IDEA DEVELOPMENT IN ONLINE INTERNAL CROWDSOURCING

The role of peer contributions

Qian Chen

Doctoral thesis no.52, 2018
KTH- Royal Institute of Technology
School of Industrial Engineering and Management
Department of Machine Design
Division of Integrated Product Development
SE-100 44 Stockholm
Idea development in online internal crowdsourcing
The role of peer contributions

© Qian Chen, Stockholm 2018

TRITA-ITM-AVL-2018:52


Printed by: US-AB, Stockholm, Sweden
“我们虽然不是伟大的人，但如果用一颗伟大的心去做微小的事，就能成就伟大的事业。这颗心就是利他。”

/索达吉堪布（Khenpo Sodargye）
Preface

This thesis is submitted to the KTH Royal Institute of Technology in partial fulfillment of the requirements for the Doctoral Degree in Technology. The work has been carried out at the School of Industrial Engineering and Management in Machine Design, Stockholm, Sweden, with Professor Mats Magnusson (KTH) as main supervisor and Associate Professor Jennie Björk (KTH) as co-supervisor. The research project was supported by funding from China Scholarship Council (CSC) and Institute for Management of Innovation and Technology (Stiftelsen IMIT).

The thesis was publicly defended at 10:15, Friday, November 16, 2018, in Gladan, Innovationsstudion, Maskinkonstruktion, KTH Brinellvägen, 85, 100 44, Sweden.
Abstract

This thesis focuses on idea development in online internal crowdsourcing. Online crowdsourcing for ideas has seen a substantial uptake in practice and has attracted a leading wave of researchers in the academic field. Although crowdsourcing can significantly expand the knowledge resources available in terms of the volume and variety of ideas, it also creates additional challenges for innovation management to nurture ideas to innovation. An emerging management issue is how to manage voluntary peer contributions to ideas in online internal crowdsourcing of the front end of innovation.

Online internal crowdsourcing, which captures and develops ideas solely from employees, is less well-understood than other forms of crowdsourcing from external users. Furthermore, extant knowledge of ideation has thus far focused on idea generation, whereas little is known about what really happens during the development of ideas and also if and to what extent value is created when peer communities contribute to ideas. This thesis aims to explore the role of peer contributions in online internal crowdsourcing for idea development.

Based on the data of ideas and comments collected from an idea management system in a Swedish multinational company, several types of analyses have been used to increase understanding of the role of peer contributions in idea development. For example, text mining methods including sentiment and expertise analyses have been selected to observe the role of contribution content in terms of sentiment and the knowledge background of contributors. On this basis, four appended research studies were conducted. The research results identify four types of peer communication in terms of contribution behaviors based on proactive/passive engagement as well as knowledge-focus, and their contributions influence idea development in different ways. In terms of the role of peer contributions, it is seen that dimensions of peer contributions, including timeliness, content sentiment and content type, play critical roles in idea development, and their roles are influenced by the contributors’ knowledge.

These results contribute to existing theory in terms of extending the view of ideation to include idea development. This view not only provides new insights on peer-to-peer communication but also a more detailed understanding of peer contributions in online internal crowdsourcing for
ideas. Moreover, the results also provide management implications for how firms can use online internal crowdsourcing to manage voluntary peer assistance to nurture ideas.

**Keywords:** online internal crowdsourcing, idea development, peer-to-peer communication, peer contributions
Sammanfattning

Denna avhandling behandlar idéutveckling i organisationsintern online crowdsourcing. Användningen av online crowdsourcing för att fånga innovationsidéer från olika delar av organisationer har rönt stort intresse inom forskningen och åtskilliga företag har också börjat tillämpa detta arbetssätt.

Genom att använda crowdsourcing kan företag utöka sina tillgängliga kunskapsresurser på ett radikalt sätt och därigenom skapa både ett större flöde av idéer och mer variation bland dessa. Samtidigt skapar detta arbetssätt en rad nya utmaningar i termer av innovationsledning. En kritisk frågeställning som uppstår är hur företag kan hantera de bidrag till innovationsidéer som ges av kollegor i form av feedback och kommentarer i innovationsprocessens tidigare faser.

Organisationsintern online crowdsourcing fångar upp och utvecklar idéer från anställda inom en och samma organisation. Denna typ av crowdsourcing har undersökts i mindre omfattning än extern crowdsourcing. Det kan också noteras att lejonparten av studier inom området avser idéskapande i dess snävare mening. Betydligt mindre är känt om det idéutvecklingssteg som ofta följer efter idékapandet, samt om och hur kollegors bidrag till idéerna påverkar det innovativa värdeskapandet. Syftet med denna avhandling är att utforska vilken roll som bidrag från kollegor i organisationsintern online crowdsourcing spelar för idéutveckling.

En rad olika analyser har genomförts för att närmare förstå den roll som bidrag från kollegor spelar i idéutveckling. De empiriska undersökningarna är baserade på idéer och kommentarer från ett omfattande idéhanteringsystem i ett svenskt storföretag. Bland dessa metoder märks textanalys med fokus på sentimentanalys och expertis i avseende att förstå mönster i hur olika individer bidrar till utvecklingen av sina kollegors idéer. Fyra olika delstudier har genomförts för att analysera olika aspekter av detta fenomen. Resultaten av dessa visar att fyra olika kommunikationsmönster kan urskiljas i termer av huruvida individerna är passive eller aktiva och om de kommenterar på ett fokuserat eller ofokuserat sätt.

Vad avser bidragen från kollegorna visar studierna att timing, känslomässig laddning och innehållstyp spelar en viktig roll för idéutveckling och att dessas...
påverkan är avhängigt kunskapsnivån hos den kollega som ger feedback eller kommentarer.

Resultaten från detta arbete bidrar till tidigare teori genom att explicit inkludera kollektiva idéutvecklingsaktiviteter som en de tidiga faserna av innovationsprocessen och därigenom identifiera nya möjligheter att förbättra denna. Detta bidrar till en ökad generell förståelse för vikten av kommunikation mellan kollegor i tidiga innovationsfaser, men också mer detaljerade insikter om hur bidrag från kollegor inom ramen för organisationsintern online crowdsourcing påverkar idéutveckling och innovation. Utifrån resultaten ges ett antal olika managementimplikationer för hur företag på ett fruktbart sätt kan använda organisationsintern online crowdsourcing för att underlätta och påverka anställdas frivilliga bidrag till utvecklingen av sina kollegors innovationsidéer.

Nyckelord: Organisationsintern online crowdsourcing, idéutveckling, kollegor kommunikation, kollegor bidrag
Acknowledgments

All the studies and life experiences leading up to this thesis are so beautiful and will inspire me throughout my life. Along this journey, there have been a lot of people who accompanied me and contributed to this progress. I am very grateful to all of you and your contributions to this PhD project.

First of all, I would like to express my deep gratitude to my supervisor Mats Magnusson. You are so intelligent and knowledgeable in this research area. During the last years, you cleverly guided me in how to be a researcher with your inspired knowledge and encouragement. The flexible exploring space you provided let me feel your trust and thus become confident in myself. Like the light, you were there to guide me when I had become lost in my self-limitation. Like the sea waves of knowledge, your instruction drove the sails of my thinking. Your sense of humor makes this journey more fun and let me have a quite enjoyable PhD experience. The importance of ‘ambition’ that you told me will remain throughout all the research endeavors of my life.

I would like to thank my co-supervisor Jennie Björk. You are so adept at research methodology, which largely promoted the progress of this project. Without your supervision, a newcomer like me would not have been able to perform the big data analysis and use complex research methods. Besides the guidance of data collection and analysis, you always remind me to set the schedule of supervision meetings, and you always kindly give me warm caring. I was quite impressed by your cautious attitude on research. The importance of being ‘honest’ and ‘transparent’ that you told me will positively influence me throughout my research journey.

I am grateful to Magnus Karlsson for your kind support and valuable knowledge input to my PhD project, particularly at the early phases of the process. Many thanks to Alexander Kock, for allowing precious time to carefully read the manuscript. Your comments have had great importance to my work in the later phases.

My appreciation also extends to all colleagues in the Division of Integrated Product Development. Thank you for your warm companionship, support, and help. Your wonderful discussions in research seminars positively stimulated my thinking, broadened my view and provided me with a new research perspective. A special thanks to Liridona Sopjani; your critical thinking inspired me a lot. As PhD students, we always had similar challenges, and your kind experience sharing and encouragement let me better accept the back and forth situations and understand myself to continue moving forward.

I would like to thank Susanne Nilsson. You are very kindhearted to take care of me. Thank you very much for your all kind help over the last years. With your encouragement, I realized that I could be a help giver by sharing ideas in
each research seminar, which has broken my self-doubts and changed my passive attitude in discussions. Sofia Ritzén, your hard work and your great discussions always inspired me during the last years. Thanks to Sigurður Hannesson, your cooperative data analysis has helped a lot for further exploration. To Jens Hemphälä and Jens Hagman, thank you very much for your companionship in the same previous office and sharing of ideas in discussions. Thanks also go to Ingrid Kihlander, Jenny Janhager Stier and Gunilla Ölundh Sandström; your great companionship provided me with a very warm and positive working environment.

I also would like to express my gratitude to my Chinese colleagues in other divisions in KTH. Qingling Xia, Fang Li, Yu Ye, Liu Yan, Jinzhi Lu, Lei Feng, Xuan Sun, Xin Tao, Yang Wang, Xinhai Zhang, Zhou Zhou. Thank you for your appreciated friendship, letting distant journeys become close to home.

I am grateful to my home supervisor Yu Yang in Chongqing University. You are always so kind to support and care about my studies at KTH, which helped me to have a positive work progress. Thanks to my Chinese colleagues in EDRC, Chongqing University, who always kindly care for me even we were far away from each other.

My special thanks to the case company who has provided me opportunities to pursue my research interest. Many thanks to Mikael Johannesson and Marcus Andersson in the case company who arranged your precious time to answer my questions and share your expertise.

I would also like to convey my deep regards to the CINet PhD workshop, who has provided opportunities for me to share my ideas and get much productive input to my research. My appreciation also extends to China Scholarship Council (CSC) and Institute for Management of Innovation and Technology (Stiftelsen IMIT), who has provided the financial support for this project.

Further, I would like to take this opportunity to express my personal and sincere gratitude towards Khenpo Sodargye. Even if it is challenging to be a PhD student, your spiritual guidance helps me to practice this work with a humble and peaceful mind, to be effectively focused on what I needed to do and to continue moving ahead no matter what difficulties I had.

To my friends in Sweden, Bingxing Yao, Xiao LI, Yi Yuan, Zhongxuan Liu, Rui Xu, thank you very much for your kind caring and help in my life.

Finally and without hesitation I would like to thank my families. To my parents, thank you very much for your love, trust and caring. To my husband who has been supportive in every way possible, and my little son who has brought many exciting experiences during this process, I am grateful to have you in my life. Many thanks to my younger sister, my brother and my parents-in-law, especially for your love and support.

Qian Chen
Stockholm, 2018
List of appended Papers

**Paper I**


**Paper II**


**Paper III**


**Paper IV**

## Table of contents

Preface .......................................................................................................................... I  
Abstract ........................................................................................................................ III  
Sammanfattning ........................................................................................................... V  
Acknowledgments ......................................................................................................... VII  
List of appended Papers ............................................................................................... IX  
Table of contents .......................................................................................................... XI  
1 Introduction ............................................................................................................... 1  
  1.1 Thesis outline ........................................................................................................ 3  
2 Exposition of theory ................................................................................................. 4  
  2.1 Innovation, Ideation, Ideas ................................................................................... 4  
  2.2 Front end of innovation ....................................................................................... 6  
    2.2.1 The digitalization of FEI .............................................................................. 7  
    2.2.2 Changes to FEI with the digitalization ....................................................... 8  
  2.3 Online internal crowdsourcing ........................................................................... 10  
    2.3.1 From online crowdsourcing to online internal crowdsourcing ............... 10  
    2.3.2 Challenges in managing online internal crowdsourcing for ideas .......... 11  
    2.3.3 Idea development: a typical part of online internal crowdsourcing in FEI 12  
  2.4 Peer-to-peer communication as a means to develop ideas .................................. 14  
  2.5 Peer contribution as a factor influences idea development ............................... 17  
    2.5.1 Feedback: one type of peer contribution in idea development .............. 17  
    2.5.2 The role of feedback .................................................................................. 17  
  2.6 Research questions .............................................................................................. 18  
3 Research methodology .............................................................................................. 21  
  3.1 Research settings ................................................................................................. 21
3.2 Research strategy ................................................................. 22
3.3 Summary of research studies, appended papers and research questions  ................................................................. 24
3.4 Research methods .................................................................. 25
  3.4.1 Papers I, II, III ................................................................. 26
  3.4.2 Paper IV .......................................................................... 32
3.5 Methodological assessment .................................................... 34
  3.5.1 Validity .......................................................................... 35
  3.5.2 Reliability ...................................................................... 37
3.6 Methodological limitations .................................................... 37
4 Summary of the appended papers ............................................ 39
  4.1 Paper I ............................................................................ 40
  4.2 Paper II ........................................................................... 41
  4.3 Paper III .......................................................................... 42
  4.4 Paper IV .......................................................................... 43
5 Analysis .................................................................................. 45
  5.1 The types of peer communication in idea development .......... 45
  5.2 The role of peer contributions in idea development .............. 48
6 Discussion and management implications ................................. 54
  6.1 Timeliness of peer contributions ........................................ 55
  6.2 Content of peer contributions ............................................ 56
  6.3 The influence of peer knowledge on contribution ................. 58
  6.4 Management implications for peer contributions ............... 58
7 Limitations and future research ................................................. 62
8 References ............................................................................. 66
1 Introduction

Extant research on the front end of innovation (FEI) clearly points out that firms can benefit substantially if the early stages of the new product development (NPD) process are effectively managed and improved (e.g. Khurana & Rosenthal, 1998; Verworn, 2009). Within the FEI, the most important factor for successful innovation is typically referred to as valuable ideas (Schemmann, Herrmann, Chappin, & Heimeriks 2016; Van den Ende, Frederiksen, & Prencipe, 2015; Verworn, 2009). Thus, different approaches, particularly the internet-based one, have been used for idea management programs in order to fertilize, capture, mature, and evaluate ideas.

One of the approaches, online crowdsourcing for ideas, has become very popular among firms since 2000 (Braham, 2010). This is hardly surprising, as earlier examples and research, for instance, GoldCorp, Innocentive and TopCoder, have already shown the great benefits of the implementation of online crowdsourcing approaches (Jayakanthan & Sundararajan, 2011; Schemmann et al., 2016), particularly in idea generation with much increased volume and variety of ideas (Blohm, Leimeister, & Krcmar, 2013). However, online crowdsourcing also poses substantial challenges for firms’ capabilities to transform enormous volume and variety of ideas to innovation. In order to nurture good ideas into good currency (Van de Ven, 1986) and cull bad ones to avoid unnecessary costs, an increasing number of firms, indeed inspired by the power of crowdsourcing (Bayus, 2013; Howe, 2006, 2008), are beginning to use internal crowdsourcing for ideas.

Online internal crowdsourcing for ideas, in general, is managing ideas solely from employees inside firms to introduce innovation. It is distinct from other online crowdsourcing from internal or external sources and brings about changes to firms across organizations. More specifically, compared to the traditional organizational setting, the usage of online internal crowdsourcing substantially changes the architecture of work practices from face to face to virtual platform interaction, beyond the limitations of expertise, organization position, and geographic distance. Furthermore, online internal crowdsourcing such as IdeaBoxes in Ericsson (Björk, Karlsson, & Magnusson, 2014) offers a digital landscape reaching all processes of idea management, thus providing more
opportunities for not only co-creating ideas but also commenting on ideas. It is usually accompanied by changes in communication patterns, operation processes and forms of outcomes, since the horizontal peer-to-peer relationships (Sherif, Zmud, & Browne, 2006) in traditional settings are disrupted particularly during the commenting processes after ideas have posted. For example, the commenters at present are self-organized by the voluntary collective wisdom with diverse expertise instead of a limited number of specified experts, resulting in not only the virtual peer-to-peer communication but also a large number of diverse and complex peer contributions to ideas. Altogether, main changes to firms’ FEI through the use of online internal crowdsourcing could be concluded as 1) from face to face to virtual communication without the limitation of geographic distance, 2) from idea generation to idea development with transparent contributions to ideas, 3) from a limited number of individuals to large volume collectives as contributors, 4) from only specific experts to peer communities with diverse knowledge access, 5) from ideas to comments as contributions. These changes consequently bring about a new idea management pattern for FEI inside firms.

Nevertheless, the changes to some extent create additional challenges to the already difficult management of FEI, particularly the management of peer contributions in idea development. Peer contributions for idea development in online internal crowdsourcing are referred to as the given feedback. Briefly put, the challenges to managing them are pronounced in aspects including breaking the former hierarchical organizational structure for ideation (Erickson, Trauth, & Petrick, 2012), motivating employees with formal employment in firms to help peers develop ideas, allowing diverse contributions to ideas with an openness of mind, and so on. This leaves research with many issues to better manage online internal crowdsourcing for ideas, something which at present are attracting scholars’ attention (Malhotra, Majchrzak, Kesebi, & Looram, 2017; Zuchowski, Posegga, Schlagwein, & Fischbach, 2016). In order to cater to the changes and confront the management challenges in FEI brought by online internal crowdsourcing, effectively organizing the dynamic peer communities as well as managing their immature peer contributions are critical in order to transform employee creativity into innovation. However, little is known about what really happens to ideas with peer contributions after idea generation in online internal crowdsourcing. Hence, contributions to develop ideas by peers are of interest, and a key question is whether the potential value is realized when employees contribute to their peers’ ideas.
Given that some aspects of online internal crowdsourcing are not well known, this thesis focuses on idea development and aims to explore the role of peer contributions in online internal crowdsourcing for idea development. In order to fulfill this aim, empirical studies are conducted based on the data collected from an internal idea management system in a Swedish multinational company. On this basis, clustering analysis and statistical analysis have been used to first identify the types of peer communication in terms of peer contribution behaviors. Thereafter, text mining methods including sentiment and expertise analyses have been used in order to gain a detailed understanding of the role of contribution content and the knowledge background of contribution providers. By doing so, it is firstly found that there are different types of peer communication, identified according to peers’ proactive/passive engagement as well as knowledge-focus, and these different types of peer communication significantly and differently influence the peer contributions on ideas. The second finding is that peer contributions, from perspectives including timeliness, content sentiment and content type, play a critical role in idea development, and the role of contribution sentiment is influenced by the expertise of contribution providers.

1.1 Thesis outline

This thesis consists of four appended papers and a covering paper. The structure of the covering paper is as follows. It starts with an exposition of theory in which related theories are reviewed and research questions are proposed. Thereafter, the methodological choices and assessment and the summaries of each of the appended papers are presented. In what follows, the empirical results are analyzed. The thesis concludes with a discussion about its implications for theory and practice, and limitations for future study.
2 Exposition of theory

As the aim of this thesis is to explore the role of peer contributions in online internal crowdsourcing for idea development, the literature is reviewed from FEI to peer contributions step by step. Firstly, the key concepts such as innovation, ideation and ideas in the present thesis are introduced. Secondly, the changes to FEI and challenges in online internal crowdsourcing are analyzed. In what follows, idea development performed by the peer contributions through peer communication in online internal crowdsourcing is highlighted. Thus, theories related to peer communication and contribution such as knowledge collaboration, electronic networks of practice, and feedback are introduced in Sections 2.4 and 2.5. Finally, the section concludes with a discussion of the research gap and the posing of research questions in Section 2.6.

2.1 Innovation, Ideation, Ideas

Innovation, normally defined as ideas that have been developed and implemented (Van de Ven, 1986), has commonly been understood from two perspectives: processes and outcomes (Garud, Tuertscher & Van de Ven, 2013; Nambisan, Lyttyinen, Majchrzak, & Song, 2017). The perspective of innovation outcomes is focused on ideas while the one of innovation process is related to ideation. However, it is conceptualized that innovation is more than novel ideas and ideation. More specifically, on the one hand, innovation is a range of outcomes successfully implemented by not only novel but also useful ideas, such as new products, platforms, services, and businesses (Amabile & Pratt, 2016; Crossan & Apaydin, 2010; Nambisan et al., 2017). On the other hand, innovation is a process covering the generation, development and implementation of new ideas (Garud et al., 2013) by people who communicate and share knowledge over time. It is different from the creativity defined as the production of ideas, which is often conceived as FEI (Amabile & Pratt, 2016) or ideation in a narrow sense and lacks consideration of the idea implementation.

Indeed, in relation to innovation process, ideation can be seen as a sub-process of innovation (Crossan & Apaydin, 2010). Nevertheless, the activities in ideation are not clear, particularly when their context is shifted from individual to collective with the wide usage of information
technology. In order to outline the characteristics of ideation in this thesis, the conception of ideation must be defined. In the traditional organized setting, ideation at the beginning is referred to as idea generation for problem framing and solving through divergent thinking at individual level (Treffinger, Selby, & Isaksen, 2008). Thereafter, it has been commonly defined as idea generation without evaluation (Basadur, Graen, & Green, 1982) at firm level, normally including the generation and development of new ideas (Bergendahl & Magnusson, 2015) to define and solve problems. At present, the activities of ideation are further extended through virtual problem-framing and problem-solving approaches including the collective generation, screening and initial selection of creative and commercially valuable ideas before their further implementation (Schemmann et al., 2016). Moreover, as an iterative and continuous process within the whole process of innovation, ideation actually is not merely related to the early phase of innovation but also iteratively occurs during idea refinement and implementation after the present ideation. As a consequence, ideation in this study is considered as a process in the early phase of innovation centering on idea generation and development for problem framing or/and problem solving, which is also named as FEI in this present thesis.

Idea is the spark of innovation. It has been treated as a critical factor in innovation (Van de Ven, 1986) and the product of ideation for creativity (Amabile & Pratt, 2016). Given that the idea is generated when there is a need to solve a current problem situation (Nagpaul & Pruthi, 1979), ideas have normally been referred to as solutions to problems (Boeddrich, 2004; Skilton & Dooley, 2010). However, as problem identification, problem structuring and idea formulation (Kijkuit & van den Ende, 2007) are the most important activities during idea generation, the collective ideation activities surrounding problems in this definition have been overlooked. Furthermore, as studied by Westerski, Iglesias and Garcia (2012), derived from ambiguous stages of innovation processes such as problem definition or solution searching in virtual environments, some proposed ideas differ on the level of completeness in the description of problem as well as solution. A more comprehensive definition of ideas is thus needed to understand the outcomes as well as the process of innovation. According to the conception of ideas mentioned in previous works (Magnusson, Wästlund, & Netz, 2016; Nambisan et al., 2017; Schweitzer, 2014), ideas normally span a diverse range of topics and typically include information about customer needs (problem information) as well as ways of satisfying these needs (solution information).
information) (Bayus, 2013). In what follows, ideas generated in our focused ideation are defined as consisting of problem and/or solution with different described levels and to some extent missing knowledge about the problem and/or solution, which is continuously and iteratively developed with the related knowledge input during ideation. Therefore, ideas in this thesis are referred as to problem or solution or both problem and solution, something which can be divided as initial ideas in idea generation and developed ideas in idea development, respectively.

To summarize, innovation includes ideation and ideas, but ideation and ideas are not equal to innovation. Ideation is a sub-process of innovation, and ideas are the immature outcomes (Bayus, 2013) embedded in innovation processes where the realization of novel and useful ideas is transferred to the economic products. As a consequence, the present thesis focuses on the ideas generated in ideation with incomplete problem and solution knowledge, something which is referred to as the form of problem, solution or both problem and solution. Ideation is the early phase of innovation referred to as FEI, which centers on idea generation and idea development. The details of the characteristics of FEI and ideas are presented in the following sections.

2.2 Front end of innovation

FEI, a term derived from the work by Smith and Reinertsen (1998), is considered to be the early stage of the innovation process and roughly covers the activities performed to generate and nurture an innovation idea before it becomes a project to enter the formal new product development (NPD) process. Compared to the formal NPD and the later market commercial process, FEI is characterized by uncertainty, equivocality and being ill-defined. As mentioned above, other names such as ideation (e.g. van den Ende et al., 2015), creativity (Amabile & Pratt, 2016) and fuzzy front end (e.g., Massey, 2002; Verworn, 2009) are popularly used as well for this process in some research.

As “the greatest opportunities for improving the overall innovation process lie in the very early phases of NPD” (Backman, Börjesson, & Setterberg, 2007, p18), much attention has been paid by scholars to the management of the FEI process, especially to address idea management issues about uncertainty and equivocality reduction (Frishammar, Florén, & Wincent, 2011). Studies on managing this process have focused on strategy (e.g. Khurana & Rosenthal, 1997; Poskela & Martinsuo, 2009), process structure (e.g. Kurkkio, Frishammar, & Lichtenthaler, 2011; Reid
& De Brentani, 2004), uncertainty and equivocality reduction mechanism (e.g. Frishammar et al., 2011), and information technology (e.g. Gordon Tarafdar, Cook, Maksimoski, & Rogowitz, 2008). Given the development and wide usage of the information technology, recently firms have benefited greatly from the effective management of FEI, especially through the virtual approach (Nambisan, 2013), and FEI at present is becoming more and more digitalized and collective.

On this basis, this section presents the digitalization of FEI and the changes to the FEI with the digital technology. By doing so, online internal crowdsourcing is eventually emphasized as one of the research interests in the context of digital FEI.

### 2.2.1 The digitalization of FEI

The trend of growing digitalization could be specifically reflected by the research streams defined by Cooper (2000) and Müller and Ulrich (2013) in the field of FEI and information systems (IS). It shows that the digitalization of FEI has been shifted from the independent usage of innovation software tools (MacCrimmon & Wagner, 1994) to the integrated usage of information systems (Westerski, Iglesias, & Garcia, 2012). However, in the early work of digitalization, the innovation software tools were designed for solely idea generation, development or evaluation (Kohn, 2006); for example, TRIZ and Mindmap for idea generation and suggestion boxes for idea development. Even the traditional IT-based creative support systems (Massetti, 1996; Wierenga & van Bruggen, 1998) are mainly designed for idea generation; processes after idea generation of FEI are weakly supported. Tracing the path of digitalization evolution trends (Adomavicius, Bockstedt, Gupta, & Kauffman, 2008), Massetti (1996) empirically examined that the IS support is superior to the conventional software support in terms of the number, novelty and value of generated ideas. Inspired by this, information systems for FEI have been widely developed and adopted in informative and innovative firms. In particular, the internal initiatives based on crowdsourcing principles have attracted much attention, through which employees have opportunities to virtually contribute in FEI, for example, Innovation Jam at IBM (Bjelland & Wood, 2008), and IdeaBoxes at Ericsson (Björk et al., 2014). These developed online internal crowdsourcing initiatives, beyond the limitations of software tools, have generally integrated the idea management processes including ideas generation, development and evaluation in the platform, resulting in a more digitalized FEI.
2.2.2 Changes to FEI with the digitalization

With the growing digitalization of FEI, there are many significant changes in idea management for FEI. These changes have recently inspired research interests in idea management for FEI, particularly the processes after idea generation (Beretta, 2018; Chan, Li, & Zhu, 2018; Hoornaert, Ballings, Malthouse, & Van den Poel, 2017; Magnusson et al., 2016).

As defined in the previous literature, idea management is “a sub process of innovation management with the goals of effective and efficient idea generation, evaluation and selection” (Brem & Voigt, 2007, p. 306). More specifically, it has been referred to as two aspects: process structure and tool (Mikeslone & Liela, 2015). The aspect of process structure is concerned with terms related to idea activities, such as ideation (Beretta, 2018; Björk & Magnusson, 2009). By contrast, the aspect of tool is connected to terms such as suggestion box and idea management system, which are used to organize ideas and facilitate FEI (Aagaard, 2012; 2013) by leveraging collective intelligence. Although the process structure of idea management in FEI does not fundamentally change, some changes in specific activities are emphasized due to the development of idea management tools (Mikeslone & Liela, 2015) in the context of digitalized FEI (Beretta, 2018; Schemmann et al., 2016).

The changes accompanied by the FEI digitalization can be mainly reflected by the Rhodes’s 4-Ps model (Couger, 1993) in terms of four interactive components during idea development: press, person, process, and product. More specifically, 1) the press, environmental support (Rhodes, 1961) for idea management in FEI, has changed from face to face to virtual platform. In this case, the generation and development of ideas are performed through virtual interaction, which is not bound by ordinary limitations of time, expertise, organization positions and geographic distance. Consequently, FEI tends to be more open to accessing distant knowledge, particularly with the usage of online crowdsourcing principles. Furthermore, 2) the volume as well as variety of participating persons have been largely increased with the open calls of crowdsourcing for participation, resulting in the “person” in ideation shifting from individuals to collectives. The collectives referred to are communities self-organized by employees, experts, customers or suppliers, beyond boundaries and across individuals, organizations and firms (Nambisan et al., 2017). On this basis, the users’ role as social actor has been re-conceptualized (e.g. Lamb & King, 2003), their experience as driven by different benefits has been discussed (e.g. Kohler, Fueller,
Matzler, Stieger, & Füller, 2011; Nambisan & Bron, 2009), the selection of internal or external person has been argued (Poetz & Schreier, 2012), and the effects of different roles have been explored (e.g. He & King, 2008; Hunton & Beeler, 1997). In addition, 3) the FEI process has been more extended and complex with the increased reliance on the idea management system based on crowdsourcing, frequently replacing the earlier use of traditional suggestion boxes (Sandström & Björk, 2010; Westerski, Dalamagas, & Iglesias, 2013). In terms of the extension of the FEI process, the activities of ideation are extended from idea generation to idea development and the boundary between idea generation and idea development becomes clearer than before with the transparent innovative commenting behaviors and contributions surrounding ideas. For example, ideas are created with idea submission behaviors, developed with commenting and voting, and screened with claiming and selection (Björk et al., 2014). Besides the extension of process, FEI processes tend to be more complex due to the diverse participators, the voluntary interest-driven participants and the embedded iterative problem-framing and problem-solving activities related to ideas. Last but not least, 4) products, referred to as knowledge trajectories expressing the artifact of thoughts such as ideas and comments, have been changed as well. On the one hand, ideas tend to be the concept consisting of problem and solution (e.g. Magnusson et al., 2016; Nambisan et al., 2017) rather than only marketing problems (Boudreau & Lakhani, 2013) or technical solutions (Afuah & Tucci, 2012). On the other hand, since opportunities for commenting have been given with the support of information systems, products at present include not only ideas but also comments.

To sum up, with the development and wide usage of information technology, FEI tends to be more digitalized and collective across the overall process of organizing ideas in terms of the changed press, person, process and products. This is particularly pronounced by the usage of online-based technology called online internal crowdsourcing. However, understanding the more digital and collective FEI through online internal crowdsourcing remains a challenge for innovation management researchers and practitioners alike due to the limited extant knowledge. In particular, the different potential impacts of diverse participators (e.g. Magnusson & Björk, 2009; Sosa, 2011) and their collective participants on different processes of FEI (Acar & van den Ende, 2016; Kijkuit & van den Ende, 2007), may result in increased dynamics, and consequently more pronounced complexity to manage online internal crowdsourcing. This research is therefore mainly focused on online internal
crowdsourcing for ideas, which will be described in detail in the next sections.

2.3 Online internal crowdsourcing

Given that online internal crowdsourcing is one specific type of crowdsourcing, and developed from it, the development of and challenges in online internal crowdsourcing compared to crowdsourcing in general were first analyzed. In what follows, the need for research in the area of idea development is highlighted. Peer communications and peer contributions are then discussed in conclusion as two important aspects for understanding the new pattern of idea development in online internal crowdsourcing.

2.3.1 From online crowdsourcing to online internal crowdsourcing

With the digitalization of FEI, firms are currently leveraging productivity and collective intelligence of crowds with diverse expertise rather than a limited number of internal experts (Howe, 2006, 2008; Simula & Ahola, 2014; Surowiecki, 2005) for problem solving (e.g. Brabham, 2008; Chesbrough, 2006), marketing and market research (e.g. Whitla, 2009) as well as ideation of new products and services (e.g. Erickson et al., 2012). This phenomenon, referred to as crowdsourcing (Erickson et al., 2012; Howe, 2006), has become a popular way for firms to answer the most vexing innovation questions in order to seize new opportunities to compete in the market (Boudreau & Lakhani, 2013). With the opening call, it provides opportunities for external crowds, including customers, employees and community members, with diverse knowledge backgrounds and work experience, to freely and voluntarily communicate, contribute and learn together on a large scale. Nevertheless, besides the advantages of crowdsourcing on innovation, disadvantages such as the difficulties of protecting intellectual property as well as too many generated ideas with low quality bring about many substantial challenges concerning, for instance, the selection of crowds (Poetz & Schreier, 2012; Schemmann, Chappin, & Herrmann, 2017), motivation (Cusella, 1982), and idea evaluation (Magnusson, 2009; Magnusson et al., 2016).

In order to address the above-mentioned management challenges across external and internal crowds, there is at present a specific recent trend to apply crowd-like approaches to FEI inside firms through the use of firm-online internal communities. This turns the internal ideation process in
FEI into a truly collective ideation process, as internal crowds can not only freely submit ideas but also voluntarily comment on others’ ideas, thereby providing potentially valuable feedback. Here, the described approach to make use of merely internal crowds for FEI is labeled as ‘online internal crowdsourcing’ and includes idea generation, idea development and idea evaluation, with the intention to bring about innovation of different types, e.g. new processes, products, business, and services innovation. Although the FEI process indeed strictly comprises far more than the ideation process, the reason the relations between online internal crowdsourcing for ideas and FEI is highlighted in this study, is that ideation is regarded as the core process in FEI (van den Ende et al., 2015), playing a critical role for overall innovation performance (Kock, Heising, & Gemünden, 2016).

A stream of literature has emerged that corresponds with the increased relevance of online internal crowdsourcing. Based on previous research, it can be concluded that online internal crowdsourcing for ideation is distinct both from hierarchy-based work with employees and external crowdsourcing with external crowds (Zuchowski et al., 2016). Specifically, on the one hand, compared with the traditional intra-organizational hierarchy-based ideation environment, it is more open through the provision of a platform for increasing the innovation exploration scope and flexibility inside companies (Boudreau & Lakhani, 2013). On the other hand, compared with external crowdsourcing, internal participants are expected to be more active and reliable in generating ideas, as they are employees who are more qualified and trusted with longer term-oriented goals than what is the case for participants in external crowds (Simula & Vouori, 2012).

2.3.2 Challenges in managing online internal crowdsourcing for ideas

Besides the challenges to managing external participators and participations in normal crowdsourcing, the use of an open innovation crowdsourcing approach in an intra-organizational setting also brings about specific challenges to manage, something which results in barriers to managing ideas under this specific context. For example, firms find it difficult to integrate crowdsourcing initiatives into their organizational practices because of the need to break the former hierarchical organization structure for ideation (Erickson et al., 2012). Furthermore, although employees can freely work online regardless of their formal position, they are generally under time pressure as most of them perform
ideation as part of their work (e.g., Meloche, Hasan, Willis, Pfaff, & Qi, 2009), and the creation and development of ideas thus compete with other work activities. This time pressure might be an impediment for them to participate as the balance of benefits and efforts is commonly regarded as an important factor in the firms’ environment, where time is money (Brzozowski, Sandholm & Hogg, 2009).

Apart from the specific challenges mentioned above, online internal crowdsourcing also faces some general challenges in managing crowds such as the motivation of crowds’ engagement. For example, employees might be hesitant to engage in online internal crowdsourcing particularly because the managers and internal experts are mixed as peers (Malhotra et al., 2017). These challenges attract much attention within different research areas about innovation management, such as motivation. It is a challenge to develop and select the valuable ideas as well considering the limited openness of employees within a firm (Baer, 2010; Berretta, 2018), because some of them might resist accepting ideas from outsiders to bring new ideas to innovation (Simula & Vouori, 2012). Other areas like social interaction in ideation (Björk & Magnusson, 2009), feedback seeking (De Stobbeleir, Ashford, & Buyens, 2011), and information value in innovation (Aral & Van Alstyne, 2011), are frequently discussed.

On a whole, substantial changes to FEI under the context of online internal crowdsourcing pose challenges to management ideas. The challenges are pronounced on firm and individual levels as well as idea levels, something which mainly includes the breaking of boundaries across organizations, motivating employees’ engagement, and developing the increased volume and variety of ideas. As a consequence, managing online internal crowdsourcing tends to be a hot issue attracting scholars’ interests, particularly at idea level with the increased volume of ideas, which however does not guarantee the final success. As contributions to developing ideas hold the potential to improve innovation, idea development tends to be an important area to focus on in innovation management.

2.3.3 Idea development: a typical part of online internal crowdsourcing in FEI

Given the changes to FEI and challenges in online internal crowdsourcing, a more narrow and specific view is needed in order to understand the new pattern of idea management in the context of online internal crowdsourcing. Due to the limited extant knowledge on the process of
idea development in internal online crowdsourcing, questions like how and who contributes to ideas are not clear. Consequently, the present thesis typically focuses on the peer communities and their contributions for idea development.

Compared to the traditional approaches to management ideas in FEI, the differences brought by the usage of online internal crowdsourcing is pronounced and dominated by the transparent and collective idea development process. It is mainly derived from the opening calls for the peer contributions to ideas, something which enables employees not only to create ideas but also to improve them through voluntarily and collectively commenting and voting. Namely, more opportunities to collectively contribute to develop ideas by peers are provided in online internal crowdsourcing, and thus the engagement of employees in ideation not only shifts from individuals to collectives but also extends from creation to development. Accordingly, ideation in online internal crowdsourcing at present is substantially characterized by the collective idea development with a large increased volume and variety of contributions to ideas.

Previous literature has started to focus on the virtual collective ideation from perspectives such as social networks (Björk & Magnusson, 2009), knowledge domains (Björk, 2012; Tang, 2015) and motivation of participants (van den Ende et al., 2015). Nevertheless, a cohesive independent and systemic theoretical understanding of how interactions operate in virtual collective idea development is still limited (Binnewies, Ohly, & Sonnentag, 2007; De Stobbeleir et al., 2011; Drazin, Glynn, & Kazanjian, 1999), especially as concerns the extra role behaviors (Van Dyne & LePine, 1998), which may often be the case for ideation activities as these are rarely defined as parts of employees’ formal tasks. Even in terms of scant literature about virtual idea development, previous research is often based on the assumption that idea development resembles idea generation, or idea selection (e.g. Beretta, 2018; Chan et al., 2018; Hoornaert et al., 2017) in the area of ideation, lacking specific and independent studies on idea development. Separating idea development from idea generation and selection is actually still being advocated (e.g. Hoornaert et al., 2017). This ultimately results in the need to narrow ideation down from the mixed process of idea generation, development and selection to a recently extended but immature process called idea development.
Therefore, this thesis mainly focuses on the idea development in online internal crowdsourcing, where individuals collectively interact with each other to develop and incubate new ideas by sharing knowledge and experience (Björk, 2011). In this case, peer communities interacting around ideas after idea generation engage in different organizational knowledge creation processes (Bergendahl & Magnusson, 2015; Nonaka, Byosiere, Borucki, & Konno, 1994). In these communities, reciprocal peer communication takes place between creators and commenters through feedback search (De Stobbeleir et al., 2011), information input (van den Ende & Kijkuit, 2009) and feedback responses (Wooten & Ulrich, 2014) with the row of peer contributions. In a word, idea development in online internal crowdsourcing is mainly performed by the contributors through peer communication and ideas are developed by their contributions. Consequently, here the insights about idea development are gained from the aspects of peer communication and peer contributions, which are presented in the next sections in detail.

2.4 Peer-to-peer communication as a means to develop ideas

“Generally speaking, communities are a key source of the creativity that powers the front end” (Harvey, Cohendet, Simon, & Borzillo, 2015, p. 47). Since the new open movements are increasingly identified with the peer support and influence (Bapna & Umyarov, 2015; Sykes, Venkatesh, & Gosain, 2009), one of the most promising aspects during the development of digital FEI based on internal crowdsourcing initiatives has become the widespread availability of virtual communities of practice (CoP) through peer communication venues as a form of collective action, particularly in the process of idea development. This new pattern of FEI has been referred to as “peer production” (Wasko, Teigland, & Faraj, 2009), describing how people voluntarily gather “virtually” to share knowledge and experiences driven by interests, and how peer support and help are provided for ideas. For example, collective feedback is possibly given by peers without the limitations of organization and geographic distance in internal online crowdsourcing.

Although peer communication has already existed within large organizations since “employees with functional expertise might create communities of practice as a way of maintaining connection with peers” (Wenger & Snyder, 2000, p. 141), the virtual peer communication at present is different from CoP in electronic networks of practice (ENoP)
(Brown & Duguid, 2001; Wasko & Faraj, 2005; Wasko et al., 2009) where a large group and diverse knowledge backgrounds of employees communicate through open calling across organizations. More specifically, peer communication in digital FEI is based on ENoP beyond the local CoP, accessing peers who they might not know. Driven by ENoP, peers develop new expertise that would be useful for their own practice and that of their peers (Vaast & Walsham, 2009). But there are two different collective forms labeled as crowds and communities (Dobusch & Kapeller, 2017) that exist in ENoP. These are peer-to-system communication and peer-to-peer communication. For this research, as idea development is dominated by peer-to-peer communication, this thesis focuses on this particular communities model driven by ENoP, also called virtual CoP (Ardichvili, Page, & Wentling, 2003), “a self-organizing, open activity system that focuses on a shared interest or practice and exists primarily through computer-mediated communication” (Wasko & Faraj, 2005; p. 37), in which employees inside firms have the opportunity to share their knowledge and contribute to the practice (Yang & Chen, 2008) through peer-to-peer communication. The related theories bases are CoP and networks of practice (Brown & Duguid, 2001; Wenger & Snyder, 2000;), and knowledge collaboration (Yang & Chen, 2008) including knowledge co-creation and knowledge sharing (Faraj, Jarvenpaa, & Majchrzak, 2011; Wasko & Faraj, 2005).

Similar to CoP, ENoP is a driver for online knowledge collaboration across a variety of different working environments (Amin & Roberts, 2008). However, it is characterized by more openness and fluidity (Faraj et al., 2011; Wasko et al., 2009), resulting in more dynamic peer communication and more uncertain peer contributions compared to those from CoP where groups of members know each other and work together in a shared practice through meeting face to face (Wasko & Faraj, 2005).

In terms of the dynamicity of peer-to-peer communication, one typical phenomenon is the turnover (Ransbotham & Kane, 2011) of participators due to fluctuations in interest, making the value of their contribution to idea development uncertain to some extent. More specifically, in the peer-to-peer communication of idea development driven by ENoP, peers contribute to ideas through voluntary and collective knowledge co-creation or sharing, something which is mainly motivated by self-interests. Nevertheless, the interest-driven practice is restricted by the contributors’ ability as well as time. In a word, elements including time,
interest and motivation (Faraj et al., 2011) are the prerequisites for peer-to-peer communication to develop ideas in online internal crowdsourcing. But on the other hand, those prerequisites elements characterized by uncertainty are to some extent randomly dependent on the personality of peers as well as on the communication context. As a consequence, the activity of peer-to-peer communication in idea development is typically unpredictable, particularly when peers are more or less familiarity colleagues (Wasko & Faraj, 2005) with uncertain knowledge backgrounds and their communication mainly occurs through knowledge rather than personal familiarity or physical location. Furthermore, the successful functioning of ENoP is impossible without the active participation of a substantial part (ideally, all) of its members (Ardichvili et al., 2003). Hence, it is difficult to value the dynamic peer-to-peer communication driven by ENoP in internal online crowdsourcing for idea development.

Studies on the dynamic process of ENoP, particularly idea development (Hoornaert et al., 2017), have recently been emphasized by scholars (e.g. Wasko & Faraj, 2005). Idea development, the process with the intense knowledge input to ideas, has management tensions due to fluctuating resources. First of all, it requires that someone has to have (or be able to create) the missing knowledge parts of initial submitted ideas. Secondly, they must be willing to share their knowledge, and thirdly they must have the time and ability to add their knowledge. But the resources such as willingness, time and knowledge are not certain in the fluid ENoP process. As Faraj et al. (2011) argued about the online communities, it results in management tensions including 1) time, 2) passion, 3) socially ambiguous identity, 4) social disembodiment of ideas and 5) temporary convergence. Although these management tensions provide the view on the antecedents of dynamic peer-to-peer communication, the consequences, such as the quality of their contributions, are still not clear.

Altogether, in online internal crowdsourcing, there is typically a high turnover among participators in idea development and their contribution process is full of dynamicity and fluidity, bringing about difficulties in understanding the value of their contribution to developing ideas from both academic and practical perspectives. In order to address this issue, this thesis analyzes peer contributions in detail in the next section.
2.5 Peer contribution as a factor influences idea development

Peer contribution in online internal crowdsourcing directly contributes to ideas in the form of knowledge input and indirectly in the form of encouragement. It is generated in different ways in different processes of ideation, for example problems or needs before idea generation, ideas during idea generation and feedback after idea generation. This thesis focuses on the peer contributions in the idea development after idea generation.

2.5.1 Feedback: one type of peer contribution in idea development

Peer contribution in idea development generally takes the form of feedback. Driven by the missing knowledge part of presented ideas in idea generation, peer contribution is given through reciprocal peer-to-peer communication, including feedback search (De Stobbeleir et al., 2011), feedback given (van den Ende & Kijkuit, 2009) and feedback responses (Wooten & Ulrich, 2014), and takes place continuously between creators and commenters in idea development. In this case, individuals who obtain feedback are likely to elaborate on ideas to seize and exploit more opportunities (Hattie & Timperley, 2007; Perry-Smith & Mannucci, 2015), thereby helping ideas rise to the top (van den Ende & Kijkuit, 2009).

The present thesis focuses on the given feedback, which has been defined as a communication process where a sender conveys messages about the contributions of recipients to the recipient (Cusella, 1982; Ilgen, Fisher, & Taylor, 1979), providing helpful information and emotional support (Özer, 2013). By doing so, the term of feedback is commonly used next when peer contribution needs to be specifically distinguished and the related literature is reviewed.

2.5.2 The role of feedback

Researchers have long been interested in the role of feedback (Lam, DeRue, Karam, & Hollenbeck, 2011) in terms of feedback providers, frequency, specificity and valence in the context of teams, groups and organizations. In idea development, they discuss that on the one hand, feedback is as a continuous source of knowledge creation (Ashford & Cummings, 1983), driving the novelty and usefulness of ideas (De Stobbeleir et al., 2011; van den Ende & Kijkuit, 2009), and on the other
hand is an aspect for driving motivation for individuals’ creative performance (Carson & Carson, 1993; Ilgen et al., 1979; Zhou, 1998). Summarizing, it is generally argued that feedback leads to performance improvements (e.g. Kang, 2005; Lam et al., 2011; Lurie & Swaminathan, 2009) and to motivation for further engagement, respectively. Therefore, it is noted that 1) peer contribution and performance, and 2) peer contribution and engagement are two important aspects in observing the role of peer contributions in idea development.

However, as dispersed employees with diverse knowledge backgrounds have opportunities to contribute to ideas freely and voluntarily (Bayus, 2013; Sandström & Björk, 2010) in online internal crowdsourcing, the main dimensions of feedback, including 1) provider, 2) amount, 3) timeliness, 4) valence, 5) diversity/specificity, and 6) content type (Lam et al., 2011), have largely changed, resulting in a new pattern of peer contributions influencing idea development. More specifically, the feedback providers tend to be peer communities self-organized by more or less familiar colleagues, the feedback amount is increased radically, the feedback frequency tends to be irregular and unstable, the valence of feedback can be expressed more apparent due to the anonymity, and the feedback content becomes more complex and diverse to some extent. Those changes result overall in more uncertainty (Galbraith, 1977) and equivocality (Daft & Lengel, 1986; Frishammar et al., 2011) in idea development. Firms consequently face many challenges in managing peer contributions. In particular, how contribution can be achieved efficiently and effectively in the changing form of the organizations challenges both managers and administrators alike. This points to the necessity to attend more carefully, in a similar way to feedback, to the different dimensions such as frequency, content, and providers of peer contributions embedded in idea development, as this today has much more possibility of directly and indirectly influencing creativity (Hattie & Timperley, 2007; Perry-Smith & Mannucci, 2015).

### 2.6 Research questions

Although peer contributions are arguably critical for idea development, questions regarding how peer contributions influences idea development in online internal crowdsourcing have not yet been thoroughly investigated. This thesis, with respect to this, aims to explore the role of peer contributions in online internal crowdsourcing for idea development.
More specifically, as a new pattern of FEI process, peer-to-peer communication as a means to develop ideas in online internal crowdsourcing at present is beginning to attract the attention of both scholars and practitioners alike. However, whether potential value is realized or not when peer-to-peer communities contribute to ideas, is unclear due to the limited extant knowledge. The limitations are summarized as follows according to the literature reviewed above: 1) In terms of the idea management system based on crowdsourcing initiatives, online crowdsourcing to capture ideas from customers as well as suppliers is popularly researched while online internal crowdsourcing to manage ideas merely inside firms is just starting (Malhotra et al., 2017; Zhu, Kock, Wentker, & Leker, 2018); 2) From the process perspective, previous research is mainly focused on idea generation, while extant knowledge about idea development is thus far limited and often based on the assumption that idea development resembles idea generation (Beretta, Björk, & Magnusson, 2018); 3) Peer-to-peer communication to develop ideas driven by CoP is largely researched while the communication, full of fluidity, driven by ENoP is still not carefully studied (Wasko et al., 2009); 4) The role of contribution to ideas has been largely researched in the literature concerning feedback, but most of this research is in the context of teams, groups and organizations, and the role of peer contributions, particularly those contributed by online communication, is still unknown. Exploring the role of peer contributions in idea development in online internal crowdsourcing is thus urgently needed. However, the limited knowledge on communication brings about difficulties in exploring it.

As the social-related communication practice is essential for understanding the critical collective innovation efforts (Daft & Weick, 1984; Brown & Duguid, 1991) such as their contributions, observing the new communication pattern is arguably a first important step in exploring the role of contributions in idea development in the context of digitally transformed FEI (Wasko & Faraj, 2005). The essential demand to understand peer communication for peer contribution is supported by previous research on the knowledge creation and social interaction as well. For example, Nonka et al. (1994) argued that “communities of interaction” typically play a critical role in developing ideas. Björk (2012) concluded that communication can be regarded as resources from which new information and knowledge can be obtained. Furthermore, as peers who participate in the communication are likely to know how to develop ideas effectively (Brown & Duguid, 2001), the pattern of communication to some extent influences what they contribute and the quality of their
contribution. Last but not least, the timeliness of contribution, which is close to the active interactions of communities (Kreijns, Kirschner, & Jochems, 2003), highlights the importance of understanding peer communication as well. However, the previously proposed 90-9-1 rule, namely “90% of users are lurkers who never contribute, 9% of users contribute a little, and 1% of users account for almost all the action for participation” (Nielsen, 2006), shows that a large part of the individuals in a community actually participate and contribute in less active manner. Even if some contributors participate in an active manner, some of them lack efficiency. For this reason, understanding the peer-to-peer communication pattern in online internal crowdsourcing is not only a prerequisite for exploring the role of peer contributions, but also critical for idea development.

Altogether, as concerns the changing nature of idea development in the context of online internal crowdsourcing, from being an individual and discrete event to including a virtual collective of individuals in a process, an understanding of the types of peer communications and the roles of embedded peer contributions to develop ideas is needed. However, extant knowledge is limited. In order to fill this research gap, two research questions are proposed in this thesis.

RQ1: What types of peer communication can be identified in online internal crowdsourcing for ideas?

RQ2: How do the contributions of peer communication influence idea development in online internal crowdsourcing?
3 Research methodology

In order to address the above research questions, several empirical studies were performed and are presented in this chapter. This includes 1) research setting to represent what the empirical context, 2) research strategy about how the research was performed step by step, 3) summary of research studies with appended papers to describe the relationship between research studies and research questions, 4) research methods to introduce what methods were chosen and how they are used in each research study, 5) methodological assessment to discuss the validity and reliability of the empirical study performed in this thesis, and 6) methodological limitations.

3.1 Research settings

The empirical study of this PhD research project is constructed based on the data from an online idea management system in a Swedish multinational telecom company. The system, based on internal crowdsourcing initiatives, has been used to capture and collectively develop ideas since it was set up in 2008. It was updated in November 2014 with new and increased user and management functionalities, as well as new interfaces, so that dispersed and diverse employees can freely share and learn through information searching, creating ideas, commenting, reciprocal commenting, etc.

More specifically, after updating in November 2014, this system was performed in the form of IdeaBoxes, designated internal online spaces for brainstorming. IdeaBoxes could be used both for completion and open initiatives. The open IdeaBoxes’ key principles comprise openness, collaboration, sharing, and learning, thus employees could submit an idea and receive feedback for idea development. On this basis, in the idea management system of the case company, there are two types of IdeaBoxes, namely Ncompetitiveon-competitive IdeaBoxes and competitive IdeaBoxes identified. Non-competitive IdeaBoxes are open under a collaborative strategy for all employees, while competitive IdeaBoxes are not. That is, opportunities for employees to collectively comment on ideas are provided in non-competitive IdeaBoxes instead of competitive IdeaBoxes. In non-competitive IdeaBoxes, box managers were introduced in the system firstly as a demand side. Then the collaborative idea management was implemented like a pull-based internal idea market without any central control or steering (Björk et al.,
In 2015, this system had more than 14,000 users, 70,000 ideas and around 100,000 comments throughout the global organization, which brings both opportunities and challenges to handle ideas and comments from all and make sure that ideas could reach the right manager of IdeaBoxes in the organization and the comments could be helpful for turning ideas into innovations. In order to address this issue, this thesis conducts two research settings from an overall view on all the non-competitive IdeaBoxes and a specific view on one typical non-competitive IdeaBox, respectively. More detailed information in terms of the data collection in these two research settings is given in Section 3.4.

### 3.2 Research strategy

As there is access to the online corporate database in real-time, research is performed with abductive reasoning (Dubois & Gadde, 2002; Morgan, 2007) and driven by phenomena in parallel with the literature, following the suggestion given by Cotteleer and Wan (2016) and resulting in a circular research strategy in this PhD project (see Figure 1).

In Figure 1, it can be seen that this project starts with the literature review and phenomena analysis. During the literature review, common concepts reflecting the phenomena issues were first academically analyzed, for example, crowdsourcing, FEI, idea management systems and ideation. In what follows, research gap and phenomena issues about idea development in the area of digital FEI were realized. In order to address the research gap as well as phenomena issues, two aspects including peer communication and peer contributions were explored in this thesis.

Given the focus on peer communication and peer contributions in idea development, data was continuously explored on a deeper level, in order to check what issues could be addressed based on the collected data. During the process of data exploring, it was recognized that data consisted of online big data reflecting the contributors of ideas and contributions on ideas continuously fluctuating over time. Furthermore, not only the number of contributors and contributions but also the time and the content of the given contributions were accessible. Therefore, two research questions were proposed regarding the types of peer communication and the role of peer contributions: RQ1: What types of peer communication can be identified in online internal crowdsourcing
for ideas? RQ2: How do the contributions of peer communication influence idea development in online internal crowdsourcing?

In order to address the two research questions above, quantitative and qualitative research methods were jointly used. On the one hand, interviews with system managers and technical employees were conducted in order to better understand how ideas are captured and managed, what critical issues there were in idea development, what the practical meaning of tested variables was, and what the managerial implications were in terms of research results. On the other hand, quantitative methods including cluster analysis, text mining and statistical analysis were employed to measure the variables and test their influence through regressions along the PhD project process. Specifically, cluster analysis for communication types based on the theory of CoP and data collection concerning the number of comments and ideas contributed were first performed for RQ1. Secondly, with the employment of text mining (Kobayashi, Mol, Berkers, Kismihók, & Den Hartog, 2017, forthcoming), different communication patterns across expertise based on topic distribution were identified and questions such as how contributions influence idea development in terms of timeliness and sentiment were observed for RQ2. Thirdly, the role of contribution content type in terms of the problem and solution sides of ideas was investigated for RQ2 as well.

To sum up, the research strategy of this thesis could be concluded as follows:

1) The research process is cyclic in nature mainly based on abductive reasoning, constantly moving back and forth from one type of research activity to another and between empirical observations and theory. Grounded in this abductive logic, research studies in this thesis were conducted from theoretical understanding to practical investigation, and from the investigation back to theory over time. Thus, theoretical framework, empirical fieldwork, and case analysis evolved simultaneously (Dubois & Gadde, 2002).

2) Two main research questions were proposed in order to understand the new pattern of the idea development. But RQ1 and RQ 2 are closely related and interact with each other to some extent, so they are not investigated separately in each research study. In contrast, the data explorations to add to two research questions in each sub-study are closely related.
3) Research methods in this thesis were chosen based on the research questions, the type of collected data and the investigated variables, in order to fit the criteria of methodology assessment.

4) Empirical study was explored iteratively based on the related theory as well as the collected data. More specifically, the closed loop after methodology assessment shows that research design is continuously improved based on the reliability of methodology after data analysis.

5) Another closed loop after conclusion and discussion shows that research is continuously performed for the detailed or extended studies.

---

Figure 1: Research strategy driven by literature paralleled with phenomena

### 3.3 Summary of research studies, appended papers and research questions

Based on the above proposed research strategy, four appended sub-studies based on two different research settings were conducted to address RQ1 and RQ2. The relationship between research studies, appended papers and research questions is shown in Figure 2.
Briefly, research studies and appended papers are divided into two parts to address two research questions. They are 1) three appended papers to explore the big data about ideas and comments from all non-competitive IdeaBoxes at macro level, and 2) the study aimed at specifically analyzing the influence of contribution content in one effective IdeaBox at micro level. The main reason that studies only focus on non-competition IdeaBoxes is that competitive IdeaBoxes are closed for the comments given. For the first research study on all non-competitive IdeaBoxes, three sub-studies were conducted based on two different datasets. The first sub-study is based on all selected ideas while the second and third sub-studies are based on the ideas that received at least one comment.

### 3.4 Research methods

As visualized in the previous section, the research studies and appended papers are divided into two parts. The first part includes the studies of appended Papers I, II and III, based on all non-competitive IdeaBoxes and the second part is the study of appended Paper IV based on one specific IdeaBox. During the data collection and analysis for idea development, contribution is referred to as comments or feedback for idea development, and peers are actually commenters. In this section, data and data collection are introduced first, followed by a presentation of the selection of research methods and the measurement of main investigated variables.
3.4.1 Papers I, II, III

Data and data collection

The first research study was conducted based on all non-competitive IdeaBoxes. In this study, data about IdeaBoxes in the case company was extracted on February 2016. Considering that the latest activity in IdeaBoxes took place in February 2016, data about users’ contributions within non-competitive IdeaBoxes during one year, from November 30, 2014 to December 1, 2015, was selected. A one-year period was selected due to the consideration of data completion and quality. On the one hand, it started with the launch of the updated version of the system and ended with ideas from one full calendar year. On the other hand, the end date for data collection provided a cut-off in time earlier than the final time of idea creation and development in IdeaBoxes so that all ideas in the selected dataset have the possibility to be selected for further development or not. During this period, 5,430 participators resulted in a total of 6,012 ideas and 6,348 comments. 629 ideas were eventually accepted for further innovation actions. The participators are idea creators and idea commenters, and 6,348 comments here do not include comments from creators responding to commenters. However, for the datasets used in appended Papers I, II, and III, participators’ contributions including ideas and comments are diverse. In terms of the diversity of contributions, tags (e.g. windows platform, simulator, android), representing the knowledge areas of ideas, are useful to capture the knowledge domain of contributors according to their historic contributions in appended Paper I and Paper II. Furthermore, the historic events of ideas contributed by commenters are used to explore the communication patterns in terms of contribution behaviors in appended Paper I. Last but not least, the collected ideas and comment content are used to explore the influence of contribution sentiment and contributors’ expertise in appended Paper III

On this basis, contributions including 6,012 ideas and 6,348 comments from all non-competitive IdeaBoxes were selected in the first data extraction. Besides that, given that tags (e.g. windows platform, simulator, android) in the case of idea management system are useful to capture the knowledge domain of contributors according to their historic

---

1There were 6,361 comments in total before data cleaning. 9 comments in Chinese were removed, and 4 comments with written errors, for example ‘(Y)’, ‘It c’ were removed.
contributions, the tags of previously contributed (created or commented) ideas of 5,430 participators were selected. This data is used in appended Paper I to explore the overall peer communication patterns.

Nevertheless, given that whether ideas receive comments or not might influence the idea acceptance, the second data extraction is focused on 2,413 ideas receiving 6,348 comments provided by 2,303 individuals, while the rest of the 6,012 ideas without comments are not included. Besides that, tags of 2,413 ideas and tags of the 2,303 commenters’ previously contributed ideas were selected to investigate the knowledge background of peers. These datasets are used to explore the roles of peer contributions in the appended Papers II and III.

Data analysis

With respect to RQ 1 in the present thesis, communication patterns in terms of contribution behavior were classified through latent class (LC) analysis (Magidson & Vermunt, 2002) by R software, in which contribution behaviors in terms of idea creation and commenting are taken into account. For the RQ2, logistic regression is performed to test the influence of peer contributions on idea acceptance, as idea acceptance is treated as the dichotomous dependent variable in all appended papers, with respective values of 0 and 1. A value of 1 is given if the idea has been accepted for interest, action and/or implementation. Hence, this measure represents if the company has allocated resources to the idea, in order for it to be further investigated or realized. Contrarily, a value of 0 means that the idea has not been accepted for further consideration or investment.

In addition, different types of data analysis were applied based on the specific research questions in the appended papers.

Paper I

In order to answer what different types of peer communication patterns could be identified, peer communication in terms of contribution behaviors at individual level was firstly analyzed in the appended Paper I. At individual level, quantities of contribution behaviors including the number of ideas/comments and the depth/breadth of ideas created/commented were measured as indexes to investigate the types of peer communication. Specifically, the depth/breadth of ideas created/commented, reflecting the depth and breadth of knowledge domain involvement, is counted by the number and range of unique and
total tags, respectively. Thus, different degrees of involvement depth and breadth at individual level, here labeled as specificity and diffuseness of contribution behaviors, respectively, are calculated by the following formulas.

\[
S_{cre} = \frac{TIC_{cre}}{UTIC_{cre}} \ast \frac{1}{I_{cre}} \tag{1}
\]

\[
D_{cre} = \frac{UTIC_{cre}}{TIC_{cre}} \tag{2}
\]

Here, \(S_{cre}\) represents the level of contribution specificity through a measure of depth area that contributors have contributed to, whereas \(D_{cre}\) represents the level of contribution diffuseness based on involvement breadth. More specifically, contribution behaviors with high \(S_{cre}\) reflect a focused participant while ones with high \(D_{cre}\) reflect an unfocused participant. In addition, \(TIC_{cre}\) represents the number of total tags of contributed ideas per person, \(UTIC_{cre}\) denotes the number of unique tags of contributed ideas per person, and \(I_{cre}\) represents the number of created ideas per person.

After the measurement of the above main variables, cluster analysis was performed. For the clustering, two questions are critical for the clustering results. These include which clustering method should be used, and how many clusters there are (Fraley & Raftery, 1998). The K-means analysis method is a traditional clustering approach which is widely used for big datasets. However, it is argued that “latent class analysis (LCA) and associated software to include continuous variables offer a model-based alternative” (Magidson & Vermunt, 2002, p. 37) that performs better than K-means. Hence, LCA was chosen for the cluster analysis in this study. At present, there are three packages for LCA in R, including Latent Gold, poLCA and Mclust. Among them, Mclust is the most suitable for performing LCA on continuous data, outperforming Latent Gold and poLCA (Haughton, Legrand, & Woolford, 2012). Therefore, the Mclust package was used, by which the clusters with means can be obtained based on the suggested cluster solution.

As regards the number of clusters, this is usually identified at the highest point of BIC in model-based clustering (Fraley & Raftery, 1998; Haughton et al., 2012), where each cluster is identified with each component. However, Baudry, Raftery, Celeux, Lo and Gottardo (2010) argued that if the number of mixture components is interpreted as the number of
clusters, it can lead to overestimation of the number of clusters. In order to ensure the accuracy of clustering results, the number of clusters was determined by an entropy criterion with consideration of combining mixture components. As a consequence, the “clustCombi” function in the Mclust package was used, so as to combine mixture components for better clustering.

For the appended Paper II and Paper III, the main research methods were to investigate the role of peer contributions in online idea development, in order to answer RQ2 from the perspectives of timeliness, sentiment and providers’ knowledge backgrounds. This exploring aspect firstly inspired the collected data of the ideas’ tags, which was used in the appended Paper II. However, as there is a limitation to access the data about comments’ tags, the contributed comments are not taken into account in the measurement of the knowledge overlap of contributors in the appended Paper II. In order to address this limitation, one of the text mining methods called topic model was used to search for experts in the appended Paper III. Based on the topic model research method, all peer contributions including both ideas and comments could be taken into account through the ‘topicmodels’ package in R software.

**Paper II**

Two main variables in this research paper are feedback timeliness and knowledge overlap. For the measurement of knowledge overlap, the collected data on tags of ideas was beneficial. As tags (e.g. windows platform, simulator, android) in the selected database are used to categorize the knowledge areas of ideas, tags constitute a basis for the measurement of knowledge overlap between the contributors and the ideas they contributed. Therefore, tags of all ideas previously contributed by commenters before they comment on a specific idea were collected, something which represents the knowledge domains of contributors. The degree of knowledge overlap was measured by counting the number of identical tags between a specific idea that was commented upon and commenters’ previous contributions, capturing their overlap of knowledge domains (see Formula 3). More specifically, a high overlap shows that the knowledge background of contributors is similar to the knowledge domain of the idea, namely, contributors are familiar with a specific idea that they would then comment upon.

\[ KO = \text{Card}(P \cap I) \]  

(3)
Where $KO$ represents the level of knowledge overlap between feedback providers and an idea, $P$ is the set of tags reflecting that feedback providers’ knowledge domain, while $I$ is the set of tags labeled on an idea. $\text{Card}(P \cap I)$ denotes the number of same tags between $P$ and $I$.

Furthermore, the time aspect of peer contribution, referred to as feedback timeliness, is investigated as time interval for feedback after ideas submitted. Previous studies show that there are two main ways to measure the feedback timeliness. One way is to classify feedback frequency as low, low-moderate, moderate-high or high, based on the number of feedback responses in a defined time period (see Lam et al., 2011). Another way is to measure the time interval between feedback and idea (see Chhokar & Wallin, 1984), something called time distance between feedback given and an idea created per idea in this study. The main reason the second way was selected in this study is that the accessed data about time is big data characterized by randomness and irregularity. It is not possible to define a time period to measure the number of comments as feedback frequency, but it can be measured by the average time interval of feedback given after an idea is submitted (see Formula 4). The date and time of feedback given and ideas created are labeled in the database, and the average time distance could be calculated by the second unit through SQL syntax.

$$T = \frac{t_1 + (t_2 - t_1) + (t_3 - t_2) + \cdots + (t_i - t_{i-1}) + \cdots + (t_n - t_{n-1})}{n}$$

(4)

Where $T$ is the average time interval of feedback given after the submission of ideas. $t_i (i = 1, 2, 3, \ldots, n)$ denotes the time when the $i_{th}$ feedback is given, and $n$ represents the amount of feedback on an idea.

Apart from the above data analysis on measurement, statistical analysis is needed at the idea level to test the influence of contribution timeliness and providers on idea acceptance. During the statistical analysis, a matrix correlation was first calculated. Thereafter, a logit model was used to accommodate the use of binary variables within a large dataset (Aldrich & Nelson, 1984), through the statistical software R (Ihaka & Gentleman, 1996). Furthermore, the VIF (variance-inflated factors) test (Robinson & Schumacker, 2009) was performed for the construction of the logit model, through assessing whether there was multicollinearity among control variables and independent variables.
The main investigated variables in this research are feedback sentiment and expertise of feedback providers, respectively. For the measurement of feedback sentiment, sentiment analysis was used. As we all know, sentiment analysis at present has been well recognized through nature language processing (NLP) (Nasukawa & Yi, 2003), in particular in R software. Most related sentiment analysis packages in R software are based on polarity with the counting of the positive and negative words. One package called “sentiment” package in R proposed by Jurka Collingwood, Boydstun, Grossman, and van Atteveldt (2012) can classify polarity (positive/negative) through the training of the Naive Bayes classifier on Janyce Wiebe’s subjectivity lexicon (Riloff & Wiebe, 2003). For instance, comments like “It is good improvement from debugging point of view” are classified as positive comments while comments like “it is currently almost impossible” are classified as negative comments. In order to observe the influence of classified positive/negative feedback on ideas, the text length of total positive/negative feedback on ideas is measured to represent the information amount embedded in positive/negative feedback.

The measurement of feedback providers’ expertise at present is mainly used for expert finding in online platforms. Among the measurements, three main approaches are used. They are 1) candidate-based with the building of the candidate profile; 2) document-based approaches and 3) topic modeling. As the topic modeling based on Latent Dirichlet Allocation (LDA) outperformed several profile and document-based approaches (Paul, 2016), the measurement of expertise here is based on the LDA-based topic modeling approach with the usage of ‘topicmodels’ package in R software. After running this package, the $i_{th}$ topic of $j_{th}$ contributions including comments and ideas, $t_{ij}$ ($i = 1,2,3,...,n; j = 1,2,3,...,m$) as well as their probability distribution $P_j(C_j / t_{ij})$, can be obtained based on the word usage frequency. Here $n$ is the number of $t_{ij}$ selected topics and $m$ represents the number of observed contributions. On this basis, expertise of commenters on ideas is calculated based on the topic distribution between their previous contributions as commenters and ideas they commented upon. To be more specific, 50 topics were selected through ‘topic model’ package in R firstly. Secondly, the expertise about the $i_{th}$ topic of commenters at
comment level could be obtained through formula (5). The reason we set the number of topics rather arbitrarily at 50 followed the work of Hornik and Grün (2011) when the volume of investigated data is taken into account.

\[
E(f/l_i) = \sum_{h=1}^{z} P(C_j/l_{ij})
\]  

(5)

Where \( h = 1, 2, \ldots, z, z \) denotes the number of previous contributions.

Thereafter, with the output of the topic distribution of 2,413 observed ideas by ‘topic model,’ the expertise of commenters at idea level can be calculated through formula (6).

\[
E(f/I) = E(f/l_{t1})P(t_{l1}/I) + \ldots + E(f/l_{t1})P(t_{l1}/I) + \ldots + E(f/l_{t50})P(t_{50}/I)
\]

(6)

Where \( P(t_i/I) \) denotes the probability distribution of \( i_{th} \) topic in idea.

This calculation is inspired by the recently proposed expert-finding tool in help-giving task (Paul, 2016), where the rank of expert based on expertise was achieved through the topic match between the query information and individual previous written contributions.

In terms of the statistical analysis at the idea level, matrix correlation, the VIF (variance-inflated factors) test (Robinson & Schumacker, 2009), as well as logit models were performed, similar to the one in the appended Paper II. Besides that, the interaction effects were tested with the mean centering variables in the logistic regression model, because the mean centering value could help clarify regression coefficients without altering the overall R-square (Iacobucci, Schneider, Popovich, & Bakamitsos, 2016). In addition, considering that the likelihood of idea acceptance could not be directly interpreted by the regression coefficients in a logit model, this study interprets the findings with the Wald chi-square test as well as prediction plotting, suggested by Peng, Lee, and Ingersoll (2002).

3.4.2 Paper IV

Data and data collection

In this research study, data collection and analysis is further conducted based on the Master program done by Hannesson (2015). During the data collection, a specific IdeaBox about the general research and development (R&D) in a specific country was selected for the detailed analysis of exchanged information. This specific IdeaBox is one of the
most effective boxes of a favorable size, containing 238 ideas and 1,022 comments. This IdeaBox was set up in 2009 and closed in 2014. Furthermore, as attention to the IdeaBox changed over the course of time, the average interval of idea acceptance was considered. It is interesting to note that the final 37 ideas created last in the system were not accepted, while prior to that, the average interval between accepted ideas was three ideas. Therefore, it was imperative for our study to exclude them because they did not have enough time to get comments before data collection execution (Hannesson, 2015). According to the formula (7), 204 of 238 ideas were finally selected.

\[ N = N_{\text{ideas till accepted}} + \frac{N_{\text{ideas till accepted}} - N_{\text{accepted ideas}}}{N_{\text{accepted ideas}}} \]

More specifically, \( N \) represents the total number of ideas in the box (the value is 238), \( N_{\text{accepted ideas}} \) denotes the total number of accepted ideas (the value is 51). \( N_{\text{ideas till accepted}} \) is the number of the ideas in this setting, representing the total number of ideas before the last idea is accepted; the value is calculated as 204 through formula (7). After 204 ideas were accepted, 916 comments connected to ideas were also ultimately accepted.

**Data analysis**

With respect to RQ2 (How do the contributions of peer communication influence idea development in online internal crowdsourcing?) in the present thesis, this paper explores the role of peer contributions to the problem and solution sides of ideas from the contribution content perspective. Content analysis at comment level was first conducted to categorize the types of comments into problem and solution through coding. If comments contributed to the problem side of ideas, they were categorized as problem comments. By contrast, if the solution side of ideas is discussed in a comment, it would be categorized as a solution comment. Thereafter, the numbers of problem and solution comments to ideas were calculated at idea level. Idea acceptance was regarded as the dependent variable in this research study as well, which was measured based on whether the idea is accepted for interest, action, or implementation, where the value of 1 represents the idea has been accepted, while the value of 0 means that the idea has not been accepted for further consideration.
In addition to this, related control variables about ideas, commenters and the commenting process, for example, the sentiment of ideas and comments, the number and average sentiment of comments per idea, the average time interval of comment given and comment diversity per idea, etc. were measured as well. Among these variables, the sentiment measurement method was the same as that used in the appended Paper III, and the measurement of average time interval of comment given was the same as that used for feedback timeliness in the appended Paper II. As for comment diversity, this represents the diverse input to ideas, measured by the different numbers of comment topics on ideas. With the usage of the ‘topicmodels’ package in R based on word frequency and Shannon entropy, the suggested 30 topics (Grünn & Hornik, 2011) were obtained from all selected 916 comments. Based on this method, each comment was given an assignment of the topic with the topic distribution probability $P(t_i)$, where $t_i$ denotes the $i_{th}$ topic, $i = 1, 2, \ldots, 30$. Thereafter, the valuable topics were selected for each comment. For example, for the comment ‘I also second the logo (the one below e.g.) …… that contains links to all ideaboxes (will be a dozen by end Feb.), otherwise a project page shall point to …….’ as $P(t_2) = 0.20$, $P(t_{29}) = 0.79$, $t_2$ and $t_{29}$ were selected as the topics of this comment. By doing so, comment diversity could be measured by the number of different topics of comments.

Besides the analysis of measurements, statistical analysis is similar to the appended Paper II and Paper III, including the tests of correlation values, the diagnostics of multicollinearity and the running of logistic regression. One different aspect concerns the multicollinearity diagnostics, due to the high correlation value of independent variables. In the appended Paper IV, both VIF and Condition Index were used to further diagnose the multicollinearity.

### 3.5 Methodological assessment

Generally speaking, social research methodology involves measurement or observation. In this quantitative research, methodological assessment is about the measurement to be used in empirical study. According to the literature on philosophy of social science (e.g., McBurney, 2009), reliability and validity are key criteria to assess. Validity is concerned with how well the measurement tests what it is supposed to test, while reliability concerns the consistency of a measurement that gives the same result on different occasions (McBurney, 2009). The methodology in this
thesis is based on the criteria of validity and reliability, which is presented as follows.

3.5.1 Validity

Cook and Campbell (1976) proposed four types of validity: internal, construct, external and statistical conclusion validity. They build on one another, where internal validity refers to the setting of the measurement in studies, construct validity emphasizes the linkages between the internal and external, and external and statistical conclusion validity are primarily concerned with theory to reality.

Internal validity

Internal validity concerns the relationship between independent variable and dependent variable. This relationship is always discussed as a cause-effect relation. Here contribution providers, timeliness and content are argued as three main dimensions that potentially impact idea acceptance. This potential causality is firstly valid by the deductive reasoning from literature on feedback (e.g. De Stobbeleir et al., 2011). However, as it has been argued that feedback dimensions interact with each other (Lam et al., 2011), the confounding is particularly one of the biggest threats, for example, the influence of feedback sentiment is contingent on the feedback source. Furthermore, multicollinearity is a typical factor on internal validity as well. In order to make sure the internal validity, here the correlation of each variable, and VIF were tested during the construction of the logistic regression model. The values of VIF suggest that multicollinearity is not a concern in the regressions, as they are well below the suggested threshold level of 10 (Cohen et al., 2013) in all studies of this present thesis.

Construct validity

Construct validity concerns whether or not the measures employed fit the theories to which a test is intended (McBurney, 2009). To some extent, construct validity is firstly dependent on the logic of the variable selection reflecting the term argued by theories. Secondly, the chosen method itself determines the construct validity in the empirical studies.

In terms of the selected variables, idea acceptance is treated as the dichotomous dependent variable in all studies of this thesis. Although this variable could not be the one that leads to the idea development performance directly, it is the variable which represents the destiny of ideas, with values 0 and 1 respectively. In this dataset, a value of 1 is given
if the idea has been accepted for interest, action and/or implementation, something which represents whether or not the company has allocated resources to the idea in order for it to be further investigated or realized. By contrast, a value of 0 means that an idea has not been accepted for further consideration or investment.

For other independent variables including expertise, timeliness, sentiment, and content type, the logic of searching methods is based on the related theories and the collected data. In what follows, the methods’ selection was made by the research demand in the present thesis and the reasonability of demonstration in previous research. More specifically, expertise, which actually reflects the owned knowledge of contribution providers, is dependent upon their virtually submitted ideas as well as contributed comments content. Its measurement logic corresponds to the literature about expert finding in the web-based system, in which the topic model method is selected to measure the expertise (see Li Ma, & Huang, 2015; Tang et al., 2011). Furthermore, the logic and method of sentiment measurement fit what are expected to be measured because the ‘sentiment’ package is calculated based on the positive/negative word frequency, which is normally used in nature language processing. In addition, contribution timeliness is logically measured based on the time interval of feedback provided. Last but not least, the categorization of contribution content into problem and solution sides is done manually, with the purpose of testing what this thesis wants to test.

Apart from the theoretical view on methodology above, the research studies also included interviews with, and reports from, managers who work with IdeaBoxes’ technology and management in the case company in order to make sure the data selected from the system presents the idea development process in reality. Hence, construct validity is increased.

**External validity**

External validity refers to the generalizations. Given the online corporate data from the global company over a period of time, the measurement in this research is not only within and across the organizations, but also beyond the limitation of country culture. Hence, the findings and results of the first research study can be applied to all organizations inside the company as well as the other companies with the similar context.

In addition, the second study with a sample of effective IdeaBoxes increases the generalizations of the first study. The results about sentiment and timeliness from the first study were actually obtained in
the second study when they were treated as controlled variables. This to some extent conversely increases the generalizability of the second research study results applied to other similar IdeaBoxes inside the case company.

**Statistical Conclusion validity**

Statistical conclusion validity refers to “the ability to draw conclusions on the basis of statistical evidence of covariation as well as prediction” (Scandura, 2000). It is suggested to be evaluated in terms of the statistical properties (Sussmann & Robertson, 1986). Hence, the Nagelkerke R square and the Wald chi-square test results of the logistic regression model calculated in all studies to some extent show the conclusion validity.

In addition, as the statistic conclusion validity concerns the source error (Scandura & Williams, 2000), the collected data is pre-cleaned before statistical analysis. For example, in the text mining for sentiment and expertise, HTML or XML tags and white spaces in the raw text were removed in R software before the analysis of content.

### 3.5.2 Reliability

Reliability of measurement in this thesis mainly benefits from the method of collecting data, the tools for measuring variables and the settings of control variables in the regression model. As it is the online stored data, the collected data would be the same if it were to be selected repeatedly. Moreover, regarding the systemic variables and interpreted variables, both of their measurement results would be the same (e.g. the number of comments, the number of commenters, the comment sentiment) if they were measured again. Last but not least, based on the settings of control variables, the regression results of tested variables would be the same as well as there are no random errors while running the regression.

Besides the reliability analysis above, content categorization in the second study is also reliable as well, because it is based on the existing logical relationship between comments and ideas. Therefore, the results of this thesis can be considered to be reliable.

### 3.6 Methodological limitations

Although the selection of method in each research study has been argued, there are still some methodological limitations that need to be expressed
in this present thesis. A first drawback is the limited generalizability of research findings to other firms, as data in this research derives from a single company. One way to solve this would be to extend the data collection to allow for better comparisons of the investigation results between firms. However, to access this type of data and to perform these types of statistical analyses for one company has given us valuable results that in the future can be tested with more firms.

Secondly, the statistic method employed in this research is singular. That is, in terms of the investigation about the role of contribution behavior, content, timeliness, and source, all four appended papers used the logistic regression analysis because idea acceptance is the dependent variable in all studies without other dependent variables. Furthermore, for the dependent variables in appended papers, there is an ambiguity of idea success and the related possible variation in the definitions of idea success used in different IdeaBoxes. It would be better if more detailed research were conducted on idea quality by exploring specific and general criteria of success.

Last but not least, the Nagelkerke R square is relatively low in logistic regression models of the appended Paper I, because of substantial noise in this big dataset. A smaller sample or other control variables should be considered and tested in the future.
4 Summary of the appended papers

This chapter presents the summaries of four appended papers. In those appended papers, we have mainly focused on the peer communication in terms of contribution behaviors, peer contribution in terms of contribution providers and time, as well as contribution content sentiment and type. Appended Paper I directly addresses the first research question. The rest of the appended papers address the second research question, particularly its sub-research questions. Basic information regarding these appended papers is shown in Table 1. The following four sections contain detailed summaries of them.

Table 1 Basic information regarding the four appended papers

<table>
<thead>
<tr>
<th>No</th>
<th>Title</th>
<th>Research aim</th>
<th>Research questions/Hypothesis of each appended paper</th>
<th>Results and findings of each appended paper</th>
</tr>
</thead>
</table>
| I  | What drives the emergence of innovation contribution behaviors in online ideation? | To explore what different contribution behaviors there are in online ideation | RQ1: What different contribution behaviors can be identified in online ideation with respect to motivational proactivity and cognitive specificity?  
RQ2: How are contribution behaviors manifested in online idea generation and idea development? | 1) Four types of contribution behaviors: proactive creation, proactive unfocused participation, proactive focused participation, passive participation.  
2) Different contribution behaviors have different influence on ideas.  
3) The way of contributing in idea development plays a more significant role in ideation performance. |
| II | Collective firm-internal online idea development – exploring the impact of feedback timeliness and knowledge overlap | To explore the role of feedback timeliness and knowledge overlap between feedback providers and ideas in collective firm-internal online idea development. | H1: A longer feedback time interval in collective firm-internal online idea development increases the likelihood of idea acceptance.  
H2: A longer feedback time interval facilitates idea development, up to a point; beyond this point, it has a negative effect, constraining creative efforts and thereby leading to a reduced likelihood of idea acceptance.  
H3: A high knowledge overlap between feedback providers and ideas in collective firm-internal online idea development has a positive effect on the likelihood of idea acceptance.  
H4: A high knowledge overlap between feedback providers and ideas facilitates idea development, up to a point; beyond this point, it has a negative effect, constraining creative efforts and thereby leading to a reduced likelihood of idea acceptance. | 1) A certain time interval for feedback has a significant positive effect on the likelihood of idea acceptance.  
However, the increased time interval would lose its advantage when it is beyond an optimal point, showing the inverted U-shaped relationship with idea acceptance in idea development.  
2) Contributors who have knowledge close to ideas play a positive role in idea development. |
3. Exploring the Effects of Feedback Sentiment and Expertise in Internal Crowdsourcing for Ideas

To explore the roles of feedback sentiment and expertise in internal crowdsourcing for ideas.

- H1: Positive feedback outperforms negative feedback in terms of effects on the likelihood of idea acceptance in internal crowdsourcing.
- H2: Expertise of feedback provider has an inverted U-shaped relationship with the likelihood of idea acceptance.
- H3: The expertise of feedback providers moderates the effect of negative feedback on the likelihood of idea acceptance in internal crowdsourcing.

4. Reframing or refining ideas? Exploring the effects of peer contribution in idea development

To explore the effect of peer contribution on the development of ideas.

- RQ: What is the effect of peer contribution on the development of ideas in terms of problem reframing and solution refining?

<table>
<thead>
<tr>
<th>No</th>
<th>Title</th>
<th>Research aim</th>
<th>Research questions/Hypothesis of each appended paper</th>
<th>Results and findings of each appended paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>Exploring the Effects of Feedback Sentiment and Expertise in Internal Crowdsourcing for Ideas</td>
<td>To explore the roles of feedback sentiment and expertise in internal crowdsourcing for ideas.</td>
<td>H1: Positive feedback outperforms negative feedback in terms of effects on the likelihood of idea acceptance in internal crowdsourcing. H2: Expertise of feedback provider has an inverted U-shaped relationship with the likelihood of idea acceptance. H3: The expertise of feedback providers moderates the effect of negative feedback on the likelihood of idea acceptance in internal crowdsourcing.</td>
<td>1) Positive feedback outperforms negative feedback. 2) The expertise of negative feedback providers has an inverted U-shaped relationship with the likelihood of idea acceptance. 3) The more negative information amount provided by experts could be more helpful for idea development in internal crowdsourcing.</td>
</tr>
<tr>
<td>IV</td>
<td>Reframing or refining ideas? Exploring the effects of peer contribution in idea development</td>
<td>To explore the effect of peer contribution on the development of ideas.</td>
<td>RQ: What is the effect of peer contribution on the development of ideas in terms of problem reframing and solution refining?</td>
<td>1) Problem information plays a negative role while solution information plays positive role.</td>
</tr>
</tbody>
</table>

4.1 Paper I

This paper is the first step in the research program to uncover the new pattern of peer communication to address RQ 1 (What types of peer communication can be identified in online internal crowdsourcing for ideas?) based on peers’ contribution behaviors during ideation, extending the previous work on idea generation to idea development. As described in Table 1, the aim of the appended Paper I is to explore what roles of contribution behaviors there are in online ideation. In order to fulfill this aim, the research questions, i.e., 1) What different contribution behaviors can be identified in online ideation with respect to motivational proactivity and cognitive specificity? and 2) How are contribution behaviors manifested in online idea generation and idea development? were addressed.

Data was collected from a Swedish multinational company using an idea management system where ideas are generated and developed by
employees globally inside the firm. In order to identify the different types of contribution behaviors, the quantitative longitudinal data such as the number of comments and ideas as well as the types of idea tags (e.g., windows platform, simulator, android, etc.) was first used to measure the contribution behaviors, providing information for clustering through latent class analysis. Thereafter, with the collected data about idea acceptance or rejection as dichotomous dependent variables, a regression analysis is employed to test the influence of different ideation behaviors on idea performance.

Clustering results revealed that there are four main contribution behavioral categories, in terms of proactive/passive engagement and knowledge focus. The four main contribution behaviors refer to proactivity/passivity in creating ideas, proactivity/passivity in commenting on ideas, deep/wide knowledge involvement in idea creation, and deep/wide knowledge involvement in commenting on ideas. Logistic regression results showed that individuals belonging to different behavioral categories contribute differently to idea generation and idea development. Furthermore, contribution behaviors displayed in idea development impact ideation performance more than contribution behaviors in idea generation. It is indicated that collectively nurturing ideas after their initial generation plays an important role in idea quality (van den Ende & Kijkuit, 2009), which supports the advocating attention on idea development proposed by Bjorklund, Bhatli, and Laakso (2013).

In terms of the influences of different types of contribution on idea development, one interesting finding is that the positive influence of proactive engagement on idea acceptance might be changed to be negative if the commenters have focused on very specific knowledge domains.

These results firstly motivate the need to focus on idea development in detail. Secondly, the investigation on knowledge domain of contribution providers in the appended Papers II and III is inspired. As the first study identified the contribution behaviors in ideation, it sheds new light on peer communication patterns in different ideation processes and how they differently impact ideation performance. Moreover, it provides management implications of contribution behaviors for online ideation.

4.2 Paper II

Inspired by the peer communication identified in terms of the engagement level and knowledge focus in the appended Paper I, this
study further investigates their influences on online idea development by observing peer contributions in terms of feedback timeliness and providers’ knowledge backgrounds. Hence, the aim of this paper is to explore the role of feedback timeliness and knowledge overlap between feedback providers and ideas in collective firm-internal online idea development. In order to reach this aim, a conceptual framework was built and hypotheses were developed to address questions, for instance, 1) what feedback gives in terms of time perspective, and 2) who gives the feedback in terms of knowledge overlap. Data is collected from the same database in the appended Paper I, but the ideas without feedback are excluded during investigation. For the investigated main variables, the average time interval of feedback given after idea submission is calculated to test the role of feedback timeliness. At the same time, knowledge overlap is measured by counting the number of identical tags between the target idea and commenters’ previous contributed ideas. On this basis, logistic regression is performed with the dependent variable of idea acceptance or rejection.

By doing so, the empirical results show that idea development is significantly influenced by feedback timeliness as well as by the knowledge overlap between feedback providers and ideas. Specifically, it is found that longer time intervals for feedback given and increased knowledge overlap result in a greater likelihood of idea acceptance. However, beyond a certain point, the advantage of feedback time interval decreases, showing a curvilinear relationship, while knowledge overlap does not display significant inverted U-shaped relationship. The results not only shed new light on theory about collective idea development, but also provide management implications for collective firm-internal ideation.

### 4.3 Paper III

As it has been investigated that the knowledge background of contribution providers plays a critical role in idea development in the appended Paper II, this research is more focused on the expertise of contribution providers. In addition, another dimension, contribution sentiment, is taken into account. The purpose of this research is to explore the roles of feedback sentiment and expertise in internal crowdsourcing for ideas. In order to fulfill this aim, hypotheses were developed to address research questions like 1) What is the effect of feedback sentiment on internal crowdsourcing for ideas? and 2) How is
the effect of feedback sentiment influenced by the expertise of the feedback providers in internal crowdsourcing for ideas?

In what follows, the empirical study was based on voluminous textual data collected from a Swedish multinational company using an idea management system. On this basis, text mining methods including topic model and sentiment are employed to measure the expertise of contributors and the sentiment of contribution content. The effects of these two dimensions are investigated by performing a logistic regression analysis with the idea acceptance or rejection as a dependent variable.

Regression results reveal that both feedback sentiment and expertise potentially impact ideas in internal crowdsourcing and that these interact with each other. More specifically, it is found that positive feedback outperforms negative feedback in an overall view, and the expertise of negative feedback providers has an inverted U-shaped relationship with the likelihood of idea acceptance. Furthermore, the greater amount of negative information provided by experts could be more helpful for idea development in internal crowdsourcing.

As one of the first studies to explore feedback sentiment in conjunction with expertise, the theoretical contribution of this research primarily lies in the development of new insights regarding internal crowdsourcing for idea development through the consideration of feedback factors, providing a more detailed analysis of feedback mechanisms. Moreover, in terms of management contributions, this study provides not only guidance for the management of contributors but also implications for inducing and sustaining different contributions in firm-internal crowd-based innovation communities.

4.4 Paper IV

After the research on contribution content in terms of sentiment in the appended Paper III, this research further explores the type of contribution content based on problem-solving theory. In what follows, the research question: What is the effect of peer contribution on the development of ideas in terms of problem reframing and solution refining? was proposed.

In order to address the above question, one specific and effective IdeaBox was selected for detailed content analysis of ideas and comments. On this basis, comments are classified into two types, problem side and solution side. Thereafter, regression analysis was employed to test the influence of
problem and solution comments on the problem and solution sides of ideas. During the empirical study, two configurations of idea development process model are argued based on problem reframing and solution refining by peer communities.

In terms of the empirical results, the first finding is that peer contribution to ideas is an important antecedent for idea acceptance in FEI. Secondly, it is found that the peer contribution content is critical. Specifically, the added problem information in idea development tends to be negative, while the added solution is positive for idea acceptance. These results ultimately open discussion on the role of problem reframing and solution refining for ideas, particularly when short-term effects of idea acceptance and long-term effects of commercial innovation are taken into account.

In a word, these results not only provide new insights on the peer-to-peer communication based on problem-solving theory but also contribute to existing theory on ideation, feedback, and problem solving. Moreover, they also provide management implications for firms to manage voluntary peer contributions in firm-internal idea development.
5 Analysis

Given that several aspects of online internal crowdsourcing has not been extensively investigated, this thesis focuses on idea development and aims to explore the role of peer contributions in online internal crowdsourcing for idea development. Consequently, based on the data collected from an internal idea management system in a Swedish multinational company, two research questions 1) What types of peer communication can be identified in online internal crowdsourcing for ideas? and 2) How do the contributions of peer communication influence idea development in online internal crowdsourcing? have been addressed. More specifically, clustering analysis and statistical analysis have been used to identify the types of peer communication in terms of peer contribution behaviors firstly. Thereafter, text mining methods including the sentiment and expertise analysis have been used to have a detailed view on the role of contribution content and the knowledge background of contribution providers. By doing so, it was found that there are different types of peer communication according to peers’ proactive/passive activity as well as knowledge focus. These different types of peer communication significantly and differently influence the peer contribution on ideas. Besides that, it was found that peer contributions, from perspectives including timeliness, content sentiment and content type, play a critical role in idea development, and their roles are influenced by the expertise of peers, namely the contribution providers. On this basis, two sections of result analyses are presented in more detail.

5.1 The types of peer communication in idea development

Peer communication to develop ideas in online internal crowdsourcing is undertaken in electronic networks of practice, self-organized by a large group and diverse knowledge backgrounds of employees. More specifically, in online idea development all peers inside firms virtually share their knowledge and contribute to the ideas across and also potentially beyond the organizations. As the social-related communication practice is essential for understanding the critical collective innovation efforts (Brown & Duguid, 1991; Daft & Weick, 1984) such as their contributions, here observing the new communication patterns in terms of contribution behaviors is arguably a first important
step in exploring peer contributions to develop ideas (Wasko & Faraj, 2005) in online internal crowdsourcing. Consequently, peer contribution behaviors including creating ideas and providing comments through knowledge communication were explored in this thesis. The results with different types of communication add to the first research question at community level, idea level, and comment level, respectively.

At community level, four types of peer communication have been identified based on the volume as well as variety of peers’ contributions in the appended Paper I. These are proactive creation, proactive unfocused participation, proactive focused participation and passive participation. Compared to previous related research, results about online communication patterns and types are mostly consistent. Firstly, in terms of the active–passive dichotomy (Malinen, 2015) of online communities, the identified proactive and passive participations support previous classifications such as lurkers and posters (Lai & Chen 2014). Secondly, for the contribution behaviors distinguishing idea creating from comment providing, the identified proactive creation and passive participation are similar with the idea generators and passive users clustered by Füller, Hutter, Hautz, and Matzler (2014). Furthermore, considering that only 130 of 5,430 participants are active in commenting upon ideas, the results highlight the typical dilemma of the famous “90-9-1” principle (Arthur, 2006) in online communication. This low percentage of active contributors is similar to the one obtained in the work of Füller et al. (2014). Last but not least, as the first study on the categorization based on the knowledge focus of communities, the resulting categorizations of focused and unfocused communication in this thesis can be seen as an expansion of the SCOUT model proposed by Stewart, Lubensky and Huerta (2010). More specifically, the SCOUT model, including super contributors, contributors and OUTliers (Stewart et al., 2010), is mainly based on the engagement level of contribution behaviors, while the observed communication types in this present thesis are based on both the engagement level and the degree of knowledge focus. The previous works on the knowledge background of online communities in innovation research, for example, on cognitive distance (Nooteboom, Van Haverbeke, Duysters, Gilsing, & Van den Oord, 2007), knowledge breadth (Sosa, 2011) and knowledge distance (Acar & van den Ende, 2016), show that whether or not communities focus on a specific knowledge area could not be ignored, if making use of the wisdom of crowds and communities is taken into account. However, given the co-existence of different influences of divergent and convergent communication, the role of knowledge-based
communication in online internal idea development might have different roles, something which will be introduced in detail in the next section.

At idea level, the results in the appended Paper I show that the identified different communication types in terms of contribution behavior differently affect idea development. For example, one type of peer-to-peer communication driven by the proactive creators positively influences the likelihood of idea acceptance. More specifically, proactive creators are arguably active in submitting ideas mainly driven by interests of self-achievement and with less attention to helping others and extending their social circles through commenting (Füller et al., 2014). The positive role of their communication shows that active creators with few comments possibly lead to more specific questions and ideas being searched for, which is likely to directly increase the probability of the acceptance. Besides that, the positive role of active communication is also supported by the results in the appended Papers II, III and IV, where the number of comments, the length of comments and the number of self-comments positively influence the likelihood of idea acceptance when they are introduced as control variables.

Apart from the investigation of communication types at community and idea level, the results of peer contribution at comment level in terms of timeliness, sentiment and content type, also indirectly and roughly provide an interesting view on different types of peer communication. For example, it is found that peer communication can be discussed in terms of how fast or slow feedback was given, the positive or negative sentiment of communication, and problem reframing or solution refining. Those communication types at comment level are all important factors concerning idea development in online internal crowdsourcing. In particular, the observed co-existing problem of reframing as well as solution-refining communication, based on the types of knowledge trajectories in the appended Paper IV, supports the view that knowledge sharing in online crowdsourcing could be about the complete problem rather than solutions-only (Majchrzak & Malhotra, 2016). Nevertheless, this is in conflict with the argument about the communication for problem discussion by Afuah and Tucci (2012), who argued that it would be hard to find the match solution by peers when wicked problems are communicated. Their different influences on idea development at idea level will be introduced in the next section as the role of peer contributions.
To conclude, similar to the observed engagement types of online communities in previous studies, most peer communication is passive, and it is unclear whether the small percentage of active peer communication makes an efficient contribution. This is a typical dilemma that challenges the contribution quality (Füller et al., 2014) of peer-to-peer communication in online internal crowdsourcing, something which has inspired many scholars to investigate further about the role of peer contributions. One specific aspect in this thesis is about the knowledge background of peers and the knowledge trajectories of peer contribution, which has initially been investigated in terms of the different communication types. By doing so, this thesis not only contributes to provide a more comprehensive view on peer-to-peer communication types instead of a simple active–passive dichotomy (Malinen, 2015), but also highlights the importance of peer knowledge backgrounds and contributions associated with idea acceptance after idea development.

5.2 The role of peer contributions in idea development

Peer contributions to the development of ideas in online internal crowdsourcing are generally provided in the form of feedback. Feedback, a communication process where a sender conveys messages about the characteristics, activities, contributions, etc. of recipients to the recipient (Cusella, 1982; Ilgen et al., 1979), is a critical component of innovation processes (Kline & Rosenberg, 1986). The role of feedback has long been discussed by previous researchers, on the one hand as a continuous source of knowledge (Ashford & Cummings, 1983) to drive the novelty and usefulness of ideas (De Stobbeleir et al., 2011; van den Ende & Kijkuit, 2009), and on the other hand as a motivation driver for individuals’ creative performance (Carson & Carson, 1993; Ilgen et al., 1979; Zhou, 1998), in the context of traditional organizational settings. But extant knowledge about, whether the potential value is created when employees contribute to their peers’ ideas through feedback given in internal online crowdsourcing, is limited. In order to address this issue, the value created beyond the overall view on the role of peer contributions was investigated and analyzed in this present thesis. In terms of the role of peer contributions in idea development, empirical results in these research studies show that the timeliness and content of peer contributions, as well as the peers’ expertise, significantly impact idea development.
More specifically, it was found that the relationship between contribution timeliness and idea acceptance is curvilinear. Up to a point, the positive effect of time interval could be explained by the feeling of being less controlled and of having less limited resources to respond from the perspective of receivers, compared to the time intensity with high frequency which arguably negatively influences the improvement performance (Chhokar & Wallin, 1984; Lam et al., 2011; Lurie & Swaminathan, 2009). More specifically, the shorter time interval of contribution in forms of feedback given accompanies more informational control (Ilgen et al., 1979). It is, on one hand, likely to lead the feedback receiver to feel increased tension and anxiety to further contribute to developing ideas (Lam et al., 2011). On the other hand, it challenges the cognitive capacity of ideators to process recent feedback in real time to move ideas further, particularly in the collective online idea development where contributors generally voluntarily participate with uncertain and ill-defined contributions (Majchrzak & Malhotra, 2016; Lurie & Swaminathan, 2009).

Despite the negativity of rapid contributions to receivers, the contributions in the form of feedback itself normally have limited informational support with limited length if it is given timely. Therefore, leaving a certain time for the feedback receiver to move back and forth between feedback and ideas, or feedback providers to contribute more informational feedback, would be helpful for idea development. However, it was found that the positive effect of an increased time interval decreases beyond an optimal point. This could be explained in that the idea itself is not very attractive and the potential value of the idea is weak if there is still no contribution given on an idea a long time after the idea was submitted. Another explanation is that the willingness to further improve ideas would be constrained if the idea is not active for a long time, something which is likely to result in a decline of idea acceptance.

To sum up, the timeliness of peer contributions has an inverted U-shaped relationship with the idea development. More specifically, a longer time interval between contributions facilitates idea development, up to a point; beyond this point, there is a negative effect, leading to a decline in the likelihood of idea acceptance.

Contribution sentiment, namely feedback sentiment in idea development, is captured to distinguish positive contributions from negative contributions. Feedback sentiment in the present thesis is based on the development of sentiment analysis methods for text mining in big data.
However, little attention has been paid thus far to feedback sentiment as a whole, and research on the role of feedback sentiment in internal crowdsourcing for ideas is particularly limited (Beretta, 2018; Courtney, Dutta, & Li, 2017; Coussément, Debaere, & De Ruyck, 2017). Most previous studies attend to feedback perception, acceptance and responses in traditional organizational settings and are based on individual psychology, behavior and cognition theory. This research provides a slightly different perspective for the effect of feedback sentiment.

A first finding about contribution sentiment in this present thesis is that the effects of positive and negative feedback in online internal crowdsourcing are similar to the ones in the traditional organizational settings. More specifically, more positive feedback facilitates idea development, up to a point. And positive feedback is more helpful than negative feedback for idea acceptance. The possible explanation for the benefits of positive feedback might be that positive feedback shows the 1) potential and desirable ideas, 2) more support and interested attention provided by evaluators (Beretta, 2018; Courtney et al., 2017), and 3) more stimulation of motivation of feedback receiver for further improvement.

In particular, as Gribb (1971) argued, because positive feedback outperforms negative feedback in task efficiency as a result of its higher desirability and also because positive feedback is assumed to be more believable for individuals, the positive feedback input in internal crowdsourcing indicates more desirable acceptance of ideas than negative feedback input.

Besides that, the second finding regarding sentiment highlights the positive effect of negative feedback, something which conflicts with the findings of Beretta (2018), where negative feedback decreases the acceptance of ideas. In a normal sense, negative feedback indicates the 1) limitation of ideas itself, and 2) more scrutiny on ideas and less willingness to be accepted by commenters (Beretta, 2018). Nevertheless, this result is inconsistent with, but caters to, the trend to further explore the benefits of negative feedback due to its informative characteristic (Zhou, 1998). Zhou (1998) initially advocated the use of negative feedback with an informational rather than controlling style, indicating that negative feedback revealing the truth in an informational manner has a better effect on performance than feedback in a controlling style, as the latter might put substantial pressure on the individuals and restrain the individuals' creativity. Furthermore, with an open mind to learn from negative feedback and the assumption that negative feedback is in fact
showing the reality (Audia & Locke, 2004; Zhou, 1998), it can actually be argued that negative feedback sometimes is the best kind (Halvorson, 2013).

For contribution content type, two aspects including problem and solution were explored. The investigation results in the appended Paper IV based on problem-solving theory show that peer contributions to the problem and solution sides of ideas, respectively, differently influence the idea development. Firstly, it indicates that problem reframing and solution refining are co-existing for the idea development. The probable reason might be the “fringe of consciousness” (Dasgupta, 1994, p. 34) in the peer-to-peer problem-solving communities. In online internal crowdsourcing, problem identification, problem framing and solution structuring are not always explicit (Kijkui & van den Ende, 2007) in ideas, something which results in ideas with an initial problem state and/or solution state. Consequently, it attracts peers to contribute to reframe the problem side of ideas as well as refine the solution side of ideas.

For the different roles of contribution content type in terms of problem reframing and solution refining in this thesis, the results show that contributions to the problem side of ideas negatively impacts the probability of idea acceptance while contributions to the solution side of ideas has a positive impact. But this does not mean that reframing problems should be definitely avoided while refining solutions for ideas should be undoubtedly encouraged, because idea acceptance referred to as the dependent variable is from the short-term value perspective and it does not mean final innovation success from a long-term value perspective. This logic about dependent variables is found throughout all empirical studies in the present thesis. For the role of problem reframing, on the one hand, current ideas would be killed midway because of the lack of understanding if contributors proceed in the various directions with much problem information input. On the other hand, providing opportunities for both problem reframing and solution refining all the time might have a positive effect on idea development, because waste connected with solving the wrong problems would be avoided if there is earlier discussion on the problem side of ideas.

The final observed dimension in this present thesis is about peers’ knowledge background, namely knowledge overlap or expertise of contribution providers in this present thesis. Although there are different ways to measure peer knowledge in the appended Paper II and Paper III, both results show that peer knowledge has significant influence on idea
development. More specifically, appended Paper I shows that the higher the familiarity of contributors with the knowledge domains of ideas, the more likelihood of idea acceptance from the idea development. Compared to the inverted U-shaped relationship of cognitive distance highlighted by Nooteboom et al. (2007), the result in the appended Paper I shows that knowledge overlap does not have a significant curvilinear effect on idea acceptance.

One possible main explanation for this finding is that the terms of cognitive distance and knowledge overlap represent two different aspects, although both of them are about the knowledge domains of contributors. Cognitive distance is about the difference in knowledge domains among contributors (Nooteboom et al., 2007), while knowledge overlap here is about the familiarity of contributors with ideas that they comment upon (Acar & Van den Ende, 2016). Another reason could be that idea development is mainly linked to convergent demonstrating (Acar & Van den Ende, 2016), where high prior related knowledge is needed for mutual understanding (Kijkuit & van den Ende, 2007) and extra-help passion to develop ideas (Acar & Van den Ende, 2016; Berg, 2014). This is different from the idea generation dominated by the divergent thinking, where knowledge diversity has been argued as a positive factor (Beretta, 2018; Magnusson et al., 2016; Zhu et al., 2018) on creation.

Besides that, another reason could be the interaction effects between peer knowledge and peer contributions such as contribution sentiment. Specifically, the results in Paper III show that there is an inverted U-shaped relationship between the expertise of negative feedback providers and the probability of idea acceptance. Similar to Paper II, it firstly shows that individuals with higher expertise (i.e. experts) on ideas play a more important role than the ones with lower expertise (i.e. non-experts) on ideas (Brand-Gruwel et al., 2005; Larkin et al., 1980). However, the benefit of expertise would decrease once beyond a certain point, because of the criticism of too narrow-minded contributions (Beretta, 2018; Magnusson et al., 2016). This investigated curvilinear effect to some extent supports the previous argument that experts play different roles under different conditions. Furthermore, it provides a possible explanation for the positive role of peers’ negative contributions analyzed above. The reason that negative feedback has a positive effect in online internal crowdsourcing for ideas might be that negative feedback comes from helpful experts.
Altogether, the contribution timeliness, content sentiment, content types, and peers’ knowledge significantly influence idea development. In terms of the likelihood of idea acceptance, contribution timeliness has a curvilinear effect, the positive contributions outperform the negative ones, and contributions to the solution side of ideas outperform contributions to the problem side. Furthermore, peers’ knowledge to some extent affects the role of their contributions in idea development. Furthermore, the significant interaction effect between contribution providers and contribution sentiment supports the opinion that the role of peer contributions is contingent on peer knowledge and peer knowledge could well depend upon some contingencies (Kang, Oah, & Dickinson, 2005).
6 Discussion and management implications

The research in this thesis has examined the effects of peer contributions on idea development in online internal crowdsourcing. More specifically, peer communication patterns have been identified and the impacts of three dimensions of peer contributions, namely 1) contribution timeliness, 2) contribution content, and 3) contribution providers, have been analyzed. As one of the first studies on the development of ideas in online internal crowdsourcing, this research has informed the view on idea development, a process dominated by peer-to-peer communication and peer contributions to ideas.

Research findings show that peer contributions embedded in peer communication influence idea development in different ways, something which gives rise to the discussion on peer communication patterns and roles of peer contributions with respect to two research questions, particularly in terms of different aspects of peer contributions. With respect to RQ1 (What types of peer communication can be identified in online internal crowdsourcing for ideas?), it is found that four types of communication can be identified based on the volume as well as variety of peers’ contributions, something which contributes to the understanding of peer communication particularly in terms of online contribution behaviors. Previous studies have focused on the different types of communication based on their volume of contribution activities, resulting in the identification of the lurkers (Sun, Rau, & Ma, 2014), posters (Lai & Chen, 2014), and active-passive participation (Malinen, 2015). However, communication types identified by the quantity of contributions alone are not enough to cover the characteristics of communication patterns (Malinen, 2015) in online internal crowdsourcing. Thus the qualitative metrics need to be developed to identify communication patterns online. As “the degree of similarities and differences in practices among members of ENoP is a matter of degree of detail in the observations of practices” (Vaast & Walsham, 2009; p. 550), the knowledge trajectories of communication, such as the variety of contribution behaviors in the appended Paper I, are essential for better identifying the communication patterns in idea development in the context of internal online crowdsourcing. Therefore, the present thesis increases the understanding of peer communication patterns from the mere volume to include also the variety of peer contribution behaviors.
For RQ2 (*How do the contributions of peer communication influence idea development in online internal crowdsourcing?*), it is interesting to note that three dimensions of peer contributions, including timeliness, source and content, stand out to be important for idea development in online internal crowdsourcing. To the best of our knowledge, this is the first study on peer contributions in online internal crowdsourcing for ideas, extending the previous insight concerning front end innovation or ideation to the development of ideas.

### 6.1 Timeliness of peer contributions

From a normative sense, contribution to ideas given in real time is likely to help improve performance (Hoornaert et al., 2017; Lurie & Swaminathan, 2009). However, the direct observation on it in innovation management has still not been empirically tested, bringing challenges for the time management of the contribution. Contribution timeliness in idea development, as conceptualized in the appended Paper II, refers to the time interval of feedback given after ideas submitted and reflects the speed of the feedback process. In this conceptualization, this research has analyzed the influence of average time distance between feedback given and ideas created. On this basis, this research theoretically mainly contributes to recent calls about better understanding of internal crowdsourcing of ideas (Malhotra et al., 2017; Zuchowski et al., 2016), by showing effects of contributions to the development of ideas (Beretta, 2018; Majchrzak & Malhotra, 2016; Perry-Smith & Mannucci, 2017) in terms of contribution timeliness.

Secondly, it contributes to the research on digital innovation research by providing a more comprehensive understanding of contribution timeliness to idea development. As concerns how contributions are given, timeliness has been treated as an important aspect in the context of offline creativity and innovation management (Chhokar & Wallin, 1984; Ilgen et al., 1979; Kijkuit & van den Ende, 2007). Studies within this field highlight that the timeliness of contributions plays a role in emotional motivation and learning (Lam et al., 2011) and further decision making (Lurie & Swaminathan, 2009). Although short time intervals of contribution given to a large extent bring more opportunities for diverse knowledge assets for knowledge creation, the finding is contradictory and supports the notion that too many cooks spoil the broth (Rese et al., 2013). One possible explanation might be that too many contribution inputs within a short time period may bring more stress and anxiety with
increased feeling of personal control and more challenge of cognitive capacity (Chhokar & Wallin, 1984; Ilgen et al., 1979; Lam et al., 2011). Consequently, this thesis increases the understanding of how contributions given relates to time perspective, adding to the existing theory on feedback timeliness as well as feedback frequency (Lam et al., 2011; Lurie & Swaminathan, 2009).

6.2 Content of peer contributions

In terms of peer contribution content, as Shannon implied, the syntactic aspects of communication are not sufficient to capture the conveyed meaning, while the semantic aspect centering on the meaning of information is more relevant, as it focuses on conveyed meaning. (Nonaka et al., 1994). Content sentiment is thus a critical aspect of peer contribution. Investigation on the peer contribution sentiment here contributes to what in previous studies is referred to as feedback valence in traditional organizational settings. The majority of relevant research in the last century has indicated that positive feedback outperforms negative feedback on an overall level regarding a) feedback perception, b) feedback acceptance, and c) feedback responding, such as reciprocal communication stimulated by feedback (e.g. Cusella, 1982; Gribb, 1971; Ilgen et al., 1979; Jacobs et al., 1973; Zhou, 1998). The most reasonable and widely accepted discussion on this argument is that positive feedback might increase the receivers’ perceived self-esteem and enhance a supportive communication climate in terms of a working environment, leading to more individual satisfaction and accurate perceptions (Ilgen et al., 1979). In a similar vein, positive feedback is found to be more desirable and also tends to be more believable than negative feedback (Jacobs et al., 1973), thereby increasing the feedback acceptance. However, it is in fact also possible to benefit from negative feedback (Audia & Locke, 2004; Halvorson, 2013) as it may lead to an improved understanding. Therefore, the finding in the present thesis that negative contributions are positive for idea development contributes to providing a new and more detailed understanding of the role of contribution content in internal crowdsourcing for ideas, thereby contrasting and adding to existing theories on feedback valence (Jacobs et al., 1973; Zhou, 1998) as well.

Apart from the contribution content sentiment, another aspect is the contribution content type. A critical theoretical base in order to understand the types of peer contribution content is problem solving,
through which contribution processes can be treated as the form of the generation and exchanging of problem and solution information for ideas. More specifically, peers in internal online crowdsourcing are normally communicating with different levels of problem/solution knowledge presentation (Westerski et al., 2012) in ideas or comments. Problems and/or solutions “float around” in ideas waiting to be temporarily matched for further action through peers’ conversation, and the participating peers owning the problems and/or the solutions attempt to provide “a plausible aid in structuring a problem at hand” (Gregory & Muntermann 2014, p. 639) or a “generalizing solution to a commonly occurring problem” (Douglass 2003, p. 50), in order to frame the existing paradox of problems or that between problem and solution (Majchrzak & Malhotra 2016) and match the problem–solution pairs (Dorst & Cross 2001; Nambisan et al., 2017) of ideas. As a consequence, ideas are the combinations of problem and solution rather than just technical solutions (Bayus, 2013; Magnusson et al., 2016), and peers who own the problem (customer needs) or solution information (ways to satisfy the needs) (Majchrzak & Malhotra, 2016; Ransbotham & Kane, 2011) are open to contribute to the problem and solution sides of ideas in idea development. This research finding that problem framing and problem solving coexist is consistent with the work done by Majchrzak and Malhotra (2016). In the study by Majchrzak and Malhotra (2016), problem reframing is encouraged in crowdsourcing. But problem framing in crowdsourcing is not supported by Afua and Tucci (2012), who argued that crowds have a limited ability to deal with problems. As the first study from a perspective combining the online peer-to-peer communication and problem-solving theory in FEI, it not only contributes to the literature on innovation and information systems by focusing on the problem and solution sides of comments in internal online crowdsourcing, but also contributes to the problem-solving theory by discussing the different roles of problem reframing and solution refining.

To sum up, in terms of RQ2 (How do the contributions of peer communication influence idea development in online internal crowdsourcing?), the present thesis has identified factors that possibly influence idea development as contribution timeliness, contribution providers from expertise perspective, contribution content in terms of sentiment as well as problem/solution type. More specifically, it is found that the knowledge trajectories embedded in communication are important during idea development in terms of timeliness, source, and content dimensions.
6.3 The influence of peer knowledge on contribution

In terms of contribution providers’ knowledge backgrounds, the present thesis seeks to extend current innovation research about contributor diversity (Beretta, 2018; Zhu et al., 2018) with an examination of the expertise as well as the knowledge overlap between contribution providers and ideas. With the wide usage of crowd-like approaches, questions regarding who contributes to ideas have long been emphasized because of the growing uncertain contributions provided by diverse and dispersed contributors. Nevertheless, most previous research has focused on either ideators’ knowledge domains for online idea generation (e.g. Piezunka & Dahlander, 2015; Zhu et al., 2018) or evaluators for online idea selection (e.g. Magnusson et al., 2016), and less attention has been paid to contributors in online idea development who can help ideators complement their ideas prior to evaluation (Beretta, 2018). Our findings show that contributors suggested to be familiar with ideas commented upon them with high expertise, something which not only supports the recent argument by Acar and van den Ende (2016) and Piezunka and Dahlander (2015) in terms of peer knowledge, but is also consistent with previous research based on social networks indicating that prior related knowledge embedded in network content is suggested to be high (Kijkuit & van den Ende, 2007; Perry-Smith & Mannucci, 2017). It nevertheless does not, of course, mean that the participation of diverse contributors is not important for idea development. In contrast to the arguable positive role of contributors’ diversity for idea generation (Zhu et al., 2018), it actually highlights the different requirements of knowledge search (depth or scope) for different types of knowledge (e.g. combination or in-depth analysis) creation and development (Bergendahl & Magnusson, 2015). Overall, this finding, similar to the broader discussion about network diversity and cognitive distance in idea generation, contributes to those works by examining the knowledge network connecting ideas with its commenters (Zhu et al., 2018) in idea development.

6.4 Management implications for peer contributions

According to the analysis and discussion above, this thesis also provides some practical implication for management. One of the important managerial aspects is in regards to making use of online internal
crowdsourcing to develop ideas through peer contributions, because sometimes the focus of this platform is on the generating of ideas but not on developing them with the limitation of feedback (Malhotra et al., 2017). This creates roadblocks to the success of online internal crowdsourcing. On this basis, this thesis suggests that primary attention should be paid to managing peer contributions in order to remove the main roadblocks to developing ideas in online internal crowdsourcing.

As suggested by Malhotra et al. (2017), if internal crowdsourcing is to become an important mechanism inside firms for innovation, management needs to be serious about the contribution to develop ideas. In particular, when the influence of different contribution dimensions are deliberated, different management approaches should be considered. In terms of this managerial issue, this research provides some specific practical suggestions regarding contribution timeliness, contribution sentiment and type, and contribution providers so as to answer 1) how fast peer contributions are given, 2) who gives peer contributions, and 3) what peer contributions are suggested to develop ideas.

**Time management for peer contributions**

In terms of how feedback is given, feedback timeliness is an important aspect to be taken into account. Conventional wisdom is that employees need fast feedback for learning to improve their work (Lam et al., 2011), but our results clearly contradict this conventional wisdom. In fact, feedback given in real time potentially limits idea development midway. Therefore, firms should not merely assume that timely feedback and more feedback with high frequency are always better (Lam et al., 2011; Lurie & Swaminathan, 2009).

Emotional motivation and cognitive capacity should be taken into account when managing the timeliness of feedback. For example, leaving some time and space for ideators to accept and understand feedback is necessary so that they do not feel unnecessary stress and anxiety, but it is also important to allow them to have sufficient personal control and cognitive resources to respond to and process feedback. Furthermore, giving available time (Malhotra et al., 2017) to contribute fruitful information is critical. However, as too much time waiting for feedback might destroy the motivation to improve ideas, feedback timeliness needs to be managed in a balanced way.
Management of contribution providers

Besides the management implications about how contribution is given in terms of contribution timeliness, we can also derive implications about who gives contribution, as the difficulty in determining the fruitful ways to manage contributors has been identified as an issue.

Previous studies advocate open calls for contributors from diverse knowledge domains for knowledge creation (Beretta 2018; Zhu et al., 2018), but our results show that contributors should ideally be familiar with the knowledge domains of ideas commented upon. Therefore, firms should not simply try to expand the knowledge diversity of employees for online idea generation. It may be more important to train employees to have specific experience and knowledge to specifically help the improvement of others’ ideas. Nevertheless, although employees who are close to the ideas possibly increase the idea acceptance with their useful knowledge input, the results about different effects of expertise with different contribution sentiments suggest that it is important to be careful to not let experts exert their influence too heavily (Malhotra et al., 2017). For example, the positive relationship of the negative contribution amount with expertise suggests that employees who are familiar with ideas commented upon should give sufficient objective comments to develop ideas.

Peer contribution input to ideas

In terms of what contribution is given, empirical results regarding contribution content sentiment and type need to some specific managerial implications.

Firstly, the empirical findings suggest that negative comment should not be avoided, but rather be considered as an important vehicle for learning, whereas positive comments without substantial content could possibly be constrained to a certain degree instead of simply being encouraged. However, if contribution receivers are taken into account, whether they feel constrained or encouraged by different types of contribution sentiment to some extent depends on the contribution provider’s expertise. Consequently, the expertise of contribution providers should be taken into account when managing the peer contributions’ sentiment. More specifically, it is suggested on the one hand that a critical thinking style needs to be trained for non-experts and that simple positive feedback like ‘good idea!’ is hardly useful, but instead needs to be more specific. Even if a non-expert thinks that an idea is really good, some
reasonable objective reasons for this expression should be given within the feedback content. On the other hand, as the negative feedback proposed by high expertise is likely to kill ideas, bad ideas would be efficiently stopped by experts in order to save further efforts and costs. Nevertheless, some good ideas might be killed prematurely, so it is indicated that the objective reasons for why an idea is not regarded as valuable should be given in order to increase the opportunities for reciprocal discussion and learning to prompt further idea development.

Secondly, for the contribution content type, the focus on the problem and solution sides of ideas suggests that internal crowdsourcing should perhaps be open and flexible under different goals and contexts for both problem reframing and solution refining, extending the current crowdsourcing function solution search (Afuah & Tucci, 2012). For example, if the aim of the communities or organizations is to improve the probability of idea acceptance, the number of peer contributions regarding problem reframing should be considered due to the negative influences of problem information inputs on idea acceptance, while the positive role of solution information inputs to ideas suggests that the attempts to refine ideas in terms of the solution side should be encouraged during idea development until the problems and solutions in ideas are matched. However, if the long-term value created at firm level is taken into account, the management of problem reframing and solution refining needs be flexible according to their advantages and disadvantages because idea acceptance is an uncertain index of innovation value. More specifically, if the goal is to reduce the uncertainty of online idea management, problem reframing might be suggested to be well constructed before submission instead of being openly crowdsourced. By contrast, if the goal is to reduce the risk of investment on the wrong problem in the later stage, open discussion about problem framing online seems to be a good approach. Another possibly approach would be to separate problem framing and problem solving more clearly, potentially using internal online crowdsourcing for both activities, but not simultaneously in a stepwise fashion. By and large, this implication points to the flexible management of problem reframing and solution refining in the idea management system based on the crowdsourcing principle.
7 Limitations and future research

Although this thesis presents significant results about the role of contribution to ideas contributed by peer-to-peer communication in FEI, it still bears some limitations that may condition our results in certain ways.

First of all, this study has been focused on answering how and what contributions are given, but the reasons why peers contribute to ideas have not been researched. As a key driver for peer contributions, motivation potentially impacts idea development. Although motivation factors based on self-interest, identity, social capital and social exchange have been largely discussed in online communities (Faraj et al., 2011), most of these are focused on idea generation from an encouragement view. In contrast to idea generation, idea development provides opportunities for learning through feedback and might have different key motivation factors, particularly explaining the extra-help behaviors. Furthermore, it would have managerial benefits from the exploring of motivational factors, due to the significant role of active participation. Thus, it would increase the understanding of peer contribution from the start driver to the end outcome for idea development in online crowdsourcing if future study pays attention to the motivation of peer contribution. A particularly interesting aspect of this is related to performance measurement and related incentives, as these seem to be less developed for idea development, when compared to idea generation.

Secondly, there is an unclear value of idea acceptance triggered by the uncertainty of idea evaluation and implementation, for example, “people often reject creative ideas, even when espousing creativity as a desired goal” (Mueller, Melwani, & Goncalo, 2012: p. 13), resulting in the risk of value loss due to rejection. The value of idea acceptance is also uncertain from a long-term perspective. Therefore, criteria reflecting the innovation value of ideas need to be scientifically researched in order to measure idea development performance. One specific aspect that needs to be stated is that, as this thesis observed the role of peer contribution from short-term value in terms of idea acceptance, long-term value such as further engagement motivation and ideation performance needs to be further considered in future studies. More specifically, it would be desirable to have more complete information to define the success of
ideas or idea quality from a long-term capability-building perspective. By doing so, more comprehensive discussion about the role of peer contributions could be carried out. As a consequence, it would be valuable to include also long-term effects of peer contributions in future studies.

Thirdly, although the peer contribution is narrowed down to the feedback in idea development, only the provided feedback was investigated as peer contribution and not the responses of the feedback receiver to these contributions. As previous studies on feedback in the context of traditional organizational settings show that the responding of feedback receivers reflects not only the contribution quality itself but also the contribution effect, here it is highlighted that paying attention to the responses of the peer contribution receiver is an important aspect to be taken into account in future studies.

The fourth limitation is about the peer contribution providers as well. Different terms like focus, specificity, knowledge distance, and expertise were used to describe the peers’ knowledge, as there are still a lack of unified terms in the theoretical literature. These different usages of terms based on different measurements on the one hand enrich the perspectives of peers’ knowledge. On the other hand, they bring confusion to understanding the peers’ knowledge. Therefore, it would be interesting and valuable to have a specific study on the role and relationship among different emerging aspects of peers’ knowledge.

Furthermore, although the difference between crowd models and community models is highlighted in this research, a more detailed observation of the different roles of crowds and communities (Dobusch & Kapeller, 2017) is needed in future studies, particularly when the management of idea generation and idea development is integrated. Generally, the peer communication in idea generation is dominated by the crowd model while the one in idea development is dominated by the community model. Consequently, the detailed observation of the different roles of crowds and communities would subsequently benefit ongoing research topics on the nature and form of internal online crowdsourcing and the factors that shape innovation success (Nambisan 2013).

The fifth limitation is related to the types of peer communication. Although both the volume and the variety of peer contributions are taken into account to identify the types of peer communication in this present thesis, this identification is based on the merely dyadic interaction between peer and peer. On this basis, social network theory, which is
popularly employed in the web-based innovation research (e.g. Kijkuit & van den Ende, 2007; Björk & Magnusson, 2009), would be helpful for the deeper understanding of peer communication in future studies. The reason why the social network perspective is important for further observation of peer communication is that the overall structure of relationships of all communications besides their dyadic interactions could be analyzed.

Moreover, according to the different user roles in different types of online crowdsourcing such as innovation contests, open-source software and consumption communities (Füller et al., 2014), it is indicated that different types of online crowdsourcing potentially influence the types of peer-to-peer communication. For example, in terms of problem reframing and solution refining, different types of crowdsourcing have different knowledge-sharing trajectories for problems and solutions (Majchrzak & Malhotra, 2016) in their communications. There would not be a communication type for problem reframing if the crowdsourcing were merely for solution searching while being closed for problem discussion. Consequently, observing the different types of peer-to-peer communication in different types of online crowdsourcing would be an interest aspect in future studies.

Another future study can be derived from the discussion on the contribution timeliness. Despite the negative effect of rapid feedback from feedback receivers, this rapid feedback itself was found to normally offer limited informational support due to its limited length. Therefore, the positive role of time interval of contribution given indicates that leaving a certain time for feedback receivers to go back and forth between feedback and ideas, and allowing feedback providers to have enough time to contribute more informational feedback, would be helpful for idea development. However, although the online internal crowdsourcing provides a platform for employees to freely work online regardless of their formal position, they are under time pressure (e.g., Meloche et al., 2009) limiting their possibilities to engage in idea development. Importantly, sufficient time is an often-neglected resource for creativity (Amabile & Pratt, 2016). Even if employees feel motivated to participate, they would be hesitant to contribute to ideas if they feel a strict limitation of time. Further research on how to help participants manage time to balance their daily work and extra-help on ideas is thus required.

In addition, besides the contribution timeliness, sentiment, content type and providers, other dimensions of peer contributions are suggested to be
considered, in order to gain a more systemic view on idea development in online crowdsourcing.

Last but not least, in terms of the empirical study, the generalizability of this research is of course limited as the data is extracted from only one specific company. Further studies should extend the data collection to allow for better comparisons of the investigation results between firms.
8 References


Brabham, D. C. (2010). *Crowdsourcing as a Model for Problem Solving: Leveraging the Collective Intelligence of Online Communities for Public Good*. The University of Utah.


