect effects of crowdsourcing design approaches, we perceive this to be beyond the scope of this study. We acknowledge that collaborative crowdsourcing models, which enable active discussions of participants, sharing of solutions and encourage community building may increase community belonging and promote higher levels of solver activity and better solutions (Bayus, 2013; Boudreau & Lakhani, 2013; Hutter, Hautz, Füller, Mueller, & Matzler, 2011; Vuculescu & Bergenholtz, 2014). While these aspects of design effects are certainly relevant, in the context of this paper we primarily focus on innovation contests, wherein individuals compete with one another to develop the best solutions. Therefore, we chose to focus on central design aspects and their systematic development rather than aiming at the discussion of all potentially indirect effects of campaigns. The latter certainly deserves attention from further research. Our study thus provides an avenue for exploring relevant, but more indirect effects of design decisions.

Moreover, since the primary focus of this study is on crowdsourcing contests for innovation, the results may be different in other crowdsourcing settings, such as open

collaboration, microtasking or information pooling. While we provide an initial starting point, we encourage future research to investigate other types of crowdsourcing using the morphological box and adapt the box accordingly, if required.

Lastly, the morphological framework needs to be validated in a practical setting. While the morphological approach is theory-based and derived from extant research, we see great potential in applying this approach to practice. Future research could test the framework on crowdsourcing contests to fill any gaps and strengthen the validity of the framework. Moreover, the morphological approach could serve to identify archetypes of crowdsourcing contests, which potentially demonstrate certain patterns across the morphological box presented in this study. This could serve to facilitate future crowdsourcing contests by defining the nature of the task, determining the crowdsourcing archetype, and following the corresponding suggestions of the morphological framework.

Chapter 3

A Morphological Approach towards Crowdsourcing Project Design: A Multiple Case Study (Paper II)

Abstract

Designing a crowdsourcing campaign entails multifold interrelated decisions, and therefore, a thorough understanding of the key design decisions, and more importantly, how these decisions interact to influence the outcome of the project is crucial. However, limited attention has been paid to the overall configuration and design of such initiatives. Based on a multiple case study of three crowdsourcing campaigns, this paper empirically investigates how crowdsourcing projects are operationalized. In particular, this study explores the various design complexities and interdependencies involved in developing effective crowdsourcing campaigns drawing on innovation barrier and signaling theory perspectives. Our findings indicate a hierarchy between certain design choices, such that task related decisions influence subsequent design parameters. The case studies also show some variation in the overall design across the crowdsourcing campaigns, which highlight the design space opportunities available to crowdsourcing firms. The contribution of this study is twofold: Conceptually, this paper contributes to the crowdsourcing literature by developing an approach to conceptualize the overall design of crowdsourcing campaigns. From a practical perspective, by adopting a decision-centric approach, this paper provides an overarching perspective on different possible campaign configurations, serving as a guideline for practitioners to make more informed decisions when designing and executing crowdsourcing projects.

Keywords: *Open innovation, crowdsourcing design, case study*

3.1 Introduction

Innovation is a central determinant in creating value and fostering a competitive edge (Salomo et al., 2008), and thus is fundamental for organizations to compete in dynamically changing markets. In today's competitive business environment, internal efforts to initiate innovation processes are increasingly insufficient, and leveraging know-how from the external ecosystem is especially crucial for firms to accelerate their innovation efficiency and capability (Chesbrough & Crowther, 2006).

In this context, the open innovation paradigm offers organizations the opportunity to overcome internal innovation barriers by unleashing valuable knowledge from outside the firm's traditional boundaries. Among the many existing approaches to engage in open innovation, such as strategic alliances and co-creation, crowdsourcing for innovation has become an effective problem solving approach, attracting firms to tap into a global pool of expertise, knowledge, and creativity to address internal challenges at substantially lower costs (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Jeppesen & Lakhani, 2010). Many organizations have largely benefited from crowdsourcing-based approaches to solve internal problems, adapt to rapidly evolving customer needs, and to increase overall innovation efficiency (Brabham, 2008; Kohler, 2015; Mattos, Kissimoto, & Laurindo, 2018).

Despite the widespread adoption of crowdsourcing in practice, limited attention has been paid to the overall configuration and design of crowdsourcing projects. Previous studies have primarily investigated individual aspects of crowdsourcing design, such as the motivation of crowd members (Leimeister et al., 2009; Zhao & Zhu, 2014a), task design (Nakatsu et al., 2014; Zheng et al., 2011), communication and feedback mechanisms (Piezunka & Dahlander, 2019; Schäfer et al., 2017). However, these studies have focused on single or specific design elements, without developing an integrated picture of the overall crowdsourcing system. As a result, a conceptual framework representing the important design facets has yet to be established (Neto & Santos, 2018; Zheng et al., 2011).

Amrollahi (2015, p.2) further argues that the "crowdsourcing literature lacks a comprehensive guideline through which practitioners can initiate and manage their crowdsourcing projects." This highlights the central role of the design aspect of crowdsourcing projects. Designing a crowdsourcing project entails multifold interrelated design choices based on the nature and type of the innovation problem to be solved. These design choices play a significant role in providing the necessary information to external individuals, who then decode and interpret this information, to submit solutions to internal innovation challenges. Therefore, a better understanding of these different design choices and how they interact with one another to influence the success of the outcome is crucial for managers undertaking such projects (Leimeister et al., 2009; Natalicchio et al., 2017).

We view crowdsourcing as a means to engage in open innovation to overcome internal innovation barriers, that potentially limit the innovation efficiency and capability of an organization. Typically, crowdsourcing involves an exchange of information between two parties; the firm signals a particular need in the form of a problem statement to the crowd, who in turn, receives and decodes this information to develop solutions, which are then returned back to the seeking firm. From this perspective, we intend to address the aforementioned shortcomings by adopting an innovation barrier perspective complemented by signaling theory as the primary conceptual foundation. Thereby, we aim to explore the design complexities involved in developing effective crowdsourcing campaigns. We first draw on the extant literature to develop a comprehensive understanding of the different design facets of a crowdsourcing project, and how these interact in the overall campaign design. To enrich our findings from the literature, we engage in a case study approach to empirically investigate three distinct crowdsourcing projects for innovation to better understand what design options are chosen for each project, their interdependencies, how they are operationalized, and most importantly, the rationale behind the different design-related decisions taken when setting up a crowdsourcing project. In doing so, this study aims to close the research gap of a lacking framework for crowdsourcing design. In particular, this paper seeks to answer the central questions of which different design decisions of a crowdsourcing project need to

be considered for gaining a more comprehensive understanding of crowdsourcing campaigns and which interdependencies exist between these design-related decisions.

By addressing the aforementioned research questions, this study contributes to the current crowdsourcing literature in several ways. First, it offers an approach to systematically conceptualize the overall design of crowdsourcing campaigns to better understand and structure the key design elements of such projects. This conceptualization offers a blueprint for crowdsourcing practitioners by providing guidance for the design of crowdsourcing projects. Second, this paper investigates three distinct crowdsourcing projects to better understand the rationale behind the different design choices, and how these choices interact in terms of achieving the overall goal of running an effective and efficient campaign. By adopting a multiple case study design, we collect first-hand input from industry practitioners to enrich our understanding of how crowdsourcing projects can be effectively designed and managed.

3.2 Conceptual Background and Framework Development

Reflected in the open innovation paradigm (Chesbrough, 2003; Herzog, 2011), boundaries of organizations have become increasingly porous, as they acquire external ideas, knowledge, and technology (Herzog, 2011). Such increased interaction with external partners in the context innovation has been shown to be an effective complement to the more closed R&D model. One possible approach to gain access to external sources of knowledge and expertise that can increase a firm's innovation capabilities is to conduct crowdsourcing contests for innovation (Brabham, 2008; Kohler, 2015; Palacios-Marqués, Gallego-Nicholls, & Guijarro-García, 2021).

3.2.1 Crowdsourcing as an innovation contest

As proposed originally by Howe (2006), the underlying premise of crowdsourcing is that an organization outsources a task to a large, undefined, external group of individuals in the form of an open call. Since then, crowdsourcing has emerged as a complex, multidisciplinary concept with applications in a wide variety of domains, including computer science, public health, disaster and crisis management, information technology, software testing, business and management (Afuah & Tucci, 2012; Brabham, 2008; Gao et al., 2011; Hossain, 2015; Zogaj et al., 2014). In this study, we specifically focus on innovation contests, also commonly referred to as tournament-based crowdsourcing or broadcast search (Afuah & Tucci, 2012; Terwiesch & Xu, 2008). Innovation contests are typically used to solve challenging problems in the form of an open call to a large network of potential contributors (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Jeppesen & Lakhani, 2010). Interested contributors then self-select into participating, and compete with each other to generate the best solution(s). Consequently, the best solution(s) are awarded by the seeking firm, typically in the form of monetary awards (Afuah & Tucci, 2012; Blohm et al., 2018). While crowdsourcing also allows firms to outsource the evaluation of the ideas to the crowd (L. Chen et al., 2020), this paper focuses on crowdsourcing contests for which solutions are exclusively evaluated by the crowdsourcing firms.

The primary essence of such contests lies in mobilizing knowledge and expertise that is otherwise distributed among the crowd, to obtain novel solutions beyond the traditional boundaries of an organization (Blohm et al., 2013). However, in order to optimally design crowdsourcing initiatives, organizations must consider the key decisions which impact the success of the crowdsourcing outcome. The design of a crowdsourcing campaign is thereby determined by the integral combination of these key decisions.

3.2.2 Innovation Barriers and Signaling Theory Perspective

A large body of previous literature has emphasized that firms face many challenges when following an ambition to achieve a more innovative new product, service, or process portfolio (Bond & Houston, 2003; Mirow, Hölzle, & Gemuenden, 2008). Organizations often tend to search for solutions in the vicinity of their existing knowledge base, which in turn, results in finding solutions that are 'local' to their current knowledge trajectory (Levinthal & March, 1993; Stuart & Podolny, 1996). However, developing new products and services requires firms to search beyond the scope of its traditional organizational boundaries, and look beyond its established partner network, which often restricts access to distant knowledge (Afuah & Tucci, 2012). Crowdsourcing for innovation is a means for firms to access knowledge beyond its organizational boundaries. The underlying premise of crowdsourcing is that an organization outsources a problem, for which it is seeking solutions, to an external group of individuals, the 'crowd'.

In this context, signaling theory provides a theoretical foothold to describe the interaction and communication between two parties that are subject to asymmetrically distributed information. Although signaling theory as an economic theory was originally applied in the job market context (Spence, 1973), its applicability has been extended to a variety of other management research streams such as entrepreneurship, marketing, and human resource management (Elitzur & Gavious, 2003; Gammoh, Voss, & Chakraborty, 2006; Heil & Robertson, 1991; Suazo, Martinez, & Sandoval, 2009). In fact, recent crowdsourcing research has also adopted this theoretical perspective since it involves the interaction between two parties through signals (Durward, Blohm, & Leimeister, 2016; Pollok et al., 2019a; Zhao & Zhu, 2014a). The signaler (typically a firm) has specific information about the organization that is not available to outsiders (Kirmani & Rao, 2000). The signaler must decide on what and how to communicate or signal to the receiver, who in turn must choose how to interpret the signal and respond accordingly (Connelly, Certo, Ireland, & Reutzel, 2011). Connelly et al. (2011) identify four primary elements in the signaling process: (i) the signaler, who has specific information; (ii) the signal, which is the specific information; (iii) the receiver, who

receives the signal and (iv) the feedback that is sent to the signaler. These four elements in the signaling process serve to structure central aspects of crowdsourcing campaigns: the task to be crowdsourced, the crowd, the crowdsourcer, and the platform or communication means (Hosseini et al., 2014). Following this perspective, we draw on signaling theory as our conceptual foundation to explore how the different decisions taken in the crowdsourcing process interact to influence the signal quality projected by the firm, which in turn, impacts the overall success of the crowdsourcing initiative.

In the context of crowdsourcing, the firm 'signals' a specific need in the form of a task or problem statement to the crowd via a platform, who then interprets and decodes the signal to develop solutions that are then returned back to the firm. Connelly et al. (2011, p.61) argue that signals are rarely perceived as single signals, but instead receivers typically aggregate "a series of signals into meaningful wholes." This emphasizes the need to go beyond investigating single factors shaping crowdsourcing projects, and establish a more comprehensive perspective on the design-related decisions and their corresponding signals. Following this line of argument, we investigate the four central crowdsourcing dimensions, to extract a more complex set of design elements, which together provide a decision space for executing effective crowdsourcing campaigns. For each of the four fundamental dimensions above, we explore the extant literature to identify individual design elements that must be considered when designing and executing crowdsourcing projects.

3.2.3 Decisions in Crowdsourcing Campaign Design

One of the major challenges for crowdsourcing firms is to attract and motivate the crowd to submit solutions (Boudreau & Lakhani, 2013; Piezunka & Dahlander, 2019). Since the task description is usually the first point of contact between the crowdsourcer and the crowd (Afuah & Tucci, 2012; Gillier et al., 2018; Natalicchio et al., 2017; Steils & Hanine, 2016), a high-quality problem statement (or signal) is crucial in attracting the attention of the crowd. Pollok et al. (2019a) argue that firms can influence the perceived uncertainty and hence the participation of solvers by making specific decisions

in the problem delineation phase. For instance, the complexity and specificity of the task are important decisions to consider when delineating the problem statement. Tasks could range from highly specific tasks to open-ended tasks for which no particular problem-solving approach or solution is known (Jespersen, 2018; Leimeister et al., 2009; Nakatsu et al., 2014).

The specificity of the task determines whether the firm receives solutions that are local or distant to its current knowledge trajectory. For example, being too specific might confine the overall solution space, resulting in solutions that are local to the firm's knowledge. Hence, from a local search bias perspective, specifying the underlying task in a crowdsourcing campaign becomes a central decision parameter in crowdsourcing design (Rosenkopf & Nerkar, 2001). This is further supported by Pollok et al. (2019a), who argue that the quality of the problem statement and the firm's decisions in the problem formulation phase play a critical role in attracting the attention of potential solvers to participate in the contest and submit solutions. As such, the task as a central element in a crowdsourcing campaign must be complemented by an information exchange perspective, which includes the firm specifying the task and the targeted solution providers. From a signaling theory perspective, Connelly et al. (2011, p.43) refer to signal quality as "[...] the underlying, unobservable ability of the signaler to fulfill the needs or demands of an outsider observing the signal." Similarly, in the context of a crowdsourcing campaign, the different design decisions made during the task formulation phase interact with one another to influence the overall signal quality projected by the firm, which in turn, influences how the signal is decoded by the crowd, and hence, the quality of the submitted solutions. In fact, the decision on design elements in the problem formulation phase relate to the most prominent risk in crowdsourcing, which is receiving inferior solutions of low quality (Kannangara & Uguccioni, 2013; Liu, Xia, Zhang, Pan, & Zhang, 2016). However, by defining the problem explicitly, providing clear solution requirements, and addressing an appropriate crowd, organizations create a high-quality signal and thereby clearly communicate the objectives of the task to be crowdsourced.

A further perspective provided by applying signaling theory to crowdsourcing is the information asymmetry between the crowdsourcer (signaler) and the crowd (receiver) (Connelly et al., 2011; Mavlanova, Benbunan-Fich, & Koufaris, 2012). Since organizations often cannot disclose information publicly due to the need of protecting intellectual property and knowhow, crowdsourcing contests are subject to asymmetric information between the organization and the crowd. Crowdsourcing projects can thereby bear the risk of revealing too much information when delineating a problem. From the organization's perspective, it is important to assess these risks when designing the campaign and take appropriate measures to overcome them. In turn, there are risks associated with violation of personal data, such that the crowdsourcer must ensure security in order to attract a sufficiently large crowd and thereby potential solvers.

In fact, attracting potential solvers is central to the crowdsourcing process. Organizations can either develop their own crowdsourcing platform or use intermediary-based crowdsourcing platforms as a means to signal and communicate the task (Schenk et al., 2019). Many organizations use crowdsourcing intermediaries because intermediaries typically have an established large global network of experts in diverse fields. Furthermore, intermediaries play a mediating role by connecting the seeker with external solvers via their web-based platform (Diener & Piller, 2013; Zogaj et al., 2014). Intermediary-based crowdsourcing can be especially helpful to improve the reach of the signal by connecting with potential solvers with diverse backgrounds and skill-sets, which becomes particularly relevant for problems in which organizations seek solutions that are 'distant' to their own knowledge (Schenk et al., 2019). Moreover, intermediaries play a key role in managing the entire crowdsourcing process including formulating the problem statement, broadcasting the task to their solver community, pre-selecting appropriate solutions, managing intellectual property issues, and providing feedback to solvers (Diener & Piller, 2013; Zogaj et al., 2014; Schenk et al., 2019).

An important factor in attracting the attention of the crowd is the use of appropriate incentive mechanisms. While previous studies suggest that both intrinsic and extrinsic motivation are important in crowdsourcing contests (Zhao & Zhu, 2014a), firms must take

into account the nature and complexity of the problem when designing incentives. For problems with a higher complexity that require more time and effort, financial incentives are particularly important (Afuah & Tucci, 2012; Blohm et al., 2018; Jeppesen & Lakhani, 2010; Zhao & Zhu, 2014a). On the other hand, some solvers are strongly motivated by the competitive aspect of crowdsourcing, while others are motivated by learning through interaction with other experts (Leimeister et al., 2009). Piezunka & Dahlander (2019) also highlight that providing constructive feedback to solvers can play a critical role in participation in future contests. This creates a positive signal to the solvers that the seeker is interested in receiving solutions in the future. When solvers associate with the brand, they may be more motivated to develop solutions in the future because it creates a sense of trust and perceived fairness (Liu, Xia, Zhang, Pan, & Zhang, 2016; Garcia Martinez, 2017).

Once the ideas are received, the seeker screens and evaluates the ideas to select the best solutions which are then rewarded. Since organizations have limited resources, evaluating large sets of solutions can be tedious and increase the overall transaction cost of crowdsourcing (Afuah & Tucci, 2012; Blohm et al., 2013). Piezunka & Dahlander (2015) further argue that as the number of solutions received increase, organizations tend to filter out solutions that include distant knowledge that could be potentially relevant. Therefore, in order to benefit from the diversity (local and distant solutions), establishing clear evaluation criteria through which relevant solutions are selected is important. Since crowdsourcing contests often generate an overwhelming number of solutions, organizations must be prepared to effectively transform and implement relevant solutions into valuable information for the company (Afuah & Tucci, 2012; Blohm et al., 2013). Therefore, developing distinct capabilities to integrate and transfer externally developed solutions is crucial (Afuah & Tucci, 2012; Ford et al., 2015). Finally, success metrics are important to evaluate the overall success and performance of the campaign, because they can be helpful to recognize failures and foster learning in the future (Ford et al., 2015).

Dimensions	Design-Elements	Sources
Task	Task Delineation (10)	Afuah & Tucci, 2012; Allahbakhsh et al., 2013; Gillier et al., 2018; Hetmank, 2013; Jespersen, 2018; Lee et al., 2015; Muhdi et al., 2011; Natalicchio et al., 2017; Schenk & Guittard, 2011; Thuan et al., 2016
	Task Specificity (13)	Afuah & Tucci, 2012; Christensen & Karlsson, 2019; Colombo et al., 2013; Ghezzi et al., 2018; Hetmank, 2013; Jespersen, 2018; Leimeister et al., 2009; Nakatsu et al., 2014; Natalicchio et al., 2017; Pollok et al., 2019a; Ren et al., 2021; Schenk & Guittard, 2011; Zheng et al., 2011
	Task Granularity (10)	Afuah & Tucci, 2012; Garcia Martinez, 2017; Ghezzi et al., 2018 Lee et al., 2015; Liu, Xia, Zhang, Pan, & Zhang, 2016; Muhdi et al., 2011, Natalicchio et al., 2017; Rouse, 2010; Zhao & Zhu, 2014a; Zheng et al., 2011
	Task Modularity (6)	Afuah & Tucci, 2012; Blohm et al., 2018; Liu, Xia, Zhang, Pan, & Zhang, 2016 Nakatsu et al., 2014; Natalicchio et al., 2017; Pee et al., 2018,
	Solution Requirements (8)	Afuah & Tucci, 2012; Blohm et al., 2018; Ford et al., 2015; Ghezzi et al., 2018 Koh, 2019; Mazzola et al., 2018; Steils & Hanine, 2016; Zheng et al., 2011
	Task Allocation (10)	Afuah & Tucci, 2012; Blohm et al., 2018; Boudreau & Lakhani, 2013; Christensen & Karlsson, 2019 Geiger & Schader, 2014; Hetmank, 2013; Jeppesen & Lakhani, 2010 Leimeister et al., 2009; Piezunka & Dahlander, 2015
	Contest Duration (4)	Ayaburi et al., 2020; P.-Y. Chen et al., 2021; Leimeister et al., 2009 Muhdi et al., 2011
Crowd	Motivation & Incentives (21)	Acar, 2019; Afuah & Tucci, 2012; Blohm et al., 2018; Brabham, 2010; P.-Y. Chen et al., 2021; de Beer et al., 2017; Frey et al., 2011; Garcia Martinez, 2017, Ghezzi et al., 2018; Görzen, 2021; Hanine & Steils, 2019 Jeppesen & Lakhani, 2010; Lee et al., 2015; Leimeister et al., 2009 Li & Hu, 2017; Mazzola et al., 2018, 2020; Pee et al., 2018 Schenk & Guittard, 2011; Zhao & Zhu, 2014a; Zheng et al., 2011
	Knowledge Diversity (8)	Afuah & Tucci, 2012; Blohm et al., 2018; Boons & Stam, 2019; Ford et al., 2015; Frey et al., 2011; Natalicchio et al., 2017; Steils & Hanine, 2016, Thuan et al., 2016
	Size (2)	Afuah & Tucci, 2012; Boudreau et al., 2011;
Platform	Ownership (9)	Blohm et al., 2018; Colombo et al., 2013; Diener & Piller, 2013; Ford et al., 2015; Leicht et al., 2016; Schenk et al., 2019; Thuan et al., 2016, Zhao & Zhu, 2014a; Zogaj et al., 2014
Crowdsourcer	Solution Evaluation (9)	Afuah & Tucci, 2012; Blohm et al., 2013, 2018; L. Chen et al., 2020; Geiger & Schader, 2014; Ghezzi et al., 2018; Mack & Landau, 2020, Muhdi et al., 2011; Piezunka & Dahlander, 2015
	Implementation Potential (5)	Afuah & Tucci, 2012; Blohm et al., 2013; Ford et al., 2015; Lüttgens et al., 2014; Muhdi et al., 2011
	Feedback & Communication(11)	Blohm et al., 2013, 2018; Camacho et al., 2019; Chan et al., 2021; Jian et al., 2019; Leimeister et al., 2009; Muhdi et al., 2011; Piezunka & Dahlander, 2019; Schäfer et al., 2017; Wooten & Ulrich, 2017; Zheng et al., 2014
	Incentives & Awards (11)	Afuah & Tucci, 2012; Blohm et al., 2018; Boudreau et al., 2011; Geiger & Schader, 2014; Lee et al., 2015; Leimeister et al., 2009; Mazzola et al., 2018; Muhdi et al., 2011; Schenk & Guittard, 2011; Zhao & Zhu, 2014a; Zheng et al., 2011
	Resource Planning (9)	Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Brabham, 2008; Ford et al., 2015; Jeppesen & Lakhani, 2010; Lüttgens et al., 2014; Muhdi et al., 2011; Thuan et al., 2016; Vukovic, 2009
	Risk Management (10)	Afuah & Tucci, 2012; de Beer et al., 2017; Ford et al., 2015; Ghezzi et al., 2018; Liu, Xia, Zhang, Pan, & Zhang, 2016; Liu, Xia, Zhang, & Wang, 2016; Nakatsu et al., 2014; Natalicchio et al., 2017; Kannangara & Uguccioni, 2013; Sauerwein et al., 2016
	Legal & Intellectual Property Management (4)	Blohm et al., 2018; de Beer et al., 2017; Foege et al., 2019; Mazzola et al., 2018
	Brand Image & Trust (3)	Blohm et al., 2013; Garcia Martinez, 2017; Liu, Xia, Zhang, Pan, & Zhang, 2016
	Success Metrics (2)	Blohm et al., 2013; Ford et al., 2015

Table 3.1: Crowdsourcing campaign design elements and related literature

These four central crowdsourcing dimensions, as listed in table 3.1, guide a more complex set of design elements, which together provide a decision space for executing effective crowdsourcing campaigns. Considering that crowdsourcing is a complicated process which consists of a complex set of interdependent activities and elements, a profound understanding of the different design facets is paramount. Against this backdrop, we investigate how different design choices act as individual signals, which in turn, interact with each other to influence the overall quality of the whole signal portfolio projected by the crowdsourcing firm. We use a decision-centric approach to identify the key decisions organizations take when designing crowdsourcing projects. In order to enrich our theory, we draw on a multiple case study approach to explore the reasoning behind each decision, and how certain initial design choices limit subsequent decisions later on. In other words, this research aims to investigate the fundamental interdependencies among the key design decisions along the crowdsourcing process, and how these decisions then collectively influence the signal quality projected by the firm.

3.3 Methodology

3.3.1 Research Approach

In this paper, we adopt a qualitative, explorative case study approach to better understand the different design parameters of a crowdsourcing project. In particular, we investigate the rationale behind the different design choices made by managers when setting up crowdsourcing projects, and more importantly, how these sets of choices interact to collectively influence the overall signal quality and success of the project. To this end, we engage in a comprehensive case study to inform us about the actual decisions taken when designing such projects. Although theoretically, there could be multiple combinations of design parameters, the opportunities for taking viable decisions are much more limited in practice. For instance, certain task related decisions taken early on can significantly narrow the overall solution space and impact the opportunities to engage a broader set of potential solvers. To explore the fundamental

interdependencies between the different design decisions, we investigate three crowdsourcing projects to gather first-hand information from experienced managers across the projects. We draw on a case study approach because it is particularly appropriate for research in new areas, with the objective to examine a phenomenon in its natural setting to enrich and build theory (Eisenhardt, 1989). Furthermore, a multiple case study approach is known to increase robustness because it provides more accurate and rich information, which helps to capture the complexity of a phenomenon more comprehensively and in much greater detail than a quantitative approach (Eisenhardt & Graebner, 2007).

3.3.2 Empirical Setting

Our case studies are situated in the automotive industry, which is faced by unprecedented change due to advancing technologies, disruptive trends, and rapidly evolving customer needs (Krasova, 2018). To respond to emerging trends, customer needs, and heavy competition, innovation lies at the core of the automotive sector. However, it is important to point out that most automotive firms are established, large scale businesses with complex products and value chains, and more importantly, have well-developed innovation routines and established partners with very formalized methods of knowledge exchange and collaboration. The widespread adoption of crowdsourcing for innovation in other industries has sparked a major interest in the automotive sector over the last few years. In our research, we investigate three distinct crowdsourcing projects in a large, established automotive firm, each representing a specific type of innovation task to be crowdsourced; *service* innovation, *product* innovation and *process* innovation. To avoid any major differences across industries and inter-organizational aspects, we selected three cases within one firm in the automotive industry. The three crowdsourcing pilot projects are facilitated in collaboration with specialized intermediaries that play an important mediating role in the overall campaign design and decision process throughout the projects. This allows us to study the different design decisions taken across the three crowdsourcing campaigns within one

focal firm without introducing discrepancies due to different corporate settings.

3.3.3 Data Collection

To ensure rich data, a 'clinical research approach' was used to collect valuable data from an inside organizational perspective (Sköld & Karlsson, 2007). This provided the opportunity to collect substantial amounts of data from multiple interactions with key stakeholders, participation in meetings, and access to relevant emails and documents. Furthermore, this enabled us to dig deeper into the individual cases and to enhance our overall understanding of how crowdsourcing projects are operationalized in practice. Consequently, this provided rich context to better assess and evaluate the information generated from our informants.

Semi-structured interviews were conducted with different individuals who were actively involved across the three projects. Among the interviewed individuals were innovation managers, project managers, subject-experts, and the crowdsourcing intermediary that had a primary role in the decision-making process of the projects (shown below in table 3.2).

Case	ID	Position	Role in Project	Duration (min)
A	A-01	Innovation Manager, Procurement	Project Lead	46
	A-02	Innovation Manager, Production	Project Owner & Expert	70
	A-03	Intermediary	Support in Challenge Formulation & Contest Design	45
B	B-01	Innovation Manager, Industry 4.0	Project Lead	51
	B-02	Project Manager, Industry 4.0	Project Owner & Expert	75
	B-03	Intermediary	Support in Challenge Formulation & Contest Design	71
C	C-01	Innovation Manager, Quality Assurance	Project Lead	56
	C-02	Project Manager, Connected Car	Project Owner & Expert	68
	C-03	Intermediary	Support in Challenge Formulation & Contest Design	47

Table 3.2: Overview of informants and their corresponding roles in the projects

A semi-structured interview design was specifically chosen to facilitate discussions and gather new insights from the interviewees (Yin, 2018). Each interview lasted

between 45-90 minutes and was primarily centered around the different design choices in a crowdsourcing project. The questionnaire was designed in alignment with table 3.1, such that the questions addressed broadly referred to the content of the four crowdsourcing dimensions. The questions were open-ended and intentionally rather broad in scope to derive additional and unexpected insights. In addition to validating the conceptually identified dimensions and elements through the interviews, the respondents were encouraged to freely elaborate on the four dimensions, and provide further information to explore new and unknown design aspects that were not addressed in the interview guide. To ensure the reliability of our results, each interview was recorded and transcribed (smooth verbatim technique).

The template analysis technique was used to identify themes and to structure the content because it is a very flexible approach that allows the researcher to develop relevant themes extensively (King, 2012). In particular, the selective coding procedure was used to structure and analyze the data gathered. In the selective coding process, two levels of coding were applied for the content-analysis of the interviews. In the first step, the four fundamental crowdsourcing dimensions were selected as the central categories. After the central categories were established, second-order themes were identified based on an initial and conceptually developed template derived from the crowdsourcing literature (see table 3.1). In the final step, first-order themes were generated from the interview transcripts by identifying relevant patterns, similarities, and differences across the cases.

3.3.4 Overview of Cases

Case A represents a crowdsourcing project with a focus on developing concepts to automatize the vehicle transport process in the assembly scenario - a process innovation. Autonomous Guided Vehicles (AGV) have been used across various manufacturing environments in the past. In recent years, automotive manufacturers have started to use AGV systems to transfer heavy goods between operating sites, increase in-house manufacturing efficiency, and ensure a safer operating environment. Given the strong focus on new technologies and innovations in the production context, the goal of this

project was to develop novel AGV concepts to transport finished vehicles after the final assembly to other areas like testing and rework stations, parking lots or shipping points. In other words, the ideal system should be able to navigate in workplaces and autonomously pick up the vehicle and transport it to the necessary site without any manual interaction. Solvers were given details on the vehicle dimensions (e.g., weight, ground clearance) and infrastructure specifications (e.g., surfaces, ramps, path width etc.) that solutions were required to fulfil. In other words, the seeker was soliciting detailed descriptions and drawings of AGV system concepts to transport its assembled vehicles. In total, 93 solutions were submitted from solvers across 27 countries.

Case B represents a crowdsourcing project with a focus on how 3D Printing could be used for product innovation in the automotive industry. In recent years, 3D Printing has opened up a wide range of new opportunities for automotive manufactures, such as new geometric designs, lighter structures, and improved functional integration. As part of the company's 3D Printing strategic initiative, the goal of the project was to generate new and innovative 3D printable products for a specific vehicle model. Solvers were asked to develop ideas based on customer needs and create value through added functionality, aesthetics, comfort, or customizability. The project was divided into two phases. The first phase was open to anyone to participate. The objective was to generate a variety of diverse ideas that could potentially be integrated into the car. In this phase, solvers were encouraged to be creative and could essentially come up with any 3D printable idea for the vehicle. During this phase, 246 ideas were received. In contrast, the second phase was limited to solvers who developed ideas with the most potential in the first phase. The second phase was a closed project, and solvers were given more detailed technical specifications and vehicle geometric information to produce CAD prototypes. As such, this crowdsourcing campaign is seeking input in a much more detailed solution area, aiming at innovation suggestions, which are close to potentially realized products. Since the two phases of the project have differing innovation goals and hence a different project design, we treat the two phases as individual projects (Cases B1 and B2).

Case C represents a crowdsourcing project with the primary objective of gathering new

and innovative digital services and features to improve the connected car experience and add additional value to the customer. Traditionally, automotive manufacturers collect and analyze diagnostic data to identify issues using their internal systems after vehicles are delivered to car workshops for services and repairs. Data flows are then stored and sent to internal analytics platforms for failure analysis. However, with the recent growing importance of electric vehicles, leveraging data from vehicles is an important tool for car manufacturers to identify malfunctions, eliminate failures in time, and to be prepared to react faster to potential vehicle problems. Currently, the availability of dynamic data from vehicles is still limited because manufacturers require the consent of the customer to obtain this real-time data from vehicles. In the view of the manufacturer, drivers are often not willing to share such data due to concerns regarding privacy issues, mobile data volume, and the perception that there are no visible benefits to them. Therefore, the goal of this project was to develop novel and innovative digital services and features for an existing application to encourage and incentivize drivers to share their vehicle diagnostic data with the company. The solutions were not meant to be algorithms, but rather, detailed descriptions of the service/feature, showing how it uses the existing data fields, and most importantly, ensuring its compatibility with the current data collection interface. In total, 103 solutions were submitted from solvers across 34 countries.

3.4 Results

The data analysis is separated into two steps. First, we separately investigate the individual dimensions as illustrated in table 3.1, each considered one set of coherent signals, and illustrate the interdependencies within each of these signal sets. In doing so, we explore how certain decisions taken influence other decisions within the same dimension that emerged during the coding process. The second step broadens the scope of the data analysis to provide an integrative perspective across all four dimensions. By analyzing the coded data, we identified several interdependencies between the different crowdsourcing design decisions across the four dimensions. In particular, we examine the consequences of certain task-related decisions made early on in the problem

delineation phase, and how these decisions might impact other decisions taken later on. We then illustrate the key differences among the three crowdsourcing projects in terms of the different design-related decisions made, based on the differing innovation goals of the three projects. In particular, we adopt a morphological approach to delineate the set of design choices taken for each of the three projects. In doing so, we provide empirical evidence that enhances our understanding of the rationale behind the different design related decisions taken when setting up the project. This allows to examine how these decisions interact in terms of achieving the overall goal of running an effective and efficient campaign.

3.4.1 Task

The task description or problem statement is a central element in a crowdsourcing campaign because it relates closely to the objective of the campaign and creates a link between the crowdsourcing firm and the crowd. More importantly, the problem statement is the first point of contact between the crowdsourcer and the crowd, based on which solvers decide to self-select into participating or not. The interviewees highlighted that a well-articulated problem statement is one of the most crucial aspects of designing a crowdsourcing campaign because the manner in which the problem is delineated and communicated has a fundamental impact in terms of attracting the attention of the crowd and the quality of the solutions received. According to B-02, "[t]he first thing you need to think about is the problem you want to crowdsource, what you really want to achieve, and if this is suitable for a crowdsourcing project. Based on this, the rest of the decisions follow."

According to the informants, the two most fundamental design elements within the task dimension are the task specificity and complexity, because most of the consequent decisions are influenced by the nature of the problem to be crowdsourced detailed in these two facets. The interviewees referred to high task specificity when the task was precisely defined, explicit solutions were required, and clear expectations were pre-defined in the problem statement before the launch of the crowdsourcing campaign. A-02, A-03, B-02,

C-01, C-02 further indicated that tasks are of high specificity when they are specific to a certain technology or focused on seeking elaborate prototypes or explicit solutions to a problem. Task complexity is determined by the amount of domain-specific knowledge, skill and expertise required to solve the task. The interviewees pointed out that the complexity of the task is closely related to the specificity, which means that tasks that are highly complex in nature are often difficult to specify and hence delineate.

Two-thirds of the interviewees pointed out that the innovation ambition of the task is a crucial element that must be considered when defining the degree of task specificity in the problem statement. According to B-02, "[t]he specificity of the problem statement depends on how creative and innovative the solutions should be." Problems that are high in specificity are often accompanied by an explicit set of solution requirements and guidelines. For such problems, the overall solution space of the solvers is rather limited because the solvers are bound to certain requirements that must be fulfilled in developing the solutions. In other words, the variety and breadth of the solutions tend to be rather narrow, often resulting in solutions that are 'local' to the firms existing knowledge base. However, for problems in which the firm is seeking new perspectives and out-of-the-box ideas, a lower degree of task specificity may be particularly appropriate to expand the potential solution space, meaning that firms can expect to receive a diverse variety of innovative solutions (B-02, B-03, C-01, C-02). Thereby, the informants highlighted that there is a trade-off between having an explicit set of guidelines and receiving solutions that are within the firm's existing knowledge base versus having less stringent requirements and receiving more innovative and potentially disruptive solutions.

Interestingly, A-02, A-03, B-01, C-02 pointed out that even for problems in which the task specificity and complexity are high and the solution space is rather narrow, seekers could still delineate the problem in a manner such that solvers are explicitly encouraged to be innovative in their approaches even within this narrow solution space. According to A-03, "[y]ou want to be specific where it is necessary, but fairly general where possible to really allow the creativity of the solvers to come through." Some interviewees provided alternative ways to reconcile these inherent interdependencies by suggesting

different means of presenting the task. For instance, B-01 and C-02 stated that using visual aids and providing examples from other industries might be especially beneficial to reduce the overall complexity of such problems. C-02 highlighted that "[s]ometimes, if you can see something, it is much easier to conceptualize the issue - a format to illustrate the problem clearly, have a closer interaction, and really show the solvers what our challenge is and what we want to achieve can be very helpful."

Other consequent decisions that are influenced by the specificity and complexity of the problem are the duration of the contest and whether the task should be allocated to a specific target group or not. The interviewees stated that for problems that require solvers to invest a significant amount of time and effort, the duration of the campaign should be longer than that of an ideation campaign that is focused on brainstorming ideas. Other factors to consider when defining the timeframe are the availability of the solvers and the urgency and need for a solution (B-01, C-02, C-03). C-01, A-02, B-02 also indicated that for problems that are of high complexity and related to a specific knowledge domain, a closed target group might be a better alternative to an open audience. On the other hand, for problems that are focused on ideation and creativity, a larger, open target group might be more appropriate. Therefore, these considerations must be addressed when delineating the task because the decision is contingent on the nature of the task and the solutions being solicited.

3.4.2 Platform

The platform refers to the interface through which a firm broadcasts the problem to be solved. The platform is an important dimension as it establishes a connection to the crowd and is the primary medium through which the crowdsourcing firms communicate with potential solvers. Typically, crowdsourcing firms can either develop their own crowdsourcing platform or use intermediary-based crowdsourcing platforms. All the interviewees agreed that developing own scalable platforms can be very challenging, and therefore, working with an established crowdsourcing intermediary is particularly beneficial for firms with little or no prior crowdsourcing experience. Beyond providing

the necessary IT infrastructure, intermediaries play a mediating role in the entire process by supporting the overall campaign design, providing access to the platform and marketing of the campaign to the crowd, as well as providing consulting services (B-01, B-02). Another benefit of working with an intermediary is that they typically have an established set of legal and IP standards and norms embedded in the platform that have already been accepted by their solver network, which in turn, makes the entire process much smoother (B-01, B-02, C-02).

A-02 highlighted that "[t]he crowd is a very important element of such projects and if you do not have such a network and visibility, you cannot attract good solutions." B-02 further pointed out that often intermediaries differ in expertise as well as their network, and therefore, selecting the right partner is an equally important decision, which in turn, is contingent on the nature of the task and the knowledge and skills required to develop solutions.

However, from a cost perspective, B-01 argued that, "[t]he decision to work with an intermediary is really a question of economies of scale." Since most intermediaries have an annual license cost, running multiple campaigns on one intermediary platform can reduce the overhead fixed costs. Therefore, for firms to decide whether to develop their own platform or to work with an intermediary, it is important to consider the different operating costs, their ability to establish a diverse network, the scalability, and the overall management of the platform.

3.4.3 Crowdsourcer

The crowdsourcing firm is ultimately responsible for the overall campaign design starting from task delineation phase to the evaluation and implementation of the crowdsourced ideas. The interviewees stated that from the firm perspective, the overall project governance and resource planning are two of the most critical facets in a crowdsourcing project. This includes activities such as defining a concrete project plan, setting up an adequate project timeframe with relevant milestones, identifying the relevant internal stakeholders within and across business units, securing sufficient

budget, and most importantly, ensuring that the ideas received have the potential to be absorbed into the firm. According to A-01, "[y]ou need to invest a good amount of time to set up a crowdsourcing project [...] You need to think about many factors before starting the project, for example, which stakeholders should be on board, how much budget is needed, how many man hours are required, and so on." B-01 further added that "[a] very structured approach and thorough project planning at the start can help to minimize the overall resources invested. For example, if you can leverage the expertise of different people and not have the entire project team in every meeting, you can make better use of time." In other words, assigning members of the project team with specific roles and responsibilities and ensuring regular alignment meetings can result in better operational efficiency. B-01, B-02, C-01 highlighted that ensuring the commitment from all the stakeholders in the project team at the onset of the project is especially important. C-01 stated that "[b]ecause we did not have the commitment of implementation from the product owner right from the beginning, we could not implement the ideas later on."

The interviewees also pointed out that risk management is an important element that must be considered during the set-up of crowdsourcing projects. All of the interviewees stated that the most prominent risk is the probability of only receiving low-quality ideas or solutions. According to C-01, "[i]t was a rollercoaster initially. When we first published the challenge, I was initially anxious and thought, would it interest the right people? What quality of ideas would we get?" A-03, B-01, C-01 additionally pointed out that the manner in which the task is delineated and communicated has a significant impact on the overall quality of submissions received, meaning that a high quality problem statement can significantly reduce the risk of receiving low quality solutions. Interestingly, A-02, A-03, B-01 and B-02 argued that the risk of receiving low quality solutions can be dramatically reduced by incorporating appropriate feedback mechanisms during the run-time of the contest. According to A-03, "[w]hen solvers receive feedback, they feel encouraged. Often, the questions are very crucial to the solving process, so receiving constructive feedback can definitely help the solution quality." In fact, A-03, B-01, B-02 stated that interactive feedback formats, such as regular feedback calls with solvers that have promising ideas,

might be especially effective. B-01 highlighted, "[n]ext time, I would think about a Q&A session with the crowd to answer relevant questions that we may not have thought about. And I would also think about having a final presentation or pitch session, where you invite the very best solvers to present their ideas physically or virtually, because it is very important to celebrate the ideas as well."

Another potential risk observed was the possibility of leaking confidential information in the challenge statement. For cases B1 and C, the problem was not confidential, therefore the risk was relatively low. However, cases A and B2 involved some confidential data, which was then eliminated from the problem statement to reduce the risk of information leakage. The interviewees explicitly stated that it is very important to consider how much confidential data is involved before crowdsourcing a problem. A-02 and B-02 highlighted that it is relatively difficult to delineate problems that involve highly confidential data, which in turn has an impact on the overall solution space. All the interviewees stated that the respective legal and data protection teams were consulted during the problem formulation phase to avoid any potential information leakage.

The interviewees highlighted an interesting point, stating that the chosen incentives and the defined intellectual property treatment are very closely linked to the complexity and specificity of the task. For instance, tasks that involve developing complex prototypes or elaborate solutions require solvers to invest a relatively significant amount of time and effort, and possibly more specific skill sets. In such cases, larger financial incentives and rewards are especially important (A-01, A-03, B-01, C-01, C-02). In all projects, the incentives were distributed among the top winning ideas. B-03 explicitly highlighted, "[w]e wanted to give many opportunities to the creatives. Having one big award may decrease the chance and motivation to work on a challenge." According to A-01, A-02, A-03, B-02, C-03, defining suitable intellectual property mechanisms is particularly important. For each of the three described projects, the seeker collaborated with a crowdsourcing intermediary, and followed their standard IP treatment for the respective projects. However, A-01, A-02, C-01 stated that for projects focused on idea generation as opposed to developing complex concepts or working prototypes, the seeker

received a non-exclusive right to all solutions received. On the other hand, for problems that are of higher complexity, seekers typically prefer to obtain exclusive rights to working prototypes. In such cases, solvers must be adequately compensated.

With regards to the brand image, the interviewees highlighted that it is crucial to consider the impact of the project on the overall brand image of the company before publishing the task online. The underlying goals and objectives of the task can have a substantial impact on how individuals outside the firm perceive the brand. In each of the three projects, all of the interviewees perceived the impact of the project on the brand to be positive. According to B-02, "I could really imagine when people saw this contest, they thought, ah cool, they are doing a crowdsourcing contest in the 3D printing area. This is probably not what many think about when they think of big companies and how we generate ideas." The interviewees believed that using an 'open' approach such as crowdsourcing, especially in a traditional automotive company, sparked a huge interest among the solver community to participate and submit solutions.

For each of the three projects, the solutions received were evaluated by subject experts in the respective fields. All interviewees stated that having appropriate experts on board is especially crucial for the implementation phase later on. The interviewees explicitly pointed out that the solution evaluation phase is very time intensive, and therefore defining an evaluation strategy in advance is very beneficial. A-02 argued, "[w]e had over 100 ideas to evaluate. We divided the solutions in a team of 5 experts, and everyone rated the ideas. [...] Then, we pitched our top ideas to the team in a one-day workshop, where we discussed them, challenged them, and evaluated them together to select the final winning ideas." The interviewees also stated that during the solution evaluation it is crucial to consider the implementation feasibility of the ideas. This becomes especially relevant for problems that are complex that might include very specific technical requirements. For instance, C-02 pointed out that in some cases, although the overarching concepts were very interesting, the ideas could not be implemented because they were not technically feasible or compatible with the existing hardware. A-02, B-01, B-02, C-01 highlighted that in addition to idea feasibility, defining a concrete plan with the appropriate implementation

partners is especially important to follow through. B-02 stated, "[y]ou should do another evaluation, say 3 months after the project, to see where the ideas lead to. This way you can drive implementation of the ideas better. Following up with the experts is a good way to track project success."

To measure the overall success of the projects, most of the interviewees mentioned that there were no concrete metrics in place. The quality of the ideas received and the potential to realize them were the two most important metrics that defined whether the project was a success or not. A-02, B-01 and C-01 further mentioned that the novelty and creativity of the solutions were also important success criteria. This is especially relevant for crowdsourcing projects in which the seeker is seeking new approaches and innovation solutions. According to A-01, "[w]e measured how many valued ideas and concepts we received, and then of course, how many projects we can start afterwards, and then the final measurement is whether any of these projects can go live and be implemented. Also, combined with that, we measure how much money we save with the idea or how much revenue we can make by implementing the idea." However, B-01 and B-02 mentioned that that even if the ideas cannot be directly implemented, but instead serve as an inspiration or lead towards other novel ideas, the project can still be considered a success. The interviewees suggested that developing concrete KPIs to track project success is especially important to get management support and to facilitate learning for future projects.

Some interviewees additionally highlighted that expectation management is a crucial aspect in the crowdsourcing process. The informants stated that since crowdsourcing is a relatively new tool, managers should be made aware that just like any other project, there is also a possibility of failure. According to C-01, "I thought it was important to communicate that there could be two outcomes, one is that maybe we are not able to implement any of the ideas but we should still think about how we can use them. The other outcome could be that we are able to easily implement the ideas. Either way, the two scenarios need to be communicated". Similarly, B-01 mentioned that "[t]he concept was quite new for us, so it was also important to be clear and explain to the team members what the method is about, why we want to use it, and also to align on the goals and

expectations for the project."

3.4.4 Crowd

The success of any crowdsourcing campaign relies on its ability to attract and motivate the crowd to participate and submit solutions. While the quality of the problem statement and the manner in which the task is delineated play a fundamental role in attracting the attention of the crowd, a central aspect is to understand what motivates the crowd to participate and develop solutions. The informants stated that solvers are typically motivated to participate by a combination of extrinsic and intrinsic motivation factors. Some of the interviewees link extrinsic motivation factors such as monetary awards to problems of higher complexity and those that require a specific set of knowledge or skills. For instance, A-03 argued that "[a] higher award does not necessary lead to more involvement, but it is important to take into account the complexity and effort required when allocating award structures." Beyond the typical monetary awards in crowdsourcing campaigns, A-03, B-03, C-01, C-03 highlighted that intrinsic factors such as the name and recognition of the seeker and the innovation ambition of the task also have a significant impact on the motivation of potential solvers to participate. According to B-03, "[t]he biggest motivating factor is the freedom to innovate and to come up with creative products. I mean the creatives want to show their work." C-03 further added that "[t]he possibility of seeing an idea in practice in the future is certainly a big motivation factor for the solver." Furthermore, B-03 mentioned an interesting point, that providing solvers with multiple opportunities in terms of the award distribution scheme, is especially important because "[...] having one big award might decrease the motivation to work on the challenge since the chance of winning becomes very low."

Other crowd characteristics that crowdsourcing firms need to consider when designing the campaign are the diversity and size of the crowd. Crowd size is closely related to the knowledge diversity. For instance, a large crowd of more than a hundred thousand individuals is more likely to comprise individuals with different knowledge backgrounds,

professional experience and skill sets. While organizations cannot explicitly select the exact size of the crowd, it is important to decide whether to seek a large crowd with higher knowledge diversity, or a smaller, targeted crowd with specific knowledge and skills. Most of the interviewees agreed that knowledge diversity in terms of having additional know-how outside of the specific field or industry of the problem is especially crucial when searching for innovative solutions and creative approaches to a problem. C-02 stated that, "[w]e were very open to have new ideas or approaches, so additional knowledge and experience was obviously welcome [...] You never know what great ideas exist out there, so we did not want to specify that only people with a certain background should participate. We knew that there could be topics or ideas that we are completely missing that could be interesting." A-02 further added that "[o]ne of the winning solvers was working in the aeronautics industry and applied some knowledge from there to the solution. That was quite interesting." Consequently, for problems that are highly complex in nature and specific to a certain knowledge domain, selecting a smaller crowd size with the required set of skills and knowledge might be a better option.

3.4.5 Interdependencies between crowdsourcing dimensions

In this section, we assess the operationalization of the three crowdsourcing projects in terms of the different design related decisions taken across the projects. In doing so, we show the different configurations across the cases, and develop propositions based on our findings. As such, our results also highlight critical interdependencies among the decisions choices. In particular, we find indications of hierarchy between the elements, in terms of certain design choices influencing subsequent decisions. We adopt a morphological approach as it allows to present an integrative, visual representation of the overall solution space by structuring and organizing the different design parameters and possible decision options (Ritchey, 2006). In other words, the model seeks to unravel different possible solutions to a crowdsourcing problem by accommodating "multiple alternative perspectives rather than prescribing a single solution" (Ritchey, 2006, p.11).

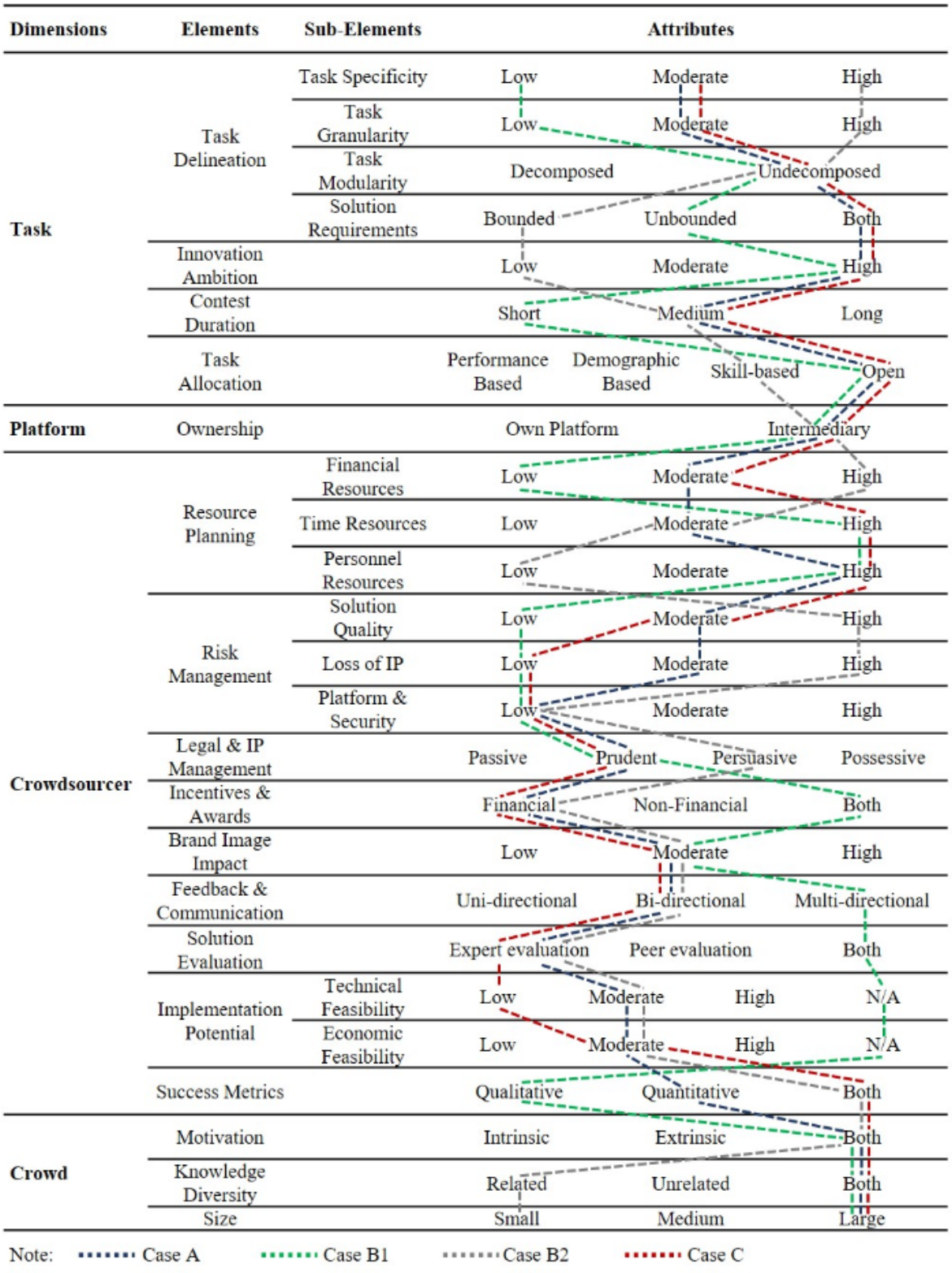

Figure 3.1: Path delineation across the three crowdsourcing projects

Figure 3.1 represents the design decisions for each of the three crowdsourcing projects. The respective values for each of the attributes presented above were evaluated and developed with the informants during the interviews. Each design element is

operationalized either as an ordinal or nominal scale, representing the actual design choices in the cases. Since a crowdsourcing campaign is designed by taking different decisions across the elements, our primary goal is to highlight the various considerations that need to be made across the design elements. We, therefore, develop a scale level guided by the actual decision type from our interviews and our ambition to demonstrate the design-related differences across the three projects.

For instance, the innovation ambition of the task is measured using an ordinal scale from low to high, meaning that the seeker firm is either seeking specific solutions to a problem close to the current situation (low innovation ambition) or searching for new perspectives and out-of-the-box, disruptive ideas (high innovation ambition). The interviewees related the innovation ambition of the campaign either to the newness of the technology to the industry or to the type of expected solutions being solicited. According to B-02 "[b]ecause the technology is relatively new in the automotive industry, I think the innovation ambition was quite high." C-01 further added the innovation ambition was high because "[t]he solvers had the space and freedom to use their imagination and be creative since we were really looking for a variety of new and innovative ideas." Similarly, C-03 mentioned that "[i]t was very innovative because the solution space was wide open with the range of possibilities that solvers could return."

However, for design elements such as the legal and IP strategy and the feedback and communication mechanism, we adopt a nominal scale delineating qualitatively different design options taken across the projects in practice. These decisions were primarily chosen depending on the potential choices as well as the design recommendation of the intermediary. A-03 and C-03 stated that for crowdsourcing projects focusing on ideation as opposed to developing concrete prototypes, the seeker opted for a non-exclusive license to all the submitted solutions rather than adopting a persuasive approach of receiving exclusive rights for every solution. Similarly, the form of communication was chosen based on the business model of the intermediary. In Cases A, B2 and C, the seeker chose a bi-directional strategy while in Case B1, a multi-directional strategy was used, meaning the solvers were able to communicate with each other through a forum.

Although theoretically, there could be multiple combinations of design parameters, the opportunities for taking viable decisions are much more limited in practice. Therefore, we use a decision-centric approach to identify the key decisions that organizations take when designing crowdsourcing projects, and more importantly, to understand how certain initial design choices limit other subsequent decisions.

The cases indicate that the underlying task is the most central decision parameter in the overall campaign design. According to the informants, the two most fundamental design elements within the task dimension are the complexity and specificity of the underlying task.

Task complexity is determined by the number of skills and expertise required to solve the underlying task. Tasks that are complex in nature typically require domain-specific knowledge and expertise to solve. Our interviews suggest that as the level of task complexity increases, the level of involvement, effort and cognitive skills needed to solve the problem also increase. For instance, in Case B1, the complexity of the task was considered rather low because the objective was to generate a variety of ideas for 3D printable products that could be integrated into cars, ultimately adding customer value. Solvers were not expected to have any specific 3D printing knowledge and were merely encouraged to submit innovative ideas. Consequently, the solvers were not limited by any specific solution requirements. Since the objective was to generate a diverse variety of potential ideas, the task was open to anyone to participate. Therefore, the seeker opted for a large, diverse crowd (over 120,000 potential solvers) with solvers from diverse knowledge backgrounds. Furthermore, since solvers were not required to develop concrete solutions, but rather come up with innovative ideas, the time and effort required to submit ideas can be estimated to be rather low, therefore, the individual financial rewards chosen were also relatively low (total prize pool of approx. 27,000 Euros). The prize pool was distributed among the solvers with the maximum individual award of 2,500 Euros. In total, 246 ideas were submitted during this project phase. For such tasks that are open to a large crowd, seekers should expect to receive a large number of solutions and should consequently plan adequate resources for the evaluation

of the ideas. The seeker used a combination of peer and expert evaluation to sieve throughout the ideas efficiently.

In contrast, in Case B2, the complexity of the task was considered high because solvers were required to develop concrete prototypes of their ideas. During this phase, five selected solvers were given detailed technical specifications and vehicle geometries to develop 3D printable files. The project was invite-based, meaning that only five solvers were selected to participate. The solvers were limited to those that had the relevant domain-specific knowledge and expertise to develop concrete solutions. In this phase, the focus was rather on collaboration with the seeker to develop a product that meets the expectations, and therefore, the seeker had close interaction with the solvers during the development process. In order to deliver concrete prototypes, the solvers were expected to have exclusive knowledge and expertise in the 3D printing domain. Since the seeker was tapping into such monopolistic competencies, the financial rewards chosen were also relatively higher than that of the first phase (total prize pool of 25,000 Euros). Each solver received an award of 5,000 Euros for their submission.

Our cases clearly demonstrate that the complexity of the task triggers many other design decisions across the other dimensions such as the type of incentives chosen, the size and knowledge diversity of the crowd, the quantity and quality of the solutions received, and the manner in which the solutions are evaluated. Therefore, it is crucial to take into account the difficulty of the problem and the level of skill and expertise required when designing the campaign. We therefore state Proposition 1a and 1b accordingly:

P1a: If the task is defined at a high complexity level, crowdsourcing campaigns are designed to target solvers with specific domain knowledge.

P1b: Attracting solvers with specific domain knowledge requires higher financial rewards.

Beyond the task complexity, the interviewees pointed out that the task specificity plays a fundamental role in the overall project design. Task specificity refers to the scope of the problem to be solved. It could range from highly specific tasks to open-ended tasks for which no particular problem-solving approach or solution is known. The specificity

of the task typically reflects whether the company searches for solutions that are local or distant from its exiting knowledge base. For instance, in Case B1, the solvers were not limited to any specific solution requirements since the seeker was explicitly looking for innovation ideas and impulses for 3D printable products. The only requirement was that the potential idea should be customer centric, meaning that it should create added value for the customer. Since the seeker was looking for highly innovative ideas, the solution requirements were unbounded, meaning that the task specificity was low. By choosing to have low task specificity, the seeker was opting for radical input that had not been explored yet.

Similarly, in Case C, the objective of the project was to gather innovative ideas for digital services for an existing application to improve the connected car experience of the customer. The seeker was explicitly looking for out-of-the box ideas that they had not considered before. In this case, the task specificity is considered moderate because the task included some technical specifications related to certain required data fields and the compatibility with the existing software, but on the other hand, solvers were encouraged to develop innovative ideas. According to C-01, "[o]ur goal was to get a lot of disruptive ideas and inspirations from all sorts of domains [...] From a technical perspective, the solutions had to be compatible with our technology, but from an innovation perspective, the scope was wide and solvers were absolutely free to come up with innovative ideas. We tried not to be too specific and to keep it quite open for solvers to provide us with concepts that we had not thought about before." In other words, the solution requirements were rather bounded in terms of certain technical limitations, but unbounded in the sense that the solution space was completely open for the solvers, meaning that solvers were free to be innovative in their approaches.

In contrast, in Case B2, the task specificity was high because solvers were required to develop concrete solutions based on very specific details and deliverables, meaning that the solution requirements were tightly bounded. B-01 and B-02 highlighted that the solvers were given explicit specifications regarding car geometries and were expected to deliver prototypes in a specific (CAD) format. In this case, the seeker was not looking for

radical ideas but instead, searching for rather local and in particular feasible solutions to the existing task.

Our informants explained that when the task is very specific and solvers are required to meet explicit solution criteria, the received solution space tends to be rather confined. In other words, solvers are limited in terms of their freedom to be innovative. B-01 explicitly highlighted that "[w]hen you provide too much information, it is not any different than solving it internally, because you limit the thoughts and out-of-the-box thinking of the solver by transporting our thinking to them." Therefore, our cases indicate that when organizations opt for low task specificity, they choose to access knowledge distant to their current trajectory, which could potentially result in more radical, out-of-the-box solutions. On the other hand, for tasks that are more detailed and require solvers to fulfil specific criteria, the solution space is reduced, meaning that solvers are forced to interpret the problem through the lens of the firm, resulting in solutions that are incremental in nature and more local to the firm. We therefore propose:

P2a: High task specificity forces the solver to adopt a seeker perspective.

P2b: Adopting a seeker perspective limits the solution space for problems with a high innovation ambition, resulting in solutions that are more likely to be incremental.

The case assessment highlighted the innovation ambition of the task as an important design element. The informants explicitly highlighted that the degree of innovation is an important facet in terms of the decision-making process within a crowdsourcing project. In the context of our study, we define the innovation ambition of the task based on the expected newness of the solution to the industry.

A key decision in the crowdsourcing process is whether to seek a large crowd with diverse knowledge or to address a small, targeted group of individuals with related expertise. In other words, when organizations seek to acquire distant knowledge (low task specificity), a larger crowd size with higher knowledge diversity can be especially beneficial to tap into new knowledge. Since individuals typically self-select into participating, organizations cannot choose the exact number of potential contributors. However, from a campaign design perspective, organizations can choose whether to

address a large, open crowd or to select a small one. Our cases show that when the innovation ambition is high, reaching out to many solvers may increase the potential diversity and heterogeneity of the ideas, and hence the chance of receiving more innovative solutions. For instance, in cases A, B1 and C, the innovation ambition of the task was considered high because the crowdsourcing firm was explicitly seeking to receive novel ideas which had not been considered yet. Consequently, the seeker opted for a large crowd size (approx. 400,000 individuals) with a broad range of skills and knowledge. C-02 pointed out that "[w]e were very open to new ideas or approaches [...] You never know what great ideas exist out there, so we did not want to specify that only people with a certain background should participate. We knew that there could be ideas that we are completely missing, that could be interesting."

On the other hand, in Case B2, the specificity and complexity of the task was high, meaning that the seeker was looking for specific solutions based on certain solution criteria. In other words, the solvers were not asked to come up innovative ideas, but instead, were given explicit instructions and were confined to a limited solution space. According to B-02, "[f]or this challenge, I think it was important for solvers to have to experience with UX design as well as knowledge about the 3D printing technology and how it can be used in the automotive industry." Therefore, in this phase of the project, the seeker worked with a very small target group of five experts that had the required knowledge and expertise.

Our interviews therefore demonstrate that for tasks with a higher innovation ambition that focus on receiving new and disruptive ideas, reaching out to a larger crowd increases the chances of receiving innovative solutions. This leads to our third proposition:

P3: The higher the innovation ambition of the underlying task, the higher the required knowledge diversity and heterogeneity among the crowd.

3.5 Discussion

Our study contributes to the crowdsourcing literature by developing an approach to conceptualize the overall design of crowdsourcing campaigns to better understand and structure the key design elements of such projects. In particular, we explore the various design complexities and interdependencies involved in developing effective crowdsourcing campaigns. Despite the growing importance of crowdsourcing projects in practice, limited attention has been paid to the overall configuration and design of such initiatives, and how certain individual design decisions impact subsequent decisions to form a comprehensive crowdsourcing project. Since designing a crowdsourcing campaign entails multifold interrelated design decisions, we engage in a case study approach to empirically investigate three distinct crowdsourcing projects for innovation to better understand how they are operationalized, and what rationale guided the different design related decisions taken, when setting up each of the projects.

3.5.1 Theoretical Contributions

Despite the growing research interest in the crowdsourcing field, there is little information about the overall design and set up of crowdsourcing projects. Previous research has primarily focused on addressing single or specific design elements rather than developing a comprehensive picture of the overall crowdsourcing system. As a result, there is a 'lack of standardization' (Neto & Santos, 2018, p. 490) for crowdsourcing projects, and a conceptual framework representing the important design facets has yet to be established (Zheng et al., 2011). In our research study, we aim to alleviate this gap by developing a 'comprehensive guideline' (Amrollahi, 2015, p. 2) to better understand and structure the key design related decisions across crowdsourcing projects.

We adopt an innovation barrier perspective coupled with signaling theory to investigate how crowdsourcing campaigns can be designed effectively to capture relevant innovation. In particular, such crowdsourcing initiatives offer organizations the opportunity to address innovation problems in terms of tapping into sources of external

knowledge. In the context of crowdsourcing, the decision to conduct local or distant search is typically contingent on the nature and complexity of the crowdsourced task, and more importantly, the specificity or scope of the problem. The manner in which the problem is delineated and communicated determines whether the firm solicits solutions that are local or distant from its existing knowledge base (Afuah & Tucci, 2012; Gillier et al., 2018; Jespersen, 2018). Hence, from a local search bias perspective, crowdsourcing can be a means to overcome innovation barriers within firms. However, in order to design effective crowdsourcing campaigns, there are some key design facets, which interact together to impact the overall success of the initiative. We draw on signaling theory to explore how different decisions taken by the firm influence the signal quality projected by the firm, which in turn, influences the success of the crowdsourcing campaign. In particular, this conceptual perspective allows to structure crowdsourcing campaigns into main decision dimensions, which together provide a comprehensive basis for delineating decision elements.

Our research complements some major findings in the crowdsourcing literature. The cases indicate that the underlying task is the most central decision parameter in the overall campaign design because it relates closely to the objective of the campaign and more importantly influences subsequent decisions. This finding is supported by Pollok et al. (2019a), who argue that the quality of the problem statement and the firm's decisions in the problem formulation phase play a critical role in attracting the attention of potential solvers to participate in the contest and submit solutions. Within the task dimension, the two most fundamental design elements are the complexity and specificity of the task. Our results show that as the complexity of the task increases, crowdsourcing campaigns are designed to target individuals that have domain-specific knowledge. This finding complements Ren et al. (2021), who find that professionals, having domain-specific knowledge, are better in solving tasks that require specialist knowledge than a more general crowd. Furthermore, for problems with a higher complexity, solvers require more time and effort, and hence, adequate compensation through financial incentives becomes especially important. This is supported by a large body of prior crowdsourcing research (Afuah & Tucci, 2012; Blohm et al., 2018; Ghezzi et al., 2018; Jeppesen & Lakhani, 2010;

Lee et al., 2015). Our findings extend the current literature on task specificity by showing that tasks that are very specific in nature, force solvers to adopt a seeker perspective. Consequently, the overall solution space is confined, and solvers are forced to interpret the problem through the lens of the firm, resulting in solutions that are more likely incremental in nature and more local to the existing knowledge base of the firm. This is supported by Jespersen (2018), who states that tasks that are highly specific often lead to solutions that are incremental in nature. Similarly, Afuah and Tucci (2012) argue that the specificity of the task reflects whether the company is searching for solutions that are local or distant to its current knowledge base. Our research complements these findings, proposing that the specificity of the task is a key design decision that must be considered, which in turn, influences the overall solution space and the innovation potential of the solutions.

Following the signaling theory perspective, the potential solvers are at the receiving end of the signal, who screen the problem projected by the seeker and assess whether they are able to provide solutions, given their individual knowledge and capabilities (Pollok et al., 2019a). Furthermore, Connelly et al. (2011, p.61) argue that signals are rarely perceived as single signals, but instead, receivers typically aggregate "a series of signals into meaningful wholes." Therefore, it is crucial for firms to apply a portfolio perspective when deciding on signals in a crowdsourcing context, and how these different signals might interact with each other. Hereby, our study strongly suggests that the decisions related to the complexity and specificity of the task play a substantial role for the portfolio perspective of signaling, which in turn, need to be considered explicitly in view of their impact on the crowd's perception of the whole signal portfolio.

Extending research, our results suggest innovation ambition of the task to be an additional, critical decision element in the context of crowdsourcing project design. The innovation ambition of the task determines the crowd that should be targeted. Our cases reveal an important trade-off between the specificity and innovation ambition of the task. For problems that are particularly complicated to solve internally, firms may engage in crowdsourcing for innovation, to generate new perspectives on how to solve

such problems (Boudreau & Lakhani, 2013). However, to convey the complexity of the problem, firms may have a tendency to engage in more specific task delineation. Since more complicated tasks are typically subject to more internal research and development, and hence, have a greater chance of accumulating 'local' knowledge about the different facets of the problem, firms may tend to provide more detailed descriptions. As a result, solvers are forced to apply a seeker perspective, which in turn, limits the innovation ambition of the task. Although our case studies demonstrate that for tasks with a higher innovation ambition, reaching out to a larger crowd with diverse knowledge and competences increases the chances of receiving innovative solutions. Considering that crowdsourcing can be a means to overcome internal innovation challenges within firms, our study indicates that the trade-off between the specificity of the task and the innovation ambition is an important issue to be considered with respect to the design of the project.

3.5.2 Managerial Implications

In our study, we adopt a 'clinical' case study approach to examine three crowdsourcing projects set in an established firm environment, providing a detailed account on the rationale behind the different design decisions taken along the crowdsourcing process. In doing so, we gather first-hand information from experienced crowdsourcing managers to inform us about the actual decisions taken when designing such projects. Furthermore, our research explores the fundamental interdependencies between the different design decisions.

Therefore, from a practical standpoint, this study provides valuable insights for practitioners and managers undertaking crowdsourcing projects. By adopting a decision-centric approach, this paper provides different configurations of crowdsourcing projects, allowing managers to choose alternative solutions for each design parameter, depending on the goals of the crowdsourcing initiative. Through our cases, we demonstrate the underlying rationale for certain decision choices, and point out crucial interdependencies among certain design elements. In doing so, we seek to provide a

comprehensive guideline and blueprint for crowdsourcing, allowing managers to make more informed decisions to effectively design such projects.

Our results indicate that organizations must clearly define in advance whether they are seeking innovative, out-of-the-box ideas or are rather seeking incremental improvements to their existing portfolio. This finding is embedded in the literature of innovation newness (Schultz, Salomo, & Talke, 2013; Talke, Salomo, Wieringa, & Lutz, 2009), and challenges organizations to define the desired degree of innovation during the design phase of a crowdsourcing campaign.

Furthermore, our results show that it is very important to strike a balance between being too specific and, therefore, limiting the solution space of the problem versus being open, which enables solvers to think out-of-the-box, but at the same time, increases the risk of receiving low-quality solutions. Our case studies demonstrate that even for problems in which the task specificity and complexity are high, which results in a rather narrow solution space, seekers could still present the problem in a manner such that solvers are encouraged to be innovative. For instance, some interviewees suggested using visual aids to better convey the complexity of the problem, while others suggested providing examples from other industries to gather inspirations and widen the overall potential solution space. This provides first evidence of possible practical approaches to addressing evident tensions in design choices.

3.5.3 Limitations & Future Research

As with any research, this paper also has limitations. Although our cases offer rich practical insights, we primarily focused on the seeker perspective by gathering data through interviews with various stakeholders involved in the process. The perspective of the solvers is only indirectly assessed. As such, a promising avenue for further research is the assessment of how potential solvers perceive the design of a crowdsourcing campaign, especially in terms of its complexity, specificity and the innovation ambition in the context of a portfolio perspective on signaling in crowdsourcing. The various design decisions taken throughout the project result in a portfolio of different signals

received by the solvers. Our results indicate some significant dilemmas in the decision making process, especially in the context of the task specificity and the innovation ambition. Future research could examine these trade-offs and assess how such trade-offs could be potentially resolved through a portfolio of signals, which might even offer an opportunity to include contradicting signals. Hence, we see potential in identifying the design facets that solvers perceive as central in shaping a high-quality signal, and whether the solvers' perceptions match those of the seeker.

Furthermore, we subjectively assess the innovation ambition based on the interviews with our informants. Future research is encouraged to operationalize the innovation ambition using dedicated scales, and further explore relationships among certain design elements, and how these might shape the outcome and success of the campaign. In our study, we relate the innovation ambition of the task to the newness of the technology to the industry or the novelty of the solution received. However, considering that innovativeness is a multi-dimensional phenomenon, future research could include other perspectives such as the need or customer dimension of newness, rather than focus on the means and technology side. Although this might potentially restrict the potential to transfer and implement the solutions, it could potentially trigger novel solutions that avoid firm-inherence rigidities due to internal and external resource configurations.

Next, our study focuses on different crowdsourcing projects within one focal firm in the automotive industry. It is important to point out that most automotive firms are large-scale, established firms with complex products and value chains. In addition, such firms are characterized by well-developed routines, established supplier networks, and stringent industry standards. This often results in organizational inertia, which, in turn, makes adopting new innovation strategies such as crowdsourcing as a form of open innovation relatively complex in comparison to small-scale firms that are more flexible and efficient. Therefore, future research could potentially enrich this model in the context of other industries and different corporate settings, to determine if there are additional design elements that might be relevant in the overall crowdsourcing project design.

Finally, in our study we focus primarily on intermediary-based crowdsourcing

projects that engage in an open call to a large crowd. However, there might be other crowdsourcing options that target a closed group of individuals such as industry experts with specific skillsets, consultants or other partners in the value chain. This, in turn, could lead to completely different design decisions along the process. Future research could investigate these options to explore if there are any major differences in terms of the design choices involved and the overall set up of the project. We believe the morphological approach presented in this study provides a promising foundation for these other types of crowdsourcing projects and are confident that the identified dimensions remain central. However, we encourage future research to contrast different types of crowdsourcing campaigns adopting the morphological approach presented in this study.

Chapter 4

Designing Crowdsourcing Contests for Ideation: Investigating the Relationship between the Task Delineation and Crowdsourcing Performance (Paper III)

Abstract

A major challenge for crowdsourcing firms is to attract and motivate the crowd to submit solutions. Prior research emphasizes that the task to be crowdsourced is one of the most crucial aspects of designing a crowdsourcing campaign. Therefore, the manner in which the task is delineated and presented plays a central role in the overall crowdsourcing campaign design. To address this issue, this study empirically assesses three central design elements in the context of crowdsourcing contests for ideation: task complexity, task specificity, and innovation ambition of the crowdsourcer, and how they influence the overall campaign performance. Drawing on a rich dataset of 392 ideation challenges from 2010 to 2020, we investigate the impact of these three design elements on crowdsourcing performance in terms of the ratio of the total number of submitted solutions to the total number of interested solvers per challenge. Complementing prior research on a well-articulated problem statement, the findings of the paper highlight that the each of the three examined characteristics of the task have a fundamental impact on crowdsourcing performance. In particular, the results show that the innovation ambition communicated in the challenge statement is especially crucial for success in ideation campaigns.

Keywords: *Crowdsourcing contest design, ideation, open innovation*

4.1 Introduction

Despite the growing significance of innovation contests and the myriad advantages it brings, one of the most prominent managerial challenges for crowdsourcing firms is to attract and motivate the crowd to submit solutions (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Piezunka & Dahlander, 2015). Since the task description is typically the first point of contact between the seeking firm and the crowd, a well-articulated problem statement is especially important in attracting the attention of the crowd to participate in innovation contests (Afuah & Tucci, 2012; Natalicchio et al., 2017). In fact, Garcia Martinez (2017) posits that solver motivation to participate is triggered by certain characteristics of the underlying task. Similarly, Ghezzi et al. (2018) explicitly point out that crowdsourcing firms face multiple trade-offs when delineating the task, such as ensuring that the problem statement is articulated clearly (Afuah & Tucci, 2012), providing solvers with adequate information, and at the same time, avoiding unnecessary constraints that potentially hinder their creativity (Steils & Hanine, 2016). In particular, two fundamental components of the task description are the task complexity, which determines the knowledge and skills required to solve the task (Bao, Tang, & Ma, 2019; Garcia Martinez, 2017; Natalicchio et al., 2017; Ye & Kankanhalli, 2013), and the task specificity, which defines the scope, requirements and solution space for the submissions (Boons & Stam, 2019; Jespersen, 2018; Nakatsu et al., 2014). Another critical component that has been ignored by extant research is the innovation ambition of the seeking firm, which in turn, indicates the (innovative) nature of the solutions being sought. To this end, limited prior studies have explored how these attributes of the task contribute to solvers' decisions to participate and submit solutions in innovation contests (Ghezzi et al., 2018). As a result, this lack of a comprehensive conceptualization limits our understanding of how certain decisions taken when delineating the task influence the outcome of crowdsourcing initiatives [1].

[1]This paper was presented at the OUI, 2021. The conference paper began with a broader introduction on the relevance of crowdsourcing for innovation. To avoid redundancy, it has been condensed here.

A second shortcoming is that despite the extant literature on the different factors that motivate the crowd to participate (Acar, 2019; Ghezzi et al., 2018; Lee et al., 2015; Leimeister et al., 2009; Zhao & Zhu, 2014a), little is known about how certain decisions taken when articulating the problem statement play a role in motivating solvers to contribute in innovation contests (Ghezzi et al., 2018). In particular, empirical evidence of the impact of these different task related decisions on solver motivation to participate is still lacking. Moreover, we respond to the calls for further research highlighted by Ghezzi et al. (2018) in a recent literature review on crowdsourcing, and seek to answer the following central research questions: How can innovation problems be delineated in order to improve solver participation in crowdsourcing contests? In particular, how do certain characteristics of the task contribute to solvers' decisions to submit solutions? In consideration of the aforementioned research questions, we draw on a rich dataset of 392 ideation challenges, and seek to empirically investigate three crucial attributes of the task; task complexity, task specificity, and the innovation ambition of the seeking firm, and more importantly, how these contribute to the overall performance of a crowdsourcing campaign.

By addressing the aforementioned research questions, this study contributes to the current literature in several ways. First, it addresses one of the most prominent managerial challenges, which is to attract the crowd to participate and submit solutions in a crowdsourcing campaign (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Piezunka & Dahlander, 2015). This study further complements crowdsourcing literature on the significance of a well-articulated problem statement on campaign performance (Pollok et al., 2019a). Second, by empirically investigating three crucial attributes of the task, we enhance the current understanding on crowdsourcing campaign design in terms of how certain task related choices contribute to solvers' intrinsic and extrinsic motivation to submit solutions. Third, we draw attention to the innovation ambition of the seeker, an aspect that has been ignored by extant research thus far. Our findings indicate that the innovation ambition of the seeker has a positive impact on overall crowdsourcing performance. Consequently, the insights generated from this study have significant practical ramifications for crowdsourcing managers to make more informed

decisions to better design and operationalize crowdsourcing campaigns, in order to achieve the desired outcome.

4.2 Conceptual Background and Framework Development

4.2.1 Crowdsourcing Contests for Innovation

The underlying premise of crowdsourcing is that an organization outsources a problem, for which it is seeking solutions, to an external group of individuals, the 'crowd' (Howe, 2006). In this study, we specifically focus on innovation contests, also commonly referred to as tournament-based crowdsourcing or broadcast search (Afuah & Tucci, 2012; Terwiesch & Xu, 2008). Crowdsourcing firms typically engage in innovation contests to access knowledge beyond their organizational boundaries and to solve challenging problems in the form of an open call to a large network of potential solvers (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Jeppesen & Lakhani, 2010). The primary essence of such contests is to harness the potential of the crowd to obtain novel solutions to internal problems (Blohm et al., 2013). However, one of the major challenges in such crowdsourcing initiatives is to attract and motivate crowd members to participate and submit solutions (Boudreau & Lakhani, 2013; Piezunka & Dahlander, 2019). Since the task description is usually the first point of contact between the crowdsourcing firm and the crowd (Afuah & Tucci, 2012; Gillier et al., 2018; Natalicchio et al., 2017; Steils & Hanine, 2016), a well-delineated problem statement is crucial in attracting the attention of the crowd. In other words, the manner in which the task is articulated and conveyed to the crowd plays a fundamental role on the overall campaign performance, in terms of self-selecting and submitting solutions to a campaign. Therefore, in order to optimally design crowdsourcing initiatives, organizations must consider some key design decisions when formulating the problem statement, that in turn, could potentially impact the success of the crowdsourcing outcome.

4.2.2 A Signaling Theory Perspective

In the context of innovation contests, signaling theory provides a sound conceptual foundation to describe the interaction between two parties that have access to asymmetrically distributed information. As aforementioned in Chapter 3, recent crowdsourcing research has also drawn on this theoretical perspective because it involves the communication between two parties through signals (Durward et al., 2016; Pollok et al., 2019a; Zhao & Zhu, 2014a). In the context of crowdsourcing campaigns, the seeking firm communicates a specific need or problem to the crowd through the task description. Potential interested solvers then decode the received signal to develop solutions that are eventually returned back to the seeking firm [2]. To this end, the manner in which the problem is delineated and communicated plays a fundamental role in how solvers interpret the underlying task and more importantly, in their decision to participate and develop solutions (Garcia Martinez, 2017). Therefore, defining the problem explicitly and clearly communicating the objectives of the task is especially crucial for the success of crowdsourcing initiatives (Pollok et al., 2019a). Previous crowdsourcing research argues that the quality of the problem statement and the firm's decisions in the problem formulation phase play a critical role in the overall campaign design (Afuah & Tucci, 2012; Gillier et al., 2018; Natalicchio et al., 2017; Steils & Hanine, 2016). In particular, two fundamental components of the task description are the task complexity, which determines the knowledge and skills required to solve the task, and the task specificity, which defines the scope and solution space for the submissions. Tasks could range from highly specific tasks to open-ended tasks for which no particular problem-solving approach or solution is known (Jespersen, 2018; Leimeister et al., 2009; Nakatsu et al., 2014). The specificity of the task is crucial because being too specific might confine the overall solution space and limit the innovation potential of the solvers. Hence, specifying the underlying task in a crowdsourcing campaign becomes a central decision parameter in crowdsourcing design.

[2]The OUI conference paper presents a more detailed introduction to signaling theory. It has been omitted in the thesis for conciseness considerations.

In other words, soliciting innovative solutions to problems requires firms to explicitly communicate the accepted solution space of the submissions, while seeking solutions for specific tasks requires firms to predetermine the level of skill and knowledge required to solve the task, as well as provide a more bounded solution space.

From a signaling theory perspective, Connelly et al. (2011, p.61) argue that signals are rarely perceived as single signals, but instead receivers typically aggregate "a series of signals into meaningful wholes." This highlights the importance of developing a more comprehensive and holistic perspective on the different task-related decisions, and how these decisions influence the manner in which the signal is perceived by the crowd. Similarly, in the context of crowdsourcing campaigns, the different design decisions made during the task formulation phase interact with one another to influence the overall signal projected by the firm, which in turn, influences how the signal is decoded by the crowd, and hence, the decision of potential contributors to participate and submit solutions. Following this line of argument, we investigate three critical design decisions taken during the task formulation phase and how these decisions potentially interact with one another to influence the overall signal projected by the firm, and hence the decision to participate and submit solutions.

4.2.3 Motivating the Crowd to Participate and Submit Solutions

As previously mentioned, motivating potential contributors to participate is central to the success of crowdsourcing campaigns (Boudreau & Lakhani, 2013; Piezunka & Dahlander, 2019; Ye & Kankanhalli, 2017). Therefore, crowdsourcing firms must delineate and present the task in a manner that convinces crowd members to contribute and submit solutions. The crowdsourcing firm and the potential contributors thereby engage in a reciprocal exchange process, such that the solvers invest time and effort into developing solutions for which they expect to receive rewards in return. This exchange process is embedded in the underlying concept of the social exchange theory, which "refers to voluntary actions of individuals that are motivated by the returns they are

expected to bring and typically do in fact bring from others" (Blau, 1964, p.91). Similarly, in the context of crowdsourcing campaigns, potential crowd contributors assess the expected benefits and related costs associated with participating, and thereby make a decision whether to contribute or not. Following this line of argument, we seek to understand what motivates potential solvers to develop solutions.

A large body of prior crowdsourcing research has investigated different factors that motivate the crowd to participate and submit solutions (Acar, 2019; Afuah & Tucci, 2012; Garcia Martinez, 2017; Leimeister et al., 2009; Zhao & Zhu, 2014a). Some individuals may be motivated by intrinsic motives such as the competitive aspect of crowdsourcing, demonstrating their skills and creativity, or learning through interaction and feedback from experts. These motives are rooted in an inborn desire, and hence solvers may be motivated by the prospect of satisfaction, self-esteem, and autonomy in developing solutions (Garcia Martinez, 2017; Leimeister et al., 2009). These intrinsic motivating factors particularly highlight that the exchange process is not exclusively contingent on potential economic returns, but instead, solvers may enjoy the process of engaging in problems and developing solutions. While intrinsic motives play a central role in participating, previous studies also indicate the significance of extrinsic motives for participation, such as monetary rewards (Acar, 2019; Afuah & Tucci, 2012; Leimeister et al., 2009). When solvers engage in developing solutions, they typically invest time and effort and provide their expertise and know-how, in return for an expected outcome, which can either be monetary or non-monetary. Building on, Blau's (1964) social exchange theory, Ye and Kankanhalli (2017) argue that individuals only participate in crowdsourcing campaigns when they expect a positive net reward from a cost-benefit analysis perspective. Therefore, the problem statement must convey adequate information for solvers to determine the associated costs and benefits of participation (Ye & Kankanhalli, 2017), which in turn, enables solvers to determine whether they anticipate a positive net reward. In fact, Garcia Martinez (2017) further posits that solver motivation to participate is triggered by certain design characteristics of the underlying task. Therefore, contingent on the nature of the task, it is important for managers to take into account both extrinsic as well as intrinsic motives in terms of

the overall cost-benefit analysis, when delineating and communicating the task to the crowd. Drawing on the social exchange perspective, we further build on these arguments to empirically assess how certain design characteristics of the task influence solvers' decisions to participate and submit solutions in a crowdsourcing campaign.

4.2.4 Delineating and Formulating the Underlying Task

Problem formulation is regarded as a core strategic activity in organizations because it enables firms to recognize challenges within their value chain such that they can generate valuable innovative solutions (Baer, Dirks, & Nickerson, 2012). Baer et al. (2012) conceptualize problem formulation as "a collective activity aimed at translating an initial problem symptom or web of symptoms into a set of questions or alternative formulations of the problem that are sufficiently well-defined in terms of the causes of the symptoms to enable the subsequent search for or generation of solutions." Thereby, problem definition determines the exact problem to be solved, and consequently, the manner in which it is articulated has a fundamental impact on the quality of the solutions generated (Simon, 1973; Simon & Hayes, 1976). Following this perspective, we draw on the problem definition literature to better understand the link between the delineation of the task and its impact on the success of crowdsourcing initiatives. In the context of innovation contests, the articulation of the problem statement and the manner in which it is conveyed is central to the process, because it must contain the relevant information for solvers to develop solutions (Afuah & Tucci, 2012; Ghezzi et al., 2018; Gillier et al., 2018; Natalicchio et al., 2017; Nakatsu et al., 2014; Jeppesen & Lakhani, 2010; Sieg et al., 2010; Steils & Hanine, 2016). Therefore, in order to optimally design crowdsourcing initiatives, organizations must consider some key design decisions when formulating the problem statement that in turn, could potentially impact the success of the crowdsourcing outcome.

According to Simon (1973), problems can range from being well-structured to ill-structured in nature. Well-structured problems, such as puzzles or algorithmic problems, are those that have a well-defined problem space accompanied by explicit

problem solving approaches and known solution criteria. However, ill-structured problems refer to those that do not have an explicit problem solving approach and possess uncertainty in terms of the concepts, methods and principles required to develop solutions (Reed, 2016). The problem formulation literature emphasizes that the scope and specification of a problem is critical to the problem delineation process because it ultimately determines the accepted solution space in which problem solvers can generate viable solutions (Reed, 2016). For instance, problems that have a higher degree of specification tend to have explicit guidelines and pre-defined problem solving approaches, which in turn, could limit the creativity and innovation potential of the received solutions. However, problems that have a lower degree of specification are accompanied by less stringent guidelines and prerequisites, thereby encouraging solvers to unleash their creative potential and deviate from the beaten path (Lyles, 2013). Similarly, in the context of crowdsourcing for innovation, task specificity refers to the scope of the problem to be solved. Tasks could range from highly specific tasks with a clear set of specifications and solution requirements to open-ended tasks for which no particular problem solving approach is known (Jespersen, 2018; Leimeister et al., 2009; Nakatsu et al., 2014). For problems which are highly specific in nature, the solution space is rather confined, and therefore solvers have a lower degree of task autonomy because they are limited in their freedom to be creative and develop innovation solutions (Garcia Martinez, 2017; Hackman & Oldham, 1980; Kaufmann, Veit, & Schulze, 2011; Zheng et al., 2011). Consequently, solvers are forced to adopt a seeker-perspective and view the problem from the lens of the crowdsourcing firm (Boons & Stam, 2019; Jespersen, 2018).

Previous crowdsourcing studies have explored the relationship between task autonomy and motivation to participate and submit solutions (Garcia Martinez, 2017; Zheng et al., 2011). Garcia Martinez (2017) reveals that tasks with high autonomy that require solvers to use their imagination and tap into their creativity encourage participation because solvers are enthusiastic at the prospect of furthering their competences and demonstrating their skills. Bao et al. (2019) further argue that solvers consider a task be more valuable and worthwhile when they are expected to use their creativity and propose out-of-the-box

ideas. Following this line of argument, when the task specificity is high, the crowdsourcing firms signals that it is seeking specific solutions within a confined solution space. In other words, solvers have a lower degree of task autonomy and are limited in their problem solving approaches. As a result, solvers might be discouraged from participating, which in turn, might have a negative impact on solver participation.

Drawing on the social exchange theory perspective (Blau, 1964), solvers make a strategic assessment of the associated expected benefits and related costs associated with participating, based on the information provided in the problem statement (Acar, 2019; Afuah & Tucci, 2012; Garcia Martinez, 2017; Leimeister et al., 2009; Zhao & Zhu, 2014a). Therefore, any uncertainties related to the underlying task and the solving process strongly influence solver participation in innovation contests (Boudreau et al., 2011; Ye & Kankanhalli, 2017). Pollok et al. (2019a) particularly argue that when the task specificity is high, the overall solution space is restricted, such that solvers are required to adhere to certain solution criteria and problem specifications. Consequently, potential solvers run the inherent risk of developing solutions that might not meet the requirements and expectations of the crowdsourcing firm (Boons & Stam, 2019; Pollok et al., 2019a). This increases the participation uncertainty as solvers are unable to assess whether the time and effort invested in developing solutions will result in pay-off in terms of meeting the firm's expectations (Zheng et al., 2011). As the perceived probability of winning decreases, solvers are discouraged from participating, which in turn, could negatively influence their decision to submit solutions (Terwiesch & Xu, 2008). Thereby, our hypothesis is in line with the extant crowdsourcing literature:

Hypothesis 1: Challenges with higher task specificity will have a negative impact on crowdsourcing performance.

Next to the specificity of the task, we seek to understand how the task complexity impacts the performance of crowdsourcing campaigns. Task complexity refers to the degree to which a task is complicated and difficult to perform (Morgeson & Humphrey, 2006). Baer et al. (2012) further classify a problem as complex when it contains a large number of variables and when there is a high degree of connectivity and interaction among

the different components that can potentially change over time. Similarly, in the context of crowdsourcing contests, Natalicchio et al. (2017) characterize problem complexity by the number of distinct knowledge components included in the task and the degree of interaction between these components. The complexity of the underlying task is a central aspect because it determines the level of specialized skills and knowledge required to solve a task (Bao et al., 2019; Garcia Martinez, 2017; Morgeson & Humphrey, 2006; Natalicchio et al., 2017; Ye & Kankanhalli, 2013). For instance, complex tasks demand a higher level of competence and hence tend to impose a greater cognitive demand on individuals (Campbell, 1988; Morgeson & Humphrey, 2006).

A large body of prior research on crowdsourcing participation has investigated different factors that motivate the crowd to participate (Acar, 2019; Ghezzi et al., 2018; Lee et al., 2015; Leimeister et al., 2009; Zhao & Zhu, 2014a). Some individuals may be motivated to develop solutions based on intrinsic motives such as the competitive aspect of crowdsourcing, self-esteem and satisfaction. Solvers that are intrinsically motivated may actually enjoy the process of being creative and the autonomy associated with given problems (Garcia Martinez, 2017). Others, however, may be motivated by extrinsic motives such as the prospect of winning monetary awards, demonstrating their skills and creativity, and potential job opportunities (Brabham, 2010; Leimeister et al., 2009). Despite the extant research on motivation to participate, comparatively fewer studies have explored the impact of certain task characteristics, such as task autonomy, outcome variety and knowledge tacitness of problem on the motivation of solvers to participate in crowdsourcing contests (Bao et al., 2019; Garcia Martinez, 2017; Ye & Kankanhalli, 2013; Zheng et al., 2011). In particular, there is limited empirical research on the relationship between the complexity of the task and the decision to submit solutions in innovation contests. As organizations are increasingly using crowdsourcing to solve complex, innovation problems, it is crucial to expand our understanding of how the complexity of the task influences solvers decisions to submit solutions. In fact, from a signaling theory perspective, the manner in which the task is delineated and conveyed to the crowd, in terms of the degree of complexity and the knowledge required to solve the task, has a fundamental impact on how solvers perceive a crowdsourcing task.

Complex tasks may be difficult to decode, and as such, the crowd's interpretation of the need of the crowdsourcing firm can vary, leading to uncertainty whether the challenge is understood correctly. This uncertainty, in turn, influences their decision to participate and submit solutions or not.

Garcia Martinez (2017) explores the relationship between task complexity and solver motivation, and posits that tasks that are complex in nature are more likely to satisfy one's intrinsic motives of engaging in stimulating problem-solving. However, Afuah and Tucci (2012) make a contradictory argument stating that as the complexity of the problem increases, the problem may become 'immobile', which means that it becomes increasingly difficult to delineate and convey to the crowd. Furthermore, for problems with a higher level of complexity, the level of involvement, effort and cognitive skills required to solve the problem also increases (Bao et al., 2019; Morgeson & Humphrey, 2006; Hu, Bijmolt, & Huizingh, 2020; Ye & Kankanhalli, 2013). Potential solvers may feel a sense of insecurity and inability to develop solutions for problems that are complex and require certain skills and knowledge (Bao et al., 2019; Sun, Wang, Yin, & Zhang, 2015).Consequently, tasks with a higher complexity may discourage potential contributors from participating due to increased problem-solving uncertainty. Thereby, for tasks that are highly complex in nature and that require a significant amount of time and effort, the chances of submitting a solution are reduced. Furthermore, drawing on the underlying premise of the social exchange theory (Blau, 1964), potential crowd contributors assess the expected benefits and related costs associated with participating, and thereby make a decision whether to contribute or not. Ultimately, individuals only engage in developing solutions when they expect a positive net reward based on a cost-benefit analysis (Ye & Kankanhalli, 2017). Therefore, when the task complexity is high, solvers might perceive the related costs to be higher than the expected benefits, which in turn might negatively influence their decision to participate.

Despite the relevance of motivation displayed by extant crowdsourcing literature, limited empirical research has examined the role of task complexity on the submission of ideas in innovation campaigns. Although Garcia Martinez (2017) argues that complex

tasks are more likely to satisfy one's intrinsic motives of engaging in stimulating problem-solving, we base our hypothesis on the prevailing view in academia that the task complexity is associated with problem-solving uncertainty, which in turn, might negatively impact the willingness of solvers to contribute ideas to crowdsourcing contests. We therefore hypothesize:

Hypothesis 2: Challenges with a higher complexity will have a negative impact on crowdsourcing performance.

Another potential determinant in the success of crowdsourcing contests that remains unexplored in the current literature is the innovation ambition of the crowdsourcing firm. The communicated innovation ambition of a firm through the crowdsourcing task is determined by the nature of the solutions being sought by the crowdsourcing firm. For instance, the innovation ambition is high for problems that are seeking new perspectives and out-of-the-box, disruptive ideas. In the context of crowdsourcing contests, when the innovation ambition of the task is high, the seeker is soliciting novel ideas and a diverse variety of solutions (Steils & Hanine, 2016). Consequently, solvers are encouraged to be creative and venture into the new.

Previous crowdsourcing research has explored a variety of motives that influence solver participation in innovation contests (Acar, 2019; Garcia Martinez, 2017; Kaufmann et al., 2011; Lee et al., 2015; Leimeister et al., 2009; Zhao & Zhu, 2014a; Zheng et al., 2011). While both extrinsic and intrinsic motives are critical to the success of crowdsourcing initiatives, Zheng et al. (2011) find that the effects of intrinsic motives were twice as much as that of extrinsic motives on participation in innovation contests. In particular, Garcia Martinez (2017) reveals that tasks that encourage solvers to use their imagination and tap into their creativity positively influences participation because solvers are enthusiastic at the prospect of furthering their competences and demonstrating their skills. These motives are rooted in an inborn desire, and hence solvers may be motivated by intrinsic factors such as satisfaction, self-esteem, and autonomy in developing solutions (Brabham, 2010; Garcia Martinez, 2017; Leimeister et al., 2009). Leimeister et al. (2009) build on this argument and further posit that crowdsourcing tasks that focus on novelty and innovation

tend to satisfy an innate desire of solvers to contribute in innovation contests.

Following the aforementioned arguments, when crowdsourcing firms signal to the crowd that they are open to receive new, out-of-the-box perspectives, solvers are encouraged to be innovative, and are free to integrate and combine alternative perspectives in the development of their solutions. This complements Jeppesen and Lakhani's (2010) research which highlights the significance of marginal perspectives for problems that seek novel solutions. Furthermore, since tasks with a higher innovation ambition are typically associated with fewer specifications and guidelines, solvers are not confined to a specific solution space (Jespersen, 2018). Therefore, when the innovation ambition is high, the seeker signals to the crowd that the accepted solution space is large. Potential solvers are encouraged to tap into their creativity and develop a diverse variety of innovation solutions. This in turn, reduces the inherent risk of not meeting the requirements and expectations of the firm. Consequently, this decreases the participation uncertainty, in terms of whether the time and effort invested in developing solutions might generate a pay-off. Drawing on the underlying notion of the social exchange theory (Blau, 1964), solvers only engage in developing solutions when they expect a positive net reward based on a cost-benefit analysis (Ye & Kankanhalli, 2017). Thereby, when the innovation ambition is high, solvers might perceive the expected benefits to be higher than the associated costs of participating, which in turn should enhance their decision to participate. We therefore hypothesize:

Hypothesis 3: Challenges with a higher innovation ambition will have a positive impact on crowdsourcing performance

Based on the aforementioned arguments and the set of hypotheses presented, this study seeks to investigate the impact of three design attributes of the task (task complexity, task specificity, and the innovation ambition of the task) on the performance of innovation contests, as detailed in the research model below in Figure 4.1.

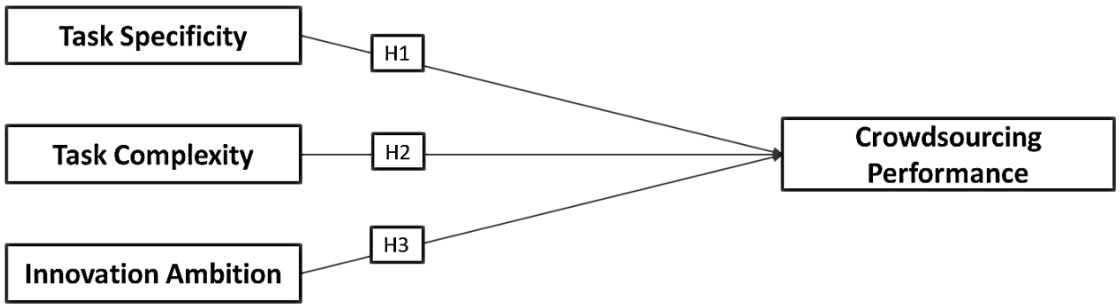

Figure 4.1: Research Model

4.3 Methodology

4.3.1 Data Collection and Sample

We drew on a rich dataset containing information on crowdsourcing challenges from 2010 to 2020 that were conducted on InnoCentive, one of the leading crowdsourcing intermediary platforms worldwide. Founded in 2001, InnoCentive has been a primary source for research on crowdsourcing (Lee et al., 2015), with many studies utilizing data from the platform (e.g. Acar, 2019; Jeppesen & Lakhani, 2010; Mazzola et al., 2018; Sieg et al., 2010). Our research focused on ideation challenges, which primarily focuses on soliciting ideas to certain problems, without solvers having to develop concrete prototypes or test their ideas in practice. In total, our dataset comprised 392 ideation challenges that were conducted on InnoCentive.

InnoCentive employs a two-step mechanism for solvers to participate in a crowdsourcing challenge. First, potential solvers are able to see a brief summary of any challenge, which is publicly available. This challenge abstract contains only a broad outline of the goals of a crowdsourcing challenge, but does not disclose concrete details or solution requirements. If a solver is potentially interested in developing a solution, (s)he must register for the challenge by accepting the challenge's individual terms and conditions. Once the solver has signed the agreement, the solver has access to the complete challenge statement, including all details and the specific goals, the solution requirements, and any further information the crowdsourcer provides to the crowd. In

the context of this study, the complete challenge statements were used to collect information on the three primary variables of interest; task complexity, task specificity, and the innovation ambition of the crowdsourcer. A description on the collected information is provided in table 4.1.

Variable	**Description**
Crowdsourcing Performance	The ratio of number of solutions submitted per challenge divided by the total number of solvers registered per challenge
Award Value (in $)	The total award amount of a challenge for the winning solution(s)
No. of Ideation Challenges per Year	The number of ideation challenges active on InnoCentive on a yearly basis
Size of Solver Base per Year	The number of solvers registered on InnoCentive on a yearly basis
Public Company Name	Crowdsourcing firm made firm name public in the crowdsourcing challenge (1 = yes, 0 = no)
Campaign Duration (in days)	The duration from the start of an ideation challenge to the solution submission deadline in days
Task Specificity	Specificity - The number of explicitly stated solution requirements in the ideation challenge description
Innovation Ambition	Innovation Ambition - The number of words related to innovation (*new, radical, novel, innov*, creativ*, out-of-the-box, outside-the-box)*
Task Complexity - No. of Sentences	Complexity - The number of sentences in the ideation challenge description
Task Complexity - Avg. Words per Sentence	Complexity - The average number of words per sentence in the ideation challenge description
Task Complexity - No. of Challenge Categories	Complexity - The number of categories (tags) associated with an ideation challenge
Task Complexity - Unique Words	Complexity - The number of unique words used in an ideation challenge description, compared to all individual words used in all ideation challenges in the database, minimum of 4 characters per word

Task Complexity - Word Lists	Complexity - The number of words related to *(complex*, dynamic*, chang*, rapid, alter, alterable, alteration*, altered, altering, alters, difficult, challenging, demanding)*

Table 4.1: Variable Descriptions

4.3.2 Variables

Dependent Variables

The dependent variable employed in this study to measure crowdsourcing performance is the ratio of submitted solutions divided by the registered solvers per challenge, which we refer to as conversion rate. Since the ratio constitutes the percentage of how many solvers who registered for a specific challenge ultimately submitted a solution, the dependent variable is a relative measurement. Ideation challenges generally aim at receiving a broad variety of ideas, and as such the ratio of the number of solvers as opposed to all potential registered solvers that ultimately develop and submit a solution is a fundamental indicator of the performance in an ideation challenge.

Explanatory Variables

Task Specificity. In this study, task specificity refers to the solution boundedness, as indicated in the extant literature (e.g. Jespersen, 2018). We measured task specificity by manually reading each challenge statement and counting the number of individual solution requirements per challenge. We jointly evaluated 10% of the challenge statements and agreed on a common understanding on the procedure of counting solution requirements. The remaining 90% of challenge statements were split equally, and potentially ambiguous cases were jointly discussed in the end. Hereby, only challenge-specific solution requirements were counted, including statements on what solvers were explicitly asked to avoid when developing solutions, and what the solutions must or should include. Generic requirements, such as how solutions should be formatted or structured were excluded from this measurement. The task specificity thus refers to the solution space of each challenge, indicating a bounded or unbounded

solution space.

Innovation Ambition. The second explanatory variable, the innovation ambition, was measured through a word count analysis of each challenge statement based on a word list comprising terms related to novelty and innovation. The more a crowdsourcer indicates certain words statement related to innovation in the challenge statement, the higher we expect the innovative ambition of the crowdsourcer to be. As such, the word list adopted to measure innovation ambition inlcuded the search terms *new*, *radical*, *novel*, *innov**, *creativ**, *out-of-the-box*, and *outside-the-box*.

Task Complexity. The third explanatory variable concerns the task complexity. The complexity of a crowdsourcing challenge has been subject to previous research and was, for instance, measured through the word count or number of sentences (Yang, Redi, Demartini, & Bozzon, 2016). We followed this approach, and accordingly measured the number of sentences, and the average number of words per sentence for each challenge statement. Beyond this measurement, we used additional measurements that indicate the complexity of a crowdsourcing task. As such, challenges are associated with certain categories (Tags) on InnoCentive, for instance Computer and Information Technology, Engineering/Design, Math/Statistics, or Business & Entrepreneurship. InnoCentive asks crowdsourcing firms to indicate initial categories, but ultimately, the association with categories is subject to InnoCentive's decision. This allowed us to assess the number of associated categories from a neutral perspective, InnoCentive finally decides which categories/tags are finally used for the challenges. A higher number of categories indicates that the challenge may require more distributed knowledge across several domains, which is in line with (Natalicchio et al., 2017), who relate the complexity of the crowdsourced task with the number of knowledge components required to solve a task. Furthermore, we additionally counted the number of unique words per challenge, using the complete word list of all challenges as a benchmark. A challenge that employs many unique words, which are not used by any other challenge in the dataset, can be expected to be more complex, since it is more individual, and might include technical terms to describe the underlying challenge and its respective goals. We used a threshold of at least five characters per word

to count the unique words per challenge. Lastly, we developed a word list containing terms related to complexity and counted the number of complexity-related words based on this list. The complexity word list included *complex**, *dynamic**, *chang**, *rapid*, *alter*, *alterable*, *alteration**, *altered*, *altering*, *alters*, *difficult**, *challenging*, and *demanding*.

Control Variables

Concerning the control variables, we collected information on the award value for the winning solution per challenge. InnoCentive employs a specific mechanism concerning the award distribution. Typically, the total award pool communicated in the challenge statement must be awarded to one or more solvers, independent of the number of solutions or their quality. InnoCentive generally recommends seekers to make one award of a minimum amount (i.e. 5,000$), however, seekers are ultimately free to decide how awards are distributed among the winning solutions. For the measurement, we assessed the total award pool per challenge. Further challenge-specific controls comprised the challenge duration in days, and a dummy variable capturing whether the crowdsourcing firm publicly displayed their company name to all registered solvers, or whether the crowdsourcer stayed anonymous.

Additional control variables included were the number of ideation challenges per year, since the total number of ideation challenges substantially differed on a yearly basis. We further controlled for the size of the available solver base on InnoCentive, measured through the total number of registered solvers per year.

4.4 Results

Sample characteristics are illustrated in table 4.2. The main variable, crowdsourcing performance, indicates that from 100 solvers who registered for an ideation challenge, on average, 15 solvers submitted a solution (14.559%). In our dataset, an ideation challenge competed, on average, with 58 other ideation challenges per year. The average challenge was active for 45 days, and 35.2% of the crowdsourcing firms publicly displayed their company name.

Variable	n	Mean	Median	Std. Dev.	Min	Max
Crowdsourcing Performance	392	14.559	14.440	5.222	1.546	29.619
Award Value (in $)	392	10,905	10,000	5272	500	50,000
Ideation Challenges per Year	392	58.143	70	21.776	10	82
Size of Solver Base per Year	392	326,714	319,845	61,779	218,928	444,663
Public Company name	392	0.352	0	0.478	0	1
Campaign Duration (in days)	392	45.107	37	18.309	18	157
Task Specificity	392	6.735	6	3.272	0	21
Innovation Ambition	392	3.811	3	3.586	0	19
Task complexity - Number of Sentences	392	57.972	54	20.817	23	141
Task complexity - Average Words per Sentence	392	17.937	17.505	2.840	10.942	29.4
Task complexity - Number of Challenge Categories	392	10.140	9	8.019	1	42
Task complexity - Unique words	392	10.768	9	8.526	0	59
Task complexity - Word Lists	392	1.750	1	2.173	0	13

Table 4.2: Descriptive Statistics

In order to test our hypotheses, we conducted a hierarchical ordinary least squares (OLS) regression. Table 4.3 displays the results for the hierarchical regressions. As the dependent variable, crowdsourcing performance was measured as the percentage of how many registered solvers submitted a solution, the coefficients indicated a percentage change in this conversion rate per increase of one unit in the independent variables. The baseline model serving as a comparison only included the control variables, and we subsequently added the three factors task specificity, innovation ambition, and task complexity, in models 2, 3, and 4, respectively. Model 5 included all variables outlined above, and thus indicated the combined effect of the three factors on crowdsourcing performance. Controlling for multicollinearity, we tested for the variance inflation

factors (VIF) for all variables in model 5. The values indicated that no issues with multicollinearity were present in the data, with the amount of challenge categories indicating the lowest value (VIF = 1.10), and the number of sentences indicating the highest value (VIF = 2.45). Testing for heteroscedasticity, a Breusch-Pagan test was conducted for model 5, which indicated no heteroscedasticity (Breusch-Pagan test p-value = 0.520).

Table 4.3: Results of Hierarchical Regression

Variable	**Model 1 (Baseline)**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Constant	5.312***	4.963***	5.780***	9.787****	11.425****
Award Value (in $)	-0.044	-0.045	-0.061	-0.053	-0.060
Ideation Challenges per Year	-0.005	-0.005	-0.008	-0.007	-0.008
Size of Solver Base per Year	0.032****	0.031****	0.030****	0.028****	0.027****
Public Company name	1.770***	1.808***	1.321**	1.716***	1.537**
Campaign Duration (in days)	-0.022	-0.022	-0.025*	-0.023*	-0.026**
Task Specificity		0.087			0.020
Innovation Ambition			0.253****		0.263****
Task complexity - Number of Sentences				0.009	-0.003
Task complexity - Average Words per Sentence				-0.228**	-0.291***
Task complexity - Number of Challenge Categories				-0.041	-0.040
Task complexity - Unique words				0.072**	0.073**
Task complexity - Word Lists				0.075	0.065
n	**392**	**392**	**392**	**392**	**392**
F-Test	**18.10******	**15.32******	**17.72******	**11.40******	**10.94******
Adj.R^2	**0.179**	**0.180**	**0.204**	**0.210**	**0.234**
R^2	**0.190**	**0.193**	**0.216**	**0.230**	**0.257**
R^2 Diff. to Baseline		**0.003**	**0.026******	**0.040*****	**0.067******

Dependent Variable: Crowdsourcing Performance (conversion rate in %)
*10%, **5%, ***1%, ****0.1%
Award Value and Size of Solver Base per Year are in 1,000 for illustration

Acknowledging the recent statement of the *American Statistical Association* (Wasserstein, Schirm, & Lazar, 2019; Wasserstein & Lazar, 2016) on the use of p-values, we provide table 4.4 to complement the provided coefficients and statistical significance levels as illustrated in table 4.3. Table 4.4 indicates the 95%-confidence intervals (CI), which we used to deepen the analysis of results.

Table 4.4: 95% Confidence Intervals of Hierarchical Regression

Variable	**Model 1 (Baseline)**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	Lower Upper	Lower Upper	Lower Upper	Lower Upper	Lower Upper
Constant	1.721 8.903 (2.91***)	1.326 8.601 (2.68***)	2.235 9.326 (3.21***)	4.809 14.764 (3.87****)	6.400 16.451 (4.47****)
Award Value (in $)	-0.143 0.054 (-0.89)	-0.144 0.053 (-0.90)	-0.158 0.037 (-1.22)	-0.152 0.046 (-1.05)	-0.158 0.038 (-1.21)
Ideation Challenges per Year	-0.005 0.012 (-0.44)	-0.028 0.018 (-0.44)	-0.031 0.014 (-0.73)	-0.030 0.016 (-0.60)	-0.031 0.014 (-0.74)
Size of Solver Base per Year	0.023 0.040 (7.46****)	0.023 0.040 (7.18****)	0.21 0.038 (6.93****)	0.020 0.037 (6.44****)	0.018 0.035 (6.06****)
Public Company Name	0.745 2.794 (3.40***)	0.782 2.834 (3.46***)	0.283 2.359 (2.50**)	0.538 2.894 (2.86***)	0.362 2.713 (2.57**)
Campaign Duration (in days)	-0.049 0.005 (-1.62)	-0.049 0.005 (-1.58)	-0.052 0.001 (-1.88*)	-0.050 0.003 (-1.71*)	-0.053 -0.000 (-1.97**)
Task Specificity		-0.060 0.233 (1.16)			-0.135 0.175 (0.26)
Innovation Ambition			0.115 0.391 (3.61****)		0.124 0.403 (3.70****)
Task Complexity - Number of Sentences				-0.024 0.041 (0.53)	-0.037 0.032 (-0.15)
Task Complexity - Average Words per Sentences				-0.416 -0.041 (-2.39**)	-0.479 -0.103 (-3.05***)
Task Complexity - Number of Challenge Categories				-0.101 0.019 (-1.34)	-0.099 0.019 (-1.32)
Task Complexity - Unique words				0.001 0.142 (1.99**)	0.003 0.143 (2.05**)
Task Complexity - Word List				-0.160 0.311 (0.63)	-0.167 0.297 (0.55)
n	**392**	**392**	**392**	**392**	**392**
F-Test	**18.10****	**15.32****	**17.72****	**11.40****	**10.94****
Adj.R^2	**0.179**	**0.180**	**0.204**	**0.210**	**0.234**
R^2	**0.190**	**0.193**	**0.216**	**0.230**	**0.257**

R^2 Diff. to Baseline	**0.003**	**0.026******	**0.040*****	**0.067******

Dependent Variable: Crowdsourcing Performance (conversion rate in %)
t-statistic in parentheses
*10%, **5%, ***1%, ****0.1%
Award Value and *Size of Solver Base per Year* are in 1,000 for illustration

While not indicating a relationship between award value and crowdsourcing performance in table 4.3, the statistical analysis that utilized 95% CIs pointed out a potentially negative relationship between the award amount and crowdsourcing performance. There was no sign for a relationship between the number of ideation challenges per year and crowdsourcing performance. However, the growing yearly solver base seemed to positively relate to the dependent variable. A relatively strong positive relationship could be observed if companies publicly displayed their firm to the registered solvers, as table 4.3 indicated that not staying anonymous can increase the conversion rate from 1.321% (model 3) to 1.808% (model 2). Lastly, the campaign duration was subject to a weak negative relationship with crowdsourcing performance.

Concerning our first hypothesis (H1) on task specificity, the hierarchical regression shown in table 4.3 did not provide evidence for an effect on crowdsourcing performance. However, table 4.4 points out that the effect of task specificity was subject to a relatively strong variation around the null. Thus, although we cannot reject that the effect might be negligible, table 4.4 indicates that we may also not reject a negative (lower limit 95% CI model 5 = -0.135) or positive (upper limit 95% CI model 2 = 0.233) impact on crowdsourcing performance against the backdrop of the 95% CI. This finding led us to an examination of potential (inverse) U-shaped relationships. Except for task specificity, neither innovation ambition nor task complexity indicated a U-shape or inversed U-shape relationship.

Table 4.5: Results for Robust Linear Regression

Variable	**Coefficient**	**Robust Standard Error**	**t**	**p**	**95% Confidence Interval**	
					Lower	**Upper**
Constant	10.321****	2.547	4.05	0.000	5.312	15.329
Award Value (in $)	-0.062	0.055	-1.12	0.262	-0.170	0.046

Ideation Challenges per Year	-0.007	0.011	-0.59	0.554	-0.029	0.015
Size of Solver Base per Year	0.026****	0.004	6.23	0.000	0.018	0.035
Public Company name	1.585**	0.638	2.48	0.013	0.330	2.840
Campaign Duration (in days)	-0.026**	0.013	-2.00	0.047	-0.052	-0.000
Task Specificity	0.319	0.199	1.60	0.110	-0.073	0.710
Task Specificity squared	-0.018*	0.009	-1.85	0.065	-0.036	0.001
Innovation Ambition	0.265****	0.068	3.88	0.000	0.131	0.399
Task Complexity - Number of Sentences	-0.004	0.016	-0.25	0.804	-0.035	0.027
Task Complexity - Average Words per Sentence	-0.288***	0.088	-3.28	0.001	-0.460	-0.115
Task Complexity - Number of Challenge Categories	-0.038	0.027	-1.39	0.166	-0.091	0.016
Task Complexity - Unique words	0.071**	0.031	2.30	0.022	0.010	0.131
Task Complexity - Word Lists	0.075	0.104	0.72	0.474	-0.130	0.279

Dependent Variable: Crowdsourcing Performance (conversion rate in %)
n = 392; F-test = 13.06****; R^2 = 0.257
*10%, **5%, ***1%, ****0.1%
Award Value and *Size of Solver Base per Year* are in 1,000 for illustration

Table 4.5 displays the results for the regression model including task specificity and its squared term. An additional test using the u-test command in STATA (see Lind & Mehlum, 2010) to control for the indication of an inverse U-shape was conducted with

the model indicated in table 4.5. The results supported an inverse U-shape relationship between task specificity, in terms of the number of solution requirements, and the conversion rate as a measure of crowdsourcing performance (p = 0.055). In consideration of the 95% CI values for task specificity in table 4.5 (upper limit 95% CI = 0.710) and the p-value for the squared term of task specificity (p = 0.065), we concluded that the relationship between task specificity and crowdsourcing performance is likely to be subject to an inverse U-shape. This finding indicated that providing solution requirements to a certain extent can help to increase crowdsourcing performance, but specifying too many requirements has a negative effect, which partially lends support for H1, and as such helped to explain the variance in the 95% CI of task specificity around zero in table 4.4.

Concerning the second hypothesis (H2) about task complexity, the results displayed a mixed and ambivalent picture of the relationship between task complexity and crowdsourcing performance. The overall length of the challenge statement, measured through the number of sentences, was not related to crowdsourcing performance. However, the average words per sentence provided support for a negative relationship between task complexity and the conversion rate. The number of challenge categories associated with a challenge did not relate to crowdsourcing performance. Concerning unique words used in a challenge statement, a positive impact on the conversion rate can be observed. However, words specifically related to complexity, as measured through the complexity word list, did not show a clear relation to crowdsourcing performance. The 95% CI points out a mixed effect, with the lower limits for model 4 and 5 showing a potential negative, and the corresponding upper limits showing a potential positive impact on crowdsourcing performance. In conclusion, H2 cannot be clearly confirmed nor completely rejected. While some variables related to the complexity of a task showed a negative relationship with crowdsourcing performance, other variables indicated a positive relationship. We will discuss possible explanations and implications of this finding in the subsequent section.

Lastly, for the third hypothesis concerning the communicated innovation ambition of

the task, we found a clear sign for a positive relationship with crowdsourcing performance ($p < 0.000$). Comparing model 3 and model 1, the hierarchical regression yielded an improvement of the explained variance by 0.026 ($p < 0.000$). Therefore, our results lend support for H3.

4.5 Discussion

This study investigated the relationship between the delineation of a crowdsourcing task and crowdsourcing performance. The task delineation was assessed through three central components, which are task specificity, the communicated innovation ambition of the crowdsourcing firm, and task complexity. Applying a signaling theory perspective, we argued that potential solvers perceive the crowdsourcing task through a portfolio of signals (Connelly et al., 2011), rather than individual signals. Consequently, solvers decode these signals and examine whether they expect a positive outcome based on a cost-benefit analysis. Thereby, the notion of Blau's (1964) social exchange theory applied to the context of crowdsourcing (Ye & Kankanhalli, 2017) states that solvers do not only take into consideration the economic benefit, but also account for other motivational factors. As such, intrinsic motives like solving a challenging and complex task, or the opportunity to demonstrate one's creativity are important incentives for solvers to engage in developing solutions for crowdsourcing challenges (Garcia Martinez, 2017). Integrating these perspectives, we stated that to better understand the motives of solvers to engage in crowdsourcing, we must consider not only individual signals, but also account for a series of signals related to the task delineation, which provide both extrinsic and intrinsic incentives for participation in solving a task. To test the relationship between task delineation and crowdsourcing performance, we used the ratio of total solutions submitted to all solvers who registered, and thus indicated interest in a specific crowdsourcing challenge. In particular, for ideation challenges, which is the focal type of crowdsourcing in our study, the conversion rate constitutes a central indicator for crowdsourcing performance. Ideation challenges aim at receiving divergent views and ideas as solutions.

4.5.1 Theoretical Implications

We find that the award value can have a negative impact on crowdsourcing performance in terms of the ratio of submitted solutions from all solvers indicating interest in solving a challenge. A possible explanation for this is that an increase in the award value may attract more solvers to register for a challenge to gain access to the challenge details, but in turn, does not increase the percentage of solvers who ultimately submit a solution at the same rate, thus leading to a decrease in the conversion rate of registering to solution submitting solvers. In line with extant literature, the monetary reward is an extrinsic motivator that attracts solvers, but intrinsic motivators are found to be more important in comparison (Kaufmann et al., 2011; Zheng et al., 2011). Since intrinsic motivation can be determined only after registering for a challenge and having access to the full challenge statements, this may explain the decrease in the ratio of registered solvers to solution submitting solvers. An analogical reasoning can be applied to the challenge duration, as more solvers may register and indicate interest over time, however, the number of submitted solutions increases at a lower rate. We also find a positive connection between challenges that explicitly indicate the identity of the crowdsourcing firm and crowdsourcing performance. The crowd seems to prefer solving challenges if they know for whom they are developing solutions.

Our findings offer significant contributions to crowdsourcing research. Extant research suggests that solvers examine the autonomy they are granted by crowdsourcing firms for solving a task, and assess whether the degree of autonomy allows them to work creatively on a solution (Garcia Martinez, 2017). Tasks that require solvers to be creative and innovative, seem to positively influence solvers' perceptions of a task (Bao et al., 2019). The opportunity of using one's creativity and imagination and improving one's competences further stimulates intrinsic motivation (Garcia Martinez, 2017), whereby intrinsic motives have been found to be more important than extrinsic motives for solver participation in the context of innovation contests (Zheng et al., 2011). Our findings complement and enhance these findings. We find strong support that when a firm communicates a higher innovation ambition through the task description, solvers

are more likely to develop and submit solutions. Communicating a high innovation ambition may be perceived as an indicator that solutions require creative thinking, and that out-of-the box ideas are accepted by the crowdsourcer. However, our findings further suggest that crowdsourcing firms should provide a limited set of solution requirements, which may serve as a point of reference for potential solvers concerning the basic requirements that the solutions must fulfill. Since our results indicate an inverse U-shaped relationship between task specificity and crowdsourcing performance, stating too many solution requirements, in turn, has a negative effect on attracting solvers to develop solutions. Specifying too many requirements may confine the solution space too much, and thus decrease the perceived creativity and imagination required to solve the task, hence reducing intrinsic motivation. Similarly, the problem formulation literature also highlights that the scope and specification of a problem is critical to the problem delineation process (Reed, 2016). For instance, problems that have a higher degree of specification tend to have explicit guidelines and pre-defined problem solving approaches, which in turn, could limit the creativity and innovation potential of the received solutions (Lyles, 2013). Our findings also indicate similar results in the context of crowdsourcing campaigns. An alternative explanation is provided through the lens of the social exchange theory (Blau, 1964). Adhering to too many specific requirements may be associated with higher effort required to develop a solution, hence it signals higher costs. If these costs are not outweighed by other benefits, solvers may decide not to engage in a crowdsourcing contest.

The effect of task complexity on crowdsourcing performance is ambivalent in our study. On the one hand, task complexity can potentially decrease crowdsourcing performance, as indicated through the average words per sentence. A possible explanation is that for tasks that are communicated in a complex manner, it is challenging for potential solvers to comprehend the task, and as such may decrease the likelihood that solvers submit a solution. On the other hand, a factor stimulating intrinsic motivation to solve a problem can be the complex nature of the task itself (Garcia Martinez, 2017), that is solvers are motivated to develop solutions because of the task complexity. Building on the same line of argument provided for task specificity,

the complexity of a task can indicate that solvers require creativity to address the complexity of a task. In fact, our results indicate that complexity, in terms of unique words used in a challenge statement, can potentially increase crowdsourcing performance. This ambiguous effect of task complexity on crowdsourcing performance is further invigorated through the number of words related to complexity used in the challenge description. Our results indicate that employing words related to complexity can either negatively or positively impact crowdsourcing performance. In fact, these findings extend previous research on the effect of task complexity, which state that the effect could either be positive (e.g. Garcia Martinez, 2017) or negative (e.g. Afuah & Tucci, 2012). Our study points out that task complexity must be considered as a multifaceted factor. While certain aspects of task complexity that stimulate the intrinsic motivation to solve a complex problem might have a positive effect, other aspects of task complexity that make it difficult for solvers to comprehend, might eventually have a negative impact on solver participation. Reconciling with the social exchange theory, in the context of crowdsourcing, we complement Ye and Kankanhalli (2017) and argue that applying this theoretical lens provides information on the effects of task complexity, as it can indicate both benefits and costs. Costs in terms of understanding a complex problem, which may be impaired by the manner in which the task is communicated, and benefits in terms of providing solvers the opportunity to develop solutions for a challenging problem, thereby stimulating intrinsic motivation. We therefore encourage future research to follow up on this ambivalent effect and separate positive and negative aspects in future analyses.

4.5.2 Managerial Implications

Concerning the focal point of this study, the task delineation of crowdsourcing challenges, we find that all three examined factors task specificity, the communicated innovation ambition of the firm, and task complexity, have an impact on the crowd's decision to participate and submit solutions in crowdsourcing contests. As such, our findings suggest that the task description sends several signals to potential solvers. Against the backdrop of

the signaling theory, firms should take into consideration that solvers perceive a bundle of signals, which in this study comprises the task complexity, specificity, and the innovation ambition of the seeker. Not considering any of these factors thus renders a task description aiming to attract a broad range of solutions less effective for motivating solvers to develop and submit solutions.

Based on our findings, we posit that crowdsourcing firms seeking creative solutions should clearly emphasize their innovation ambition and emphasize the acceptance of creative solutions. However, this does not mean that no solution requirements must be provided, but instead, firms must distinguish between communicating the innovation ambition, and defining the central requirements that solutions must fulfill. Taken together, both task specificity and the innovation ambition thereby contribute to defining the accepted solution space of a crowdsourcing challenge, and hence, serve as means to stimulate intrinsic motivation among potential participants.

Intrinsic motivation can be further stimulated through offering solvers the opportunity to solve complex tasks that require a variety of skills and diverse knowledge. However, crowdsourcing managers must achieve a balance between different facets of task complexity. While the complexity of the task itself can intrinsically motivate potential solvers, these tasks potentially run the risk that the complexity is not communicated appropriately. Complex tasks should be communicated in a comprehensible manner that facilitates the development of solutions. In contrast, if the challenge description itself is complex and makes it difficult for solvers to understand the goals and requirements, the intrinsic motivation may be negatively affected. Taken together, motivating solvers to participate and develop solutions requires a thoughtful delineation of the crowdsourced task. Moreover, there should be sufficient room for solvers to display their creativity and skills to solve complex tasks by stating only the necessary boundary requirements, which ultimately define the accepted solution space.

4.5.3 Limitations and Perspectives for Future Research

A limitation of this study is that we employed variables that were objectively measurable. However, solvers may interpret a challenge in different and more subjective ways that may diverge from the objective measurements used. A suggestion for future research is apply a solver perspective, and allow potential solvers to evaluate and determine their perception of the complexity, specificity and innovation ambition of crowdsourcing challenges, and subsequently assess whether regression analyses utilizing these more subjective measurements of the three factors are in line with this research. In this context, we also employed a measurement for crowdsourcing performance that was objectively measurable and of particular importance for ideation contests. We encourage future research to determine further aspects related to crowdsourcing performance, such as solution quality, and to replicate the approach of this study utilizing different operationalizations for crowdsourcing performance. In order to further enhance the conceptual underpinnings of this study, we suggest considering additional potential design elements not included in this study. For instance, Karachiwalla and Pinkow (2021) elaborate on a comprehensive overview of relevant design elements for a crowdsourcing initiative. Future research is encouraged to add further design elements to the conceptual model proposed in this study and assess potential interdependencies among distinct design elements.

Another limitation is the fact that we only used ideation challenges, which limits the generalization of the findings. As the nature and goals of other types of crowdsourcing tasks differ, we only focused on ideation challenges, to reduce noise in the data. Since further types of crowdsourcing challenges, such as with the goal to develop prototypes, or challenges that require experimental testing of the solutions, may be subject to different results. Essentially, these challenges are subject to different parameters considering crowdsourcing performance. For challenges that may for example seek to receive prototypes, a few high-quality solutions may be preferred over a range of more but potentially mediocre solutions. We encourage replicating this study utilizing different measures of crowdsourcing performance for other types of crowdsourcing

contests.

Beyond this, we also find strong indications that the communicated innovation ambition is positively related to the likelihood of solvers to develop and submit solutions to a crowdsourcing challenge. While we can only argue for a potential causal relationship since the challenge statement is typically read and analyzed by solvers before the actual development of solutions takes place, we suggest validating this potential causality. We specifically call for an experimental research design to verify the degree of communicated innovation ambition for the underlying task and assess the willingness to submit solutions. In this context, we also emphasize the possibility of cooperation among solvers, which can impact the possibility of solver participation (Morschheuser, Hamari, & Maedche, 2019). Bullinger et al. (2010) find that the degree of solution innovativeness in innovation contests is further influenced by the degree of cooperation. Since InnoCentive does not enable specific cooperation types among the solvers, this paper did not account for potential influences of cooperation versus competition structures by design. However, we see great potential in enhancing the suggested experiment above by applying a factorial design, which allows to assess the impact of varying degrees of communicated innovation ambition on crowdsourcing performance contingent on whether the challenge is cooperation- or competition-based. Cooperation-based tasks could allow cross-fertilization of knowledge among the solvers, that may positively contribute to the envisaged solution innovativeness by crowdsourcing firms.

Based on our findings, we further propose promising avenues for future research. We suggest examining the task specificity in more detail in future research. As we propose an inverse U-shaped relationship between task specificity and crowdsourcing performance, we recommend identifying thresholds for the number of solution requirements, and whether there are contingencies for these thresholds. Contingencies could include the degree of complexity, or whether a challenge requires expert knowledge in a field or more common knowledge. Furthermore, there may be certain requirements that are perceived negatively, whereas other solution requirements that may be

perceived positively by potential solvers. A qualitative research design, which focuses on interviewing solvers to investigate what leads to a positive or negative sentiment when confronted with various solution requirements, can be a promising starting point to deepen our understanding of the task delineation of crowdsourcing contests.

Furthermore, we propose that the task complexity requires further research. A promising avenue could be to clearly separate negative and positive aspects of complexity. Mixed method approaches, including interviews with solvers and subsequent statistical analysis of the elaborated factors could provide further insights into the relationship of complexity and crowdsourcing performance. We encourage future research to identify the variety of facets of task complexity, and separate this construct of task delineation into aspects that stimulate intrinsic motivation to solve a challenging and complex task, as well as aspects that render a complex task difficult to understand and thus negatively impact the perception of the task by potential solvers.

4.5.4 Conclusion

This study contributes to crowdsourcing theory and practice by investigating three central elements of the task delineation and their impact on crowdsourcing performance. We find that the task delineation is a central factor that impacts the crowd's perception of a crowdsourcing task, and hence the outcome of crowdsourcing challenges. Thus, crowdsourcing firms can leverage the manner in which a task is delineated to increase crowdsourcing performance, utilizing the findings of this study. In essence, firms conducting crowdsourcing for ideation should communicate that solvers are encouraged to work creatively, stimulating solvers' intrinsic motivation to engage in a crowdsourcing contest. Thereby, the solution space should be defined through the necessary solution requirements, which should, however, not restrict the opportunity to work creatively. To facilitate solution development, particularly complex tasks must be delineated in a way that makes the task understandable and plausible. Ultimately, firms should be aware that the task description must contain the necessary information, based on which solvers determine the monetary and non-monetary benefits and costs associated with

participating and solving the crowdsourcing task.

Chapter 5

Overarching Conclusion of the Thesis

The overarching objective of this doctoral thesis is to develop a profound understanding of the design and operationalization of crowdsourcing contests for innovation. The three research articles in the context of this thesis together explore the various design parameters, complexities and interdependencies, such that crowdsourcing campaigns can be effectively designed and configured to engage potential crowd contributors and capture relevant value.

This final chapter comprises three sub-sections that synthesize the central findings and contributions of each of the individual manuscripts to develop a coherent picture in response to the aforementioned research questions (see section 1.2). This chapter further discusses the major theoretical and managerial implications and outlines avenues for further research within the crowdsourcing literature.

5.1 Theoretical Implications

As aforementioned, research on crowdsourcing for innovation has gained tremendous attention over the past two decades, especially as firms are increasingly integrating crowdsourcing-based business models into their innovation processes (Afuah & Tucci, 2012; Brabham, 2008; Hossain, 2015; Kohler, 2015; Zogaj et al., 2014). In particular, innovation contests have been on the rise, enabling organizations to access a vast pool of

external know-how and expertise internal innovation challenges to solve internal innovation challenges at relatively lower costs (Boudreau & Lakhani, 2013; Brabham, 2008; Jeppesen & Lakhani, 2010). Despite the growing significance and widespread adoption of crowdsourcing in practice, the literature reports that our understanding of the overall design and configuration of crowdsourcing initiatives is still limited (Amrollahi, 2015; Neto & Santos, 2018; Ghezzi et al., 2018; Zheng et al., 2011). To this end, the three manuscripts in this thesis address this major research deficit and contribute to a deeper understanding of how crowdsourcing projects can be effectively designed and operationalized by (1) reviewing the extant crowdsourcing literature to identify and extract the key design facets, (2) developing a novel approach to conceptualize the overall configuration of crowdsourcing initiatives including highlighting key interdependencies, and (3) empirically investigating the impact of certain design parameters on crowdsourcing performance.

First, the thesis contributes to a comprehensive understanding of designing crowdsourcing campaigns for innovation. In consideration of the fundamental phase of designing a crowdsourcing campaign, this thesis seeks to answer the central question of which design-related factors organizations must consider to effectively design and execute successful crowdsourcing projects. From a design perspective, crowdsourcing research often focuses on addressing single or specific design elements, without developing an integrated picture of the overall crowdsourcing system. As such, a conceptual framework that represents the key design elements is still lacking (Neto & Santos, 2018).

To address this deficit, the first research paper conducts a systematic literature review to identify, extract and analyze the critical design elements involved in the configuration of crowdsourcing contests. Through synthesizing the principles of the social exchange theory and absorptive capacity, this study provides a novel conceptual configuration that accounts for both the attraction of solvers and the ability of the crowdsourcer to capture value from crowdsourcing contests. In particular, a morphological approach is used to structure the four central crowdsourcing dimensions

(i) task, (ii) crowd, (iii) platform, and (iv) crowdsourcer into a conceptual framework, to present an integrated overview of the various crowdsourcing design options. Since the design of an innovation contest must be tailored for its individual purpose (Adamczyk et al., 2012), adopting such a decision-centric framework provides an overarching, visual representation of the overall solution space, thereby allowing the possibility of choosing different combinations of options for each design parameter best suited to the goals of the problem to be crowdsourced. Considering that the scope of the design of a crowdsourcing challenge refers to a complete set of decisions that must be addressed when designing a crowdsourcing contest, this thesis primarily addresses the lack of a theory-based yet practicably applicable framework on crowdsourcing to enable efficient crowdsourcing contest design. In doing so, this study further responds to the many calls for further research regarding the 'lack of standardization' and the need for a 'comprehensive guideline' to better design and manage crowdsourcing projects (Amrollahi, 2015; Neto & Santos, 2018; Zheng et al., 2011).

Second, this thesis explores the various design complexities and interdependencies involved in developing effective crowdsourcing campaigns. Drawing on three crowdsourcing projects with differing innovation goals, a 'clinical' case study approach was employed to investigate the rationale behind the various design decisions and to explore how certain decisions interact with each other to influence the overall success of the project. The research findings indicate that the underlying task is the most central decision parameter in the overall campaign design because it relates closely to the objective of the campaign, and more importantly, influences certain subsequent decisions in the crowdsourcing process. Within the task dimension, the two most critical design elements are the complexity and specificity of the task to be crowdsourced. The results indicate that as the complexity of the task increases, crowdsourcing campaigns must be designed to target individuals that have domain-specific knowledge. The research findings further extend the current literature on task specificity by showing that the specificity of the task is a key design decision that must be considered, which in turn, influences the overall solution space and the innovation potential of the solutions. The results also reveal the innovation ambition of the task to be an additional, critical

decision element in the context of crowdsourcing project design, which has been ignored by extant literature. Considering that crowdsourcing can be a means to overcome internal innovation challenges within firms, this study indicates that the trade-off between the specificity of the task and the innovation ambition is an important issue to be considered with respect to the design of the project. Finally, this study draws attention to the issue of potential interdependencies across the design facets, which is an aspect that has been ignored by research thus far. Taking into account these interdependencies, the findings of this study strongly recommend crowdsourcing firms to apply a portfolio perspective when making design-related decisions, and more importantly, shed light on how these various design choices combined play a significant role in providing the necessary information to external individuals, who subsequently interpret this information to submit solutions to innovation challenges.

Third, this thesis seeks to empirically explore the link between the delineation of the task and its impact on the success of crowdsourcing initiatives. In the context of innovation contests, the articulation of the problem statement and the manner in which it is conveyed is central to the process (Afuah & Tucci, 2012; Ghezzi et al., 2018; Gillier et al., 2018; Natalicchio et al., 2017; Nakatsu et al., 2014; Jeppesen & Lakhani, 2010; Sieg et al., 2010; Steils & Hanine, 2016). Despite the overwhelming literature on the different factors that motivate the crowd to participate (Acar, 2019; Ghezzi et al., 2018; Lee et al., 2015; Leimeister et al., 2009; Zhao & Zhu, 2014a), surprising little is known about how certain decisions taken when articulating the problem statement play a role in motivating solvers to contribute in innovation contests (Ghezzi et al., 2018). In particular, empirical evidence of the impact of the different task-related decisions on solver motivation to participate is still lacking. Drawing on a rich dataset of ideation challenges, the third and final research paper addresses one of the most prominent challenges of attracting the crowd to participate and submit solutions (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013; Piezunka & Dahlander, 2015). By empirically investigating three crucial attributes of the task, this thesis enhances the current understanding on crowdsourcing campaign design in terms of how certain task related choices contribute to solvers' decisions to submit solutions. The results show that all three examined factors task specificity, the

innovation ambition of the firm, and task complexity, impact the crowd's decision to participate in crowdsourcing contests. Not considering any of these three factors thus renders a task description that aims to attract a broad range of solutions, which in turn, is less effective for motivating solvers to develop and submit solutions. Further, the results draw attention to the innovation ambition of the seeker, an aspect that has been ignored by extant research thus far.

Overall, this thesis is one of the first attempts to present an elaborate conceptual framework representing the critical design decisions in the context of innovation campaigns. From a theoretical standpoint, it contributes to the extant literature on crowdsourcing design by offering an approach to conceptualize the central design parameters, highlighting key interdependencies, and investigating the impact of the delineation of the underlying task on crowdsourcing performance.

5.2 Managerial Implications

In addition to advancing our academic understanding of crowdsourcing contests for innovation, this thesis also seeks to provide several valuable insights for practitioners and managers undertaking crowdsourcing projects. Despite the widespread adoption of innovation contests in practice, it is important to point out that not all crowdsourcing initiatives are an immediate success. In fact, the Gartner CIO Report (2016) demonstrates that crowdsourcing ranks relatively low in terms of implementation and capturing value. One contributing factor could be the limited know-how in terms of how crowdsourcing projects are effectively designed. In this context, this thesis seeks to address this gap by expanding our understanding of how crowdsourcing projects can be configured and operationalized in practice.

First, this thesis addresses two central managerial challenges in terms of how firms can motivate potential crowd contributors to submit solutions, and ultimately, how firms can capture adequate value from the received solutions. This requires practitioners to make informed decisions that account for both aspects when setting up

crowdsourcing projects. To this end, this thesis takes on a seeker perspective and makes an important contribution to practice by presenting an integrative account of the critical design elements of a crowdsourcing contest. Specifically, by adopting a morphological approach, the first research paper provides different configurations of crowdsourcing projects, allowing managers to choose alternative solutions for each design parameter, depending on the goals of the underlying task. Since attracting the crowd requires a comprehensive perspective on the crowd's perception on associated costs and benefits for solving a task, the seeking firm must address these considerations during the design phase of the contest, in order to attract appropriate crowd members to develop high-quality solutions. Similarly, capturing value from the received solutions requires firms to make a series of decisions related to internal organizational processes, resource planning and the delineation and communication of the task. Therefore, the design and set up of a crowdsourcing project entails a variety of decisions, which together influence the performance of the campaign. The conceptual framework presented in this thesis seeks to bridge the gap of a lacking framework, and serves as comprehensive blueprint through which practitioners can effectively conduct crowdsourcing campaigns.

Second, this thesis empirically investigates how crowdsourcing projects are managed in practice. By using a 'clinical' case study approach to examine three crowdsourcing projects with distinct innovation goals, this study gathers first-hand information from experienced crowdsourcing practitioners to explore the various design complexities involved in developing effective campaigns. The cases reveal a hierarchy between certain design choices, such that some design-related decisions taken early on influence subsequent design parameters. This highlights some fundamental interdependencies between design elements, such that the opportunity for taking viable decisions is much more limited in practice. In particular, the findings further indicate that the manner in which the task is delineated and communicated has a profound impact on the nature of the submissions received. For instance, the results demonstrate that it is very important for crowdsourcing firms to strike a balance between being too specific and, therefore limiting the solution space of the problem, versus being open, which enables solvers to think out-of-the-box, but at the same time, increases the risk of receiving low-quality

solutions. Similarly, firms must clearly define in advance whether they are seeking radical, out-of-the-box input or are rather seeking incremental improvements to their existing portfolio. Considering that crowdsourcing project design entails multifold interrelated design decisions, this thesis develops a comprehensive decision-centric approach to highlight the design space opportunities available to firms willing to engage in innovation contests. In particular, the morphological box is a central instrument for practice because it offers opportunities to develop blueprints of crowdsourcing campaigns. Further, by highlighting key interdependencies and providing an account on the rationale behind certain key decisions, this thesis makes a very important contribution to practice, enabling practitioners to make more informed decisions.

Third, this thesis goes one step further by empirically assessing the impact of the delineation of the task on campaign performance. A major challenge for crowdsourcing firms is to attract and motivate the crowd to submit solutions. To address this issue, the third research paper draws on a rich dataset of 392 ideation contests to investigate three attributes of the task that are central to crowdsourcing design: task complexity, task specificity, and the communicated innovation ambition. While the findings indicated that all of the three assessed design attributes have an impact on participation in crowdsourcing campaigns, firms must be especially careful when communicating the innovation ambition and specificity of the task. In the context of ideation campaigns, solvers are particularly motivated by the prospect of developing creative, out-of-the-box solutions, and hence are more likely to engage in contributing ideas when the communicated innovation ambition is high. Consequently, when seeking firms provide too many solution requirements and specifications, it has a negative effect on attracting solvers to participate. Taken together, both task specificity and the innovation ambition thereby contribute to define the accepted solution space of a crowdsourcing challenge, and serve as means to stimulate intrinsic motivation. Further, the results point out that the task complexity must be considered as a multifaceted factor. While certain aspects of task complexity that stimulate the intrinsic motivation to solve a complex problem might have a positive effect, other aspects of task complexity that make it difficult for solvers to comprehend, may eventually have a negative impact. Therefore, from a design perspective, it is crucial for crowdsourcing firms to

consider these different facets, and how they might potentially impact crowd participation, and hence the overall crowdsourcing performance. This thesis takes a first step towards providing an account on how certain characteristics of the task influence solvers' decisions to participate in crowdsourcing campaigns. By understanding the impact of the three relevant parameters on crowdsourcing performance, the findings of this study serve as a means to guide practitioners to make informed choices, taking into consideration the overall innovation goals of the underlying task.

5.3 Limitations and Avenues for Future Research

As with any research, this thesis is not without limitations. Overall, this thesis is one of the first attempts to present a comprehensive conceptual framework in the context of the design and configuration of innovation campaigns. While the morphological approach presents a structured overview of the various potential design configurations, this thesis primarily adopts a seeker perspective to generate valuable insights for practitioners to better design and operationalize such innovation contests. The perspective of the solvers is only indirectly assessed in this study. Since the various design decisions taken throughout the project result in a portfolio of different signals received by the solvers, a promising avenue for further research is the assessment of how potential solvers perceive the design of a crowdsourcing campaign. Hence, there remains immense potential in identifying the design facets that solvers perceive as central in shaping a high-quality signal, and whether the solvers' perceptions match those of the seeker.

Next, since this thesis primarily focuses on innovation contests, the results may vary in other crowdsourcing settings, such as open collaboration, micro-tasking and information pooling. In recent years, other forms of crowdsourcing that target other groups of individuals such as industry experts, consultants, and other partners in the value chain with specific skillsets have emerged. In particular, collaboration-based crowdsourcing models, which enable active discussions of participants, sharing of solutions and encourage community building have become popular. While this thesis

provides an initial starting point towards crowdsourcing design, the latter might lead to completely different design decisions along the process. Future research could investigate these options to explore if there are any major differences in terms of the design choices involved and the overall set up of the project. For instance, crowdsourcing firms might need to reconcile with different forms of crowd motivation such as social recognition and prestige within communities. The morphological approach presented in this study provides a promising foundation for these other types of crowdsourcing projects. Therefore, future research is encouraged to explore and contrast different types of crowdsourcing campaigns, using the morphological approach and adapt the framework accordingly.

In the context of crowdsourcing contests for innovation, this thesis adopts the previously developed morphological decision-centric framework to explore the rationale behind the different design decisions taken during the crowdsourcing process based on three crowdsourcing projects within one focal firm in the automotive industry. While the cases provide rich first-hand information from experienced managers, future research could potentially strengthen the validity of the framework in the context of other industries and different corporate settings to determine if there are additional design elements that might be relevant in the overall crowdsourcing project design. Through the case studies, this thesis is one of the first works to point to fundamental interdependencies between the different design decisions in the crowdsourcing process. The results indicate some significant dilemmas in the decision making process, especially in the context of the specificity of the task and the innovation ambition of the seeking firm. Future research could further examine these trade-offs and assess how such trade-offs can be resolved.

Although this thesis makes an important contribution to literature and practice by empirically assessing the relationship between the task delineation and crowdsourcing performance, a limitation is that this study primarily dwelled on ideation challenges, which in turn, might limit the generalization of the research findings. As such, crowdsourcing challenges that seek to develop prototypes, or challenges that that require

experimental testing of the solutions, may be subject to completely different results. Hence, replicating this study in the context of other types of crowdsourcing challenges could be another promising avenue for further research. Further, a rather objective measurement was employed to measure crowdsourcing performance, in the context of ideation contests. However, other types of challenges that seek to receive concrete prototypes may potentially be subject to a different set of parameters. Therefore, future work is encouraged to determine additional aspects related to crowdsourcing performance such as solution quality.

Disclaimer: The results, opinions and conclusions expressed in this thesis are not necessarily those of Volkswagen Aktiengesellschaft.

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Appendix A: Correlation Matrix

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.	Crowdsourcing Performance	1.000												
2.	Award Value (in $)	0.098*	1.000											
3.	Ideation Challenges per Year	-0.116**	-0.239****	1.000										
4.	Size of Solver Base per Year	0.403****	0.314****	-0.251****	1.000									
5.	Public Company Name	0.196****	0.200****	-0.078	0.148***	1.000								
6.	Campaign Duration (in days)	-0.106**	0.168****	-0.016	-0.133***	0.183****	1.000							
7.	Task Specificity	0.117**	0.052	-0.045	0.179****	-0.042	-0.072	1.000						
8.	Innovation Ambition	0.257****	0.183****	-0.005	0.197****	0.285****	0.100**	0.012	1.000					
9.	Task Complexity - Number of Sentences	0.276****	0.278****	0.005	0.310****	0.347****	0.034	0.358****	0.290****	1.000				
10.	Task Complexity - Average Words per Sentence	-0.082	0.091*	0.033	-0.018	0.366****	0.103**	-0.164***	0.211****	-0.127**	1.000			
11.	Task Complexity - Number of Challenge Categories	-0.145***	-0.023	0.061	-0.203****	0.001	0.041	-0.153***	0.016	-0.053	0.063	1.000		
12.	Task Complexity - Unique words	0.212****	0.030	0.030	0.111**	0.359****	0.126**	0.111**	0.219****	0.591****	0.096*	-0.043	1.000	
13.	Task Complexity - Word List	0.119**	-0.031	-0.031	0.099**	0.127**	-0.022	0.081	0.140***	0.365****	0.053	0.126**	0.311****	1.000

*Note: * 10%, ** 5%, *** 1%, **** 0.1%*

Research Paper	I	II	III
Title	Understanding Crowdsourcing Projects: A Review on the Key Design Elements of a Crowdsourcing Initiative	A Morphological Approach towards Crowdsourcing Project Design: A multiple Case Study	Designing Crowdsourcing Contests for Ideation: Investigating the Relationship between Task Delineation and Crowdsourcing Performance
Authors	• Rea Karachiwalla • Felix Pinkow	• Rea Karachiwalla • Felix Pinkow • Søren Salomo	• Rea Karachiwalla
Research Objective	Development of a conceptual integrative framework that represents the crucial design elements of a crowdsourcing project	Profound understanding of the complexities and interdependencies between the key crowdsourcing design facets	Empirical quantitative investigation of the impact of certain task-related design decisions on solver motivation to contribute ideas
CRediT (Contributor Roles Taxonomy) author statement	**Rea Karachiwalla:** Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Visualization, Supervision, Project administration **Felix Pinkow:** Validation, Data Curation, Writing – Review & Editing	**Rea Karachiwalla:** Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft **Felix Pinkow:** Conceptualization, Writing - Review & Editing **Søren Salomo:** Visualization, Supervision, Project Administration	-
Publication Success	• Presented at the Innovation and Product Development Management Conference (IPDMC) 2020 • Accepted and published at Creativity and Innovation Management	• Submitted to Technological Forecasting and Social Change	• Submitted to Academy of Management Journal (Earlier version of abstract submitted and presented at the Open and User Innovation Conference 2021)

Table 5.1: Publication Success