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Exploring employee interactions and quality of contributions in intra-organisational innovation platforms

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1. Introduction

Innovation is a social and interactive process in which collaboration, exchange of knowledge and information play crucial roles (Hemphälä & Magnusson, 2012). Through information technology (IT) platforms, firms engage employees, customers and suppliers in the generation of ideas for innovation, and this is also a way to leverage the potential of the entire organisation's collective creativity (Blohm et al., 2011b). Firms are increasingly recognising how IT tools like innovation platforms are changing the innovation process and acknowledging the platforms' role in creating, shaping and disseminating technological and social innovations outside and across the firm's boundaries (West & Lakhani, 2008; Fichter, 2009; Elerud-Tryde & Hooge, 2014). Previous studies have examined user behaviour in innovation platforms to better understand the reasons and motivations for participation (Füller, 2006), different user roles (Füller et al., 2014), collaborative and competitive behaviour (Hutter et al., 2011) and the quality of the networks of ideas (Björk & Magnusson, 2009) as well as which user behaviours lead to certain types of innovation (Dahlander & Frederiksen, 2012).

In intra-organisational innovation platforms, employees are typically invited to contribute ideas, provide feedback for joint development, refine ideas or participate in other activities (Kozinets, Hemetsberger & Schau, 2008; Gebauer et al., 2013; Bergendahl & Magnusson, 2014; Bergendahl & Magnusson, 2015). Collaborative approaches to ideation and idea development benefit the innovation platforms since they combine different types of knowledge sets, thus providing cognitive stimulation as well as pooling members' social capital, knowledge and skills (Sutton & Hargadon, 1996; Girotra et al., 2010; Bergendahl & Magnusson, 2014; Bergendahl & Magnusson, 2015). Research in innovation

and networks of innovation platforms have also benefitted from social network research, while recent studies increasingly have shown interest in the impact of network structures in user behaviour and the quality of ideas (Björk et al., 2011; Hutter et al., 2011; Dahlander & Frederiksen, 2012; Hemphälä & Magnusson, 2012). However, few studies have paid attention to the layered nature and the content of interactions (e.g., Mesch and Talmud, 2006; Hutter et al., 2011; Füller et al., 2014). Still, little research has been published on the in-depth analysis of user interactions in innovation platforms and it is unclear which user interactions contribute to the idea development.

The purpose of this paper is to explore the users' interactions in intra-organisational innovation platforms as well as the influence of user interactions to the outcome. We shed light on the following research questions: What types of employee interactions and contributions can be identified in innovation communities? How do they support the quality of contributions? We rely on data from a large firm as an example case. A Norwegian telecommunications operator named Telenor fits our research scope due to its organisational structure with several departments around the world. The firm's innovation platform, called Explorathon, was followed and studied using an exploratory study and a mixed-methods approach.

By addressing these research questions, this study contributes to research on intra-organisational innovation platforms. The study particularly contributes to a better understanding of the nature and impact of user interactions in intra-organisational innovation platforms. Based on the literature in innovation management and organisational knowledge networks, the study offers an in-depth analysis and categorisation of user interactions and contributions. Lastly, the authors combine the study findings to develop an evaluation metric that reflects the quality of contributions in innovation platforms.

2. Background

2.1 Innovation platforms for intra-organisational innovation

In the last decade, innovation communities have received increased recognition as a promising platform for innovation and collaboration (Jeppesen & Frederiksen, 2006; West & Lakhani, 2008; Wendelken et al., 2014). Especially firms are encouraged to adopt online innovation platforms and open their innovation processes by involving both internal and external sources, such as employees, customers and universities (West & Lakhani, 2008; Dahl, Lawrence & Pierce, 2011). Examples of innovation platforms are crowdsourcing (e.g., Estellés-Arolas & González-Ladrón-De-Guevara, 2012) and open innovation platforms (e.g., Enkel et al., 2009) that vary in their functional characteristics and design, including the organizer (e.g., company, public organisation), the submission period (short- or long-term), the target group (e.g., employees, customers or public), the user interaction activities (e.g., commenting, idea submission or voting) and evaluation method (e.g., jury evaluation, peer review)

among others (Adamczyk, Bullinger & Möslein, 2012). The facilitation of innovation platforms results in several advantages for both firms and members of the platform. Firms recognise innovation platforms as strategic assets that provide external expertise, generate ideas and support innovation development (Dahlander & Wallin, 2006; West & Lakhani, 2008; Adamczyk, Bullinger & Möslein, 2012). On the other hand, users have been recognised as innovators. Users participate in innovation processes because of knowledge transfer, expected benefits from using the innovations, enjoyment of the innovation process, and monetary rewards (Bogers, Afuah & Bastian, 2010; Frey, Lüthje & Haag, 2011). Furthermore, the participants of innovation platforms have the opportunity to ideate, interact and even collaborate with a large network of people who might promote their ideas (Whelan et al., 2011; Hemphälä & Magnusson, 2012; Aalbers & Dolfsma, 2015).

Innovation platforms often adopt the characteristics of communities, for example, mutual engagement, shared repertoires, shared objectives and the voluntary participation and contribution of employees (Wendelken et al., 2014). In this paper, we focus on intra-organisational innovation and its platform characteristics are described by Bansemir, Neyer and Möslein (2012, p. 44) as follows: (i) a shared purpose to search, select and develop innovations in line with an organisation's strategic objectives; (ii) membership limited to employees of a specific organisation; (iii) interaction and communication of members that primarily take place on platforms; and (iv) the lack of sustained and ongoing mutual relationships as well as mutual interdependence. This definition highlights employees' online and offline connections within firms' boundaries, focussing on the development of innovations through technological platforms. Previous work increasingly emphasise innovation not as a process carried out by single individuals but rather as a social and communicative process in which informal interaction and open communication are highlighted as a major long-term goal (Fichter, 2009; Hemphälä & Magnusson, 2012; Füller et al., 2014).

2.2 User interactions and collaboration in innovation platforms

Innovation is a social and interactive process in which collaboration, exchange of knowledge and information play crucial roles (Hemphälä & Magnusson, 2012; Fortwengel, Schüßler & Sydow, 2017). Participation in online innovation communities and platforms starts as an individual voluntary activity and frequently evolves into a social and communicative process with community members. Typically, platform members are invited to contribute to various activities, such as generating and evaluating ideas; elaborating or challenging concepts; creating or co-creating prototypes (Kozinets, Hemetsberger & Schau, 2008; Gebauer et al., 2013); providing feedback for joint development and refining ideas; as well as encouraging idea generators and other members (Bergendahl & Magnusson, 2014; Bergendahl & Magnusson, 2015). Furthermore, interactions among members could involve activities, such as asking questions, sharing experiences, and providing positive or negative feedback, while the analysis of interactions is linked to useful insights regarding the nature of innovation communities (Hutter et

al., 2011); identification of user types (Füller et al., 2014); and the quality of the contributions (Björk & Magnusson, 2009).

Prior research has focussed primarily on studying the influence of individual user behaviour in innovation communities (e.g., personality, cognitive style, motivation) as well as on studying organisational or contextual factors on user behaviour (e.g., organisational culture, leadership style, organisational design, size, etc.) (e.g., Pirola-Merlo & Mann, 2004; Shalley, Zhou & Oldham, 2004). Now, research examines collaborative approaches to ideation that open new opportunities for combining different types of knowledge sets (Bergendahl & Magnusson, 2014; Bergendahl & Magnusson, 2015), providing feedback, cognitive stimulation as well pooling members' social capital, knowledge and skills (Girotra et al., 2010). Furthermore, related studies examined how users communicate and interact with each other (Füller et al., 2014), as well as whether collaboration leads to more innovative solutions compared to a competitive setting (Bullinger et al., 2010; Hutter et al., 2011). The study findings revealed that user interactions could result in different behaviours, ranging from competitive to collaborative, while collaboration results in a varying degree of innovativeness. In addition, the initiation of external-oriented communication with other business units (BUs) (Aalbers & Dolfsma, 2015) and the teamwork in relation with organisational innovation were examined (Fay et al., 2015). Findings of these studies discuss that the external-oriented communication behaviour is more likely to contribute to innovative activity within the firm and the increased teamwork leads to higher levels of organisational innovation.

Despite the promising results in interaction and collaboration in such platforms, new ideas encounter organisational barriers and constraints. For instance, in an intra-organisational context, the lack of connections with decision makers, lack of expertise or time and sporadic flow of ideas among BUs might affect the ideas that are heard by the decision makers and hold ideators back from reaching out to others, leading to the underutilisation of initially excellent ideas (Whelan et al., 2011; Hemphälä & Magnusson, 2012). However, few studies have paid attention to the layered nature of interactions in general (e.g., Mesch and Talmud, 2006) and to the content of interactions and the quality of ideas in innovation platforms (Hutter et al., 2011; Füller et al., 2014).

2.3 Networks of user interactions

In organisations, formal and informal communication networks play a fundamental role and have been noted as antecedents to the transfer of innovative knowledge (Obstfeld, 2005; Aalbers & Dolfsma, 2014; 2015). The importance of networks has been studied in a range of innovation management subfields, such as in ideation and knowledge management (Hansen, 1999; Hemphälä & Magnusson, 2012; Phelp, Heidl & Wadhwa, 2012). Recent studies have increasingly shown interest in the impact of network structures in innovation processes (Hemphälä & Magnusson, 2012). For example, positive effects of increased networking on ideation are correlated with central network positions (Björk &

Magnusson, 2009; Björk et al., 2011), the network connectivity and the quality of the innovation are related with the quality of ideas in innovation networks (Björk & Magnusson, 2009), while the central network positions are correlated with the generation of high-quality ideas (Björk & Magnusson, 2009; Björk et al., 2011). Nevertheless, constraints of social interactions and contributions have been reported in intra-organisational networks regarding ideation and joint activities in which network members may not have developed efficient ways of working together and may not perceive each other as members of a team (Wheelan, 2010). Other related studies examined the constraint of conflict management (Schulze, Stade & Netzel, 2014) and ownership of ideas (Hannah, 2004) in organisations that indeed limit the social interactions in intra-organisational networks.

In organisations, employees are typically involved in multiple different types of networks, both formal and informal, with multiple activities or topics of conversation. These are described as multiplex networks, which are combined by informal and formal ties (Aalbers & Dolfsma, 2014; 2015). Multiplex networks are characterised by rich ties, and studies have explained how they transfer innovative knowledge in an organisation (Mesch & Talmud, 2006; Aalbers & Dolfsma, 2015). Involvement in multiple networks would arguably provide the transfer of innovative knowledge in a firm (Aalbers & Dolfsma, 2015), increasing the trust between actors and their social influence on each other, which may influence knowledge transfer, creation and adoption (Phelp, Heidl & Wadhwa, 2012). By examining multiplexity, researchers may be able to untangle some of the conflicting results related to a network's structure and tie strength (Phelp, Heidl & Wadhwa, 2012) since the interactions for searching and sharing knowledge across organisation subunits have also benefitted from the role of weak ties (Hansen, 1999) and since fewer ties among network members are more beneficial for individual creative productivity (Aubke, 2014). Nevertheless, network multiplexity is rarely observed, and research should seek to understand how the presence of multiple types of relationships among the same actors influences their knowledge outcomes (Phelp, Heidl & Wadhwa, 2012).

The network perspective on innovation communities and platforms has increased the complexity of analysing user interactions and contributions, whereas it allows an in-depth understanding of the phenomenon. Research in innovation and networks of innovation communities have benefitted from social network research and social network analysis (SNA) since social network measures are considered powerful predictors of innovation (Hemphälä & Magnusson, 2012). The suitability of SNA has been underlined as a methodology to study creative processes (Aubke, 2014), and therefore, SNA is used to reveal the relationships and dependencies of numerous factors concerning innovation. Typically, network measures applied to innovation studies refer to centrality measures, such as degree centrality; betweenness centrality and eigenvector; degree and similarity measures; and network diversity and density (Obstfeld, 2005; Björk & Magnusson, 2009; Hutter et al., 2011; Hemphälä & Magnusson, 2012; Aubke, 2014; Füller et al. 2014). The network measures were applied to investigate

both user behaviour and ideas in innovation communities, for example to explain behaviours that lead to certain types of innovations, contributions and collaborations and to examine ideas in terms of their quality (Björk et al., 2011; Hutter et al., 2011; Dahlander & Frederiksen, 2012; Füller et al., 2014).

2.4 Idea quality metrics

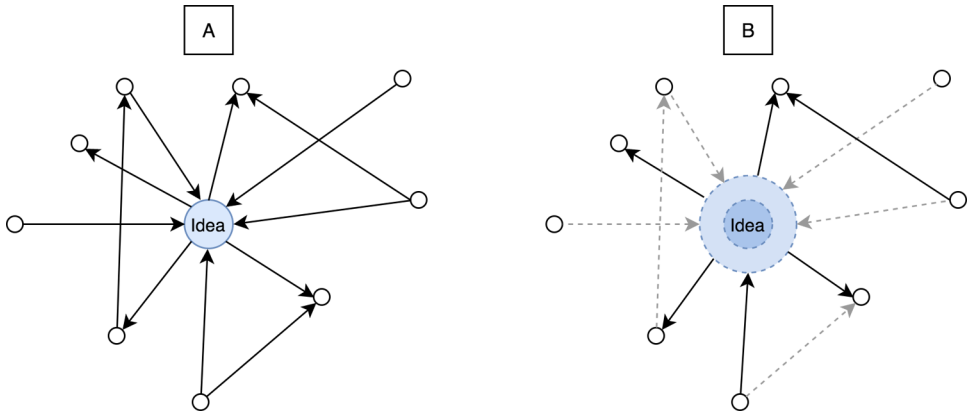
Idea quality is a complex construct consisting of qualitative characteristics, such as novelty, feasibility, relevance and elaboration, and quantitative characteristics, such as rating scales, prediction markets and network measures (Björk & Magnusson, 2009; Blohm, et al., 2011a; Blohm, et al., 2011b). Previous studies concerning online communities have examined user contributions in blogs and introduced several measures that capture both the total quantity and the quantity of contributions (Mishne & Glance, 2006; Adler et al., 2008). Studies in innovation platforms measured the popularity of user contributions and ideas by using indicators, such as the number of likes, replies or votes, and offer design suggestions for rating scale to evaluate ideas content (Riedl et al., 2013; Füller et al., 2014). Usually, firms apply qualitative criteria to evaluate the quality of ideas, and they are mostly interested in overall rankings, which help them choose the most promising candidates (Riedl et al., 2013). Moreover, an alternative way to assess idea quality and contributions is the use of network metrics (Björk & Magnusson, 2009; Fuger et al., 2017). For instance, a study found that the most connected individuals within an innovation network resulted in a higher proportion of high-quality ideas; however, the same did not apply to the most connected groups (Björk & Magnusson, 2009). Clearly, connected ideas and ideas with comments are substantially more linked in a user network compared to ideas with no comments, since the existence of quantitative characteristics, such as the number of comments and 'likes', is an indication of the popularity and significance of the ideas in an innovation community. However, when measuring the quality of ideas, the qualitative analyses of user interactions through comments are often limited and only contribute to parts of the study (e.g., Bullinger et al., 2010); alternatively, they are excluded from the analysis (e.g., Björk et al., 2011).

2.5 Synopsis

In sum, studies in user interactions and contributions in innovation platforms have neglected to explore the user interactions as a qualitative metric that affects the quality of ideas. In general, prior research has assumed an equal effect of user interactions on idea quality during an innovation process (Figure 1, A), while only few studies have paid attention to the layered nature of user interactions that affect and evolve ideas over time. Therefore, our focus is on studying innovation platforms in an intra-organisational setting and the relation of various user interactions with the quality of ideas (Figure 1,

B). Our assumption is that there are diverse user interactions that have different impacts on development, in addition to the quality of ideas in innovation platforms.

Figure 1: Study approaches: A. User interactions with equal effects on the quality of ideas, and B. User interactions with diverse effects on the quality of ideas.



3. The research context: Explorathon

To address the research questions, we study the firm-initiated innovation platform used by Telenor, a multinational Norwegian telecommunications company. Telenor runs several departments in Europe and Asia, with 13 BUs around the world. The online intra-organisational innovation platform, called Explorathon, was set up in 2014 by a cross-functional team of human resource (HR) managers and employees from Telenor's central research department. The purpose of the platform was to identify new business propositions that could help the company reach its growth targets in the coming years. All employees across the company were invited to submit, discuss and develop ideas. The expectation was that the Explorathon platform would generate innovative ideas, facilitate the adoption of the new leadership principles and encourage collaboration across Telenor's different BUs. To enable idea generation, the central HR department set up moderated idea submissions and discussions in Explorathon in early March 2015.

After the platform was launched, a global communication campaign was established to encourage participation, allowing employees to submit ideas, as well as to comment or provide 'likes' to others' ideas. A leaderboard visualised the ranking of ideas based on the number of 'likes' and comments, making the originators of the most popular ideas visible. To boost participation, the platform moderator actively suggested collaborations among users with similar ideas. Since it was an internal portal, employees were automatically logged in with their company usernames. They could choose among 11 discussion topics (Table 1), and they could submit their ideas using a simple text format, with an option to upload relevant attachments. After submission, an idea was presented in

Explorathon's idea pool, which was visible to all platform visitors. Furthermore, based on their contributions, selected participants were marked with an 'expert' badge in the online platform.

Table 1: Discussion topics in Explorathon with topic descriptions.

Topics	**Code**	**Description**
Core Communication	cCOM	The topic includes ideas about basic communication services, such as voice and SMS.
Core Connectivity	cCON	The topic includes ideas about core connectivity services from data traffic.
eCommerce	eCOM	The topic includes ideas about adjacent digital positions in eCommerce.
Financial services	fSER	The topic includes ideas about financial services.
Online Payment	oPAY	The topic refers to enabling and using mobile phones for payment.
Online Classified	oCLA	The topic includes ideas about adjacent digital positions on online classifieds.
M2M	M2M	The topic includes ideas about machine to machine (M2M).
mEducation	mEDU	The topic includes ideas about adjacent digital positions on education.
mAgriculture	mAGR	The topic refers to enabling and using the mobile phone in the agriculture sector.
mHealth	mHEA	The topic includes ideas about adjacent digital positions on health services.
Others	OTH	The topic includes ideas about something different compared to previous topics.

After the end of the submission period, a jury team of seven executives from research and development (R&D) and strategy groups at Telenor's headquarters conducted a two-step screening process to evaluate the ideas. The first screening phase was based on how engaging an idea was for the participants, based the number of 'likes' and comments, as well as whether they had the 'expert' badge. This first screening reduced the pool from 390 to 150 unique ideas. In the second phase, the jury team manually evaluated the remaining 150 ideas using the following selection criteria: relevance and ability to generate a strong effect on growth; clarity and completeness; cost and implementation complexity versus value; and the potential for further development in the BUs. This phase reduced the pool from 150 to 17 unique ideas. The contributors of the 17 selected ideas were encouraged to describe their ideas in more detail in a two-page document. The descriptions were then sent for examination to the 170 top executives in Telenor, including the chief executive officer and executive

management teams in all 13 BUs. During a three-hour workshop that took place at the end of March, each management team selected one idea for further implementation based on growth potential and the feasibility of implementation. The workshop included group work on their voted ideas, suggestions on the methodology and the subsequent steps for idea implementation as well as potential collaborations. Additionally, the management teams discussed enablers for innovation (e.g., key performance indicators, leadership, mindset, process, tools) and reflections on the Explorathon process. Finally, 11 unique ideas were selected for local implementation. The management teams took personal responsibility for following up on the selected ideas and starting the local development of the ideas. Finally, in October 2015, four ideas were implemented, while three were being developed. The remaining ideas had not been followed up at that point.

Currently, the company has launched another innovation process, called Ignite, that provides employees with the opportunity to develop and implement ideas for a digital product or service. According to the current results, the company has selected seven digital product and service ideas from among employee's ideas.

4. Method and data analysis

An exploratory study for the Explorathon platform was conducted to address the research questions and examine both the interaction types and their relationships with the quality of contributions. The case of Explorathon offers a unique rich information source to study employees' interactions and contributions across various business departments.

Explorathon can be considered an intra-organisational innovation network connected by the interactions of employees who have contributed in various ways, as has been described in the previous section. Innovation networks have been studied by applying rich methodological approaches. Purely qualitative studies, with methods like content analysis, were conducted to gain a deeper understanding of the network's content (Mahr & Lievens, 2012; Wendelken et al., 2014). Quantitative studies, with methods like surveys, are applied for the examination of innovative behaviour and characteristics of contributors (Hemphälä & Magnusson, 2012; Bergendahl & Magnusson, 2015). In addition, mixed-methods approaches are popular in network analysis studies and combine data types, such as questionnaire results and log files. Mixed-methods approaches can provide a thorough view of an innovation network to examine, e.g., the heterogeneity of user roles (Füller et al., 2014), cooperative and competitive behaviours using content analysis and SNA (Hutter et al., 2011), interrelationships between innovation idea quality and idea providers' network connectivity (Björk & Magnusson, 2009).

Therefore, we followed a mixed-methods approach to enhance the trustworthiness and reliability of our data (Denzin & Lincoln, 1994). Initially, the administrator of the Explorathon platform extracted the raw data into an Excel file and shared it with the authors. The data were anonymised, while other personal and sensitive information was carefully removed. We first performed a content analysis of the submitted ideas and comments to analyse and gain a deep understanding of interaction types in the network, as well as the content of employees' contributions. Second, we used SNA to understand how employees interact within the network and we present these results in the beginning to provide a better overview. Finally, we combined both datasets to verify, confirm and refine the findings that emerged from the previous steps. This approach offered a holistic way to understand the employees' behaviour by combining the structural data from the network analysis with the detailed qualitative data.

4.1 Qualitative study – Content analysis

The first step was to conduct a content analysis of the discussions in Explorathon to gain a deeper understanding of the platform and employees' contributions. In total, 390 ideas and 1435 comments were analysed, varying in length from a few lines to two A4 pages. In the beginning, we examined the content of submitted ideas, focussing on the social interactions that were involved. Two themes were used for ideas' analysis. The first theme refers to the target user of an idea and describes the main beneficiaries of the idea, such as the firm, customer or employee. The second theme, the intended collaborations, refers to general calls and suggestions for collaborations that are included in the ideas and involves collaboration with others, such as internal or external parties. To analyse the comments, an existing coding scheme was applied (Hutter et al., 2011), with some modifications to better describe the interaction types among employees in Explorathon. The coding schemes are presented in Tables 3–5 (Appendix), with examples from our dataset.

Due to the richness of the posts, ideas and comments were often coded into several categories. We used the software program NVivo 10 to manage the large body of data, which allowed us to categorise, code and cluster the data accordingly. Additional software for statistical analysis and data visualisation (SPSS, JMP) was used. Based on the coding schemes, two researchers coded the same dataset individually. To ensure interrater reliability and reduce individual coding biases, the meanings of the codes were negotiated and checked with the dataset; subsequently, any necessary changes were made in the coding schemes. This approach allowed the researchers to identify and understand employees' contributions in terms of idea content and interaction types. After coding a sample of 10% of the dataset and receiving a satisfactory interrater agreement ($K = 0.79$), the remaining data were coded by one researcher.

4.2 Quantitative study – Social network analysis

The second step was to run an SNA for Explorathon to reveal the relationships and dependencies of employees' interactions in the platform. We viewed Explorathon as a social network connected by employees' interactions where users can be either sources or targets of relationships. Measures of centrality were used to map the directed communication flows in the platform (Ibara, 1993). The well-established measures of directionality, namely in- and out-degree centrality measures, are predictors of the importance of an individual's position and individual contributions to a network (Freeman, 1979). Using the discussion topics to partition the data into non-overlapping subgroups, smaller networks of interactions were created accordingly. The network's connections among employees reflected a variety of interactions when discussing ideas. The interactions were classified into several types using an existing coding scheme (Hutter et al., 2011), such as interactions that provide positive feedback, ask questions and offer suggestions, among others. Furthermore, the directionality of the network was used to map the contributor types (i.e., ideas' contributors and commentators). However, the quality of interactions cannot be represented with measures of directionality. Therefore, we applied weights to various interaction types to reflect the impact of contributions in Explorathon. Using a five-point scale, the authors of this paper discussed and assigned weights to interaction types, ranging from a low to high contribution to idea development. For example, a comment receiving positive feedback was evaluated with a lower weight than a comment with suggestions for the idea. The coding scheme for interaction types is described in Table 5 (Appendix), with examples from our dataset and corresponding weights of interactions.

5. Results

5.1 Demographics

During the submission period, more than 3200 employees joined Explorathon to submit ideas and to provide comments and 'likes' for their colleagues' posts. In total, 640 employees from 11 different BUs contributed with 390 ideas and 1435 comments during 10 days (Mean = 39 ideas/day). Most users contributed to the discussions by commenting or voting (61.9%), while 38.1% of employees submitted one or more ideas. Specifically, a significant percentage of employees participated by submitting at least one idea (29.9%). Fewer employees contributed 2–3 ideas (6%), and the rest of the employees (2.2%) submitted 4–20 ideas. Throughout the submission period, there was no significant burst of ideas, while the flow of ideas and comments was quite high and steady. Regarding the gender of idea contributors, the majority were male (76.1%) compared to female contributors (23.9%). The analysis of their work type shows that the majority of idea contributors were permanent employees (72.9%), while a smaller percentage worked either with another employment type (23.8%) or in a fixed-term position (3.2%). Furthermore, the analysis of contributors' length of service revealed that a greater number of them had 4–11 years of experience (45.4%) and 16.5% of the contributors worked

for 11–20 years. Among the rest, 21.5% had 1–4 years of service, 11.9% had less than 1 year and only 4.6% had 20 or more years of experience. Further analysis of the contributors' profiles revealed that the bulk of idea contributors worked in the departments of network, IT and security (21.57%); sales and marketing (18.42%); as well as management and strategy (16.84%). In addition, the departments of R&D, products and services (14.25%); HR and customer service (12.15%); operations and data (11%); and legal, accounting and finance (5.78%) contributed significantly to the ideas pool.

5.2 Social network analysis (SNA)

The Explorathon could be represented as a social network connected by employees' interactions regarding various discussion topics. We report first on how employees interact in Explorathon and then, their 'quantified' interactions.

Initially, the networks of all discussion topics were examined, using measures of directionality. A relationship (edge) between two users in the network was established when one user commented on another user's idea or the idea's creator commented on his or her own idea. The relationship consisted of directional ties, where the direction of a relationship indicated who commented (source) and who received the comment (target). Similarly, a directed tie was established among users if one user wrote a single comment to another user. We examined the structural positions separately for each discussion topic. Table 2 presents descriptive statistics concerning Explorathon's network, with the three following node criteria: in-degree centrality, out-degree centrality and the number of submitted ideas. On average, users posted and received two comments and submitted 0.60 ideas. The high skewness values indicated heterogeneity in employees' behaviour, especially for the number of outgoing communicative relationships (out-degree centrality measure). The in-degree centrality and number of ideas also presented high skewness values. The median value for the number of submitted ideas showed that most users contributed by posting comments on others' ideas and some ideas received no comment.

Table 2: Descriptive statistics for the Explorathon network.

	Mean	**Median**	**Standard deviation**	**Variance**	**Skewness**
In-degree centrality	2.02	0.00	5.797	33.610	6.582
Out-degree centrality	2.02	1.00	5.597	31.321	12.027
Number of submitted ideas	0.60	0.00	1.375	1.892	7.236

Furthermore, directionality measures were useful for visualising the initiator of interactions and mapping the contributor types (i.e. idea contributors and commentators). We then applied weights to the various interaction types to measure the quality of interactions in Explorathon. Figures 2 and 3

present the Explorathon network with and without weighted ties; the former shows that communication was higher in density among certain users (closer to the centre of the network), while some users engaged in little or no activity and some ideas received no comment (closer to the perimeter of the network). The latter illustrates the differences in interactions and their impact on idea development, ranging from low to high contribution.

Figure 2: The Explorathon network (Harel-koren fast multiscale layout).

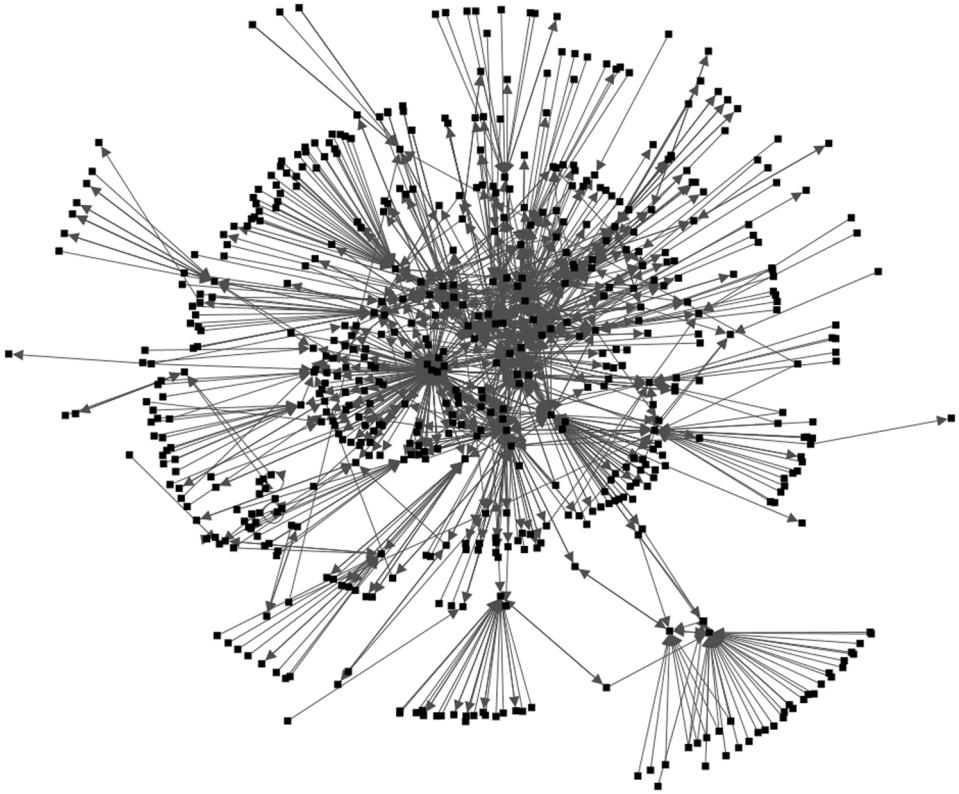
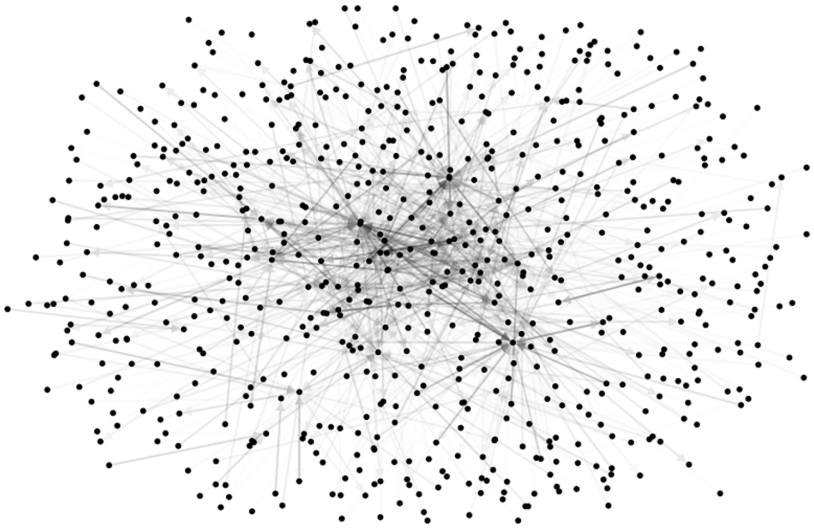


Figure 3: The Explorathon network with weighted ties (Fruchterman-Reingold layout).



Two examples of ideas were selected to illustrate the differences in centrality measures (green: out-degree centrality, red: in-degree centrality) and weights, across discussion topics. The idea networks in

Figures 4 and 5 visualise that the initiator of an interaction could be either an idea contributor or another member (commentator), while the activity of an idea contributor in some cases exceeds the activity of other members, in terms of number of interactions. The content analysis will explain more the content of the interactions.

Figure 4: Example of ideas in the 'Core communication' discussion topic.

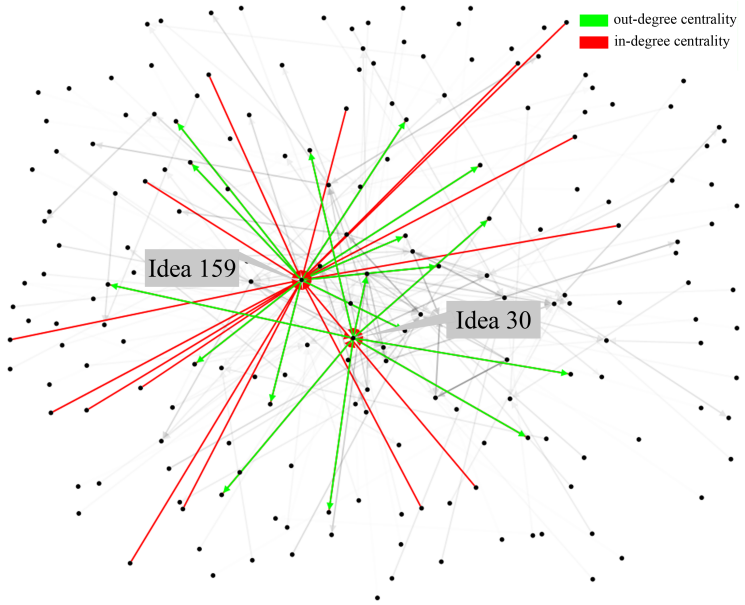
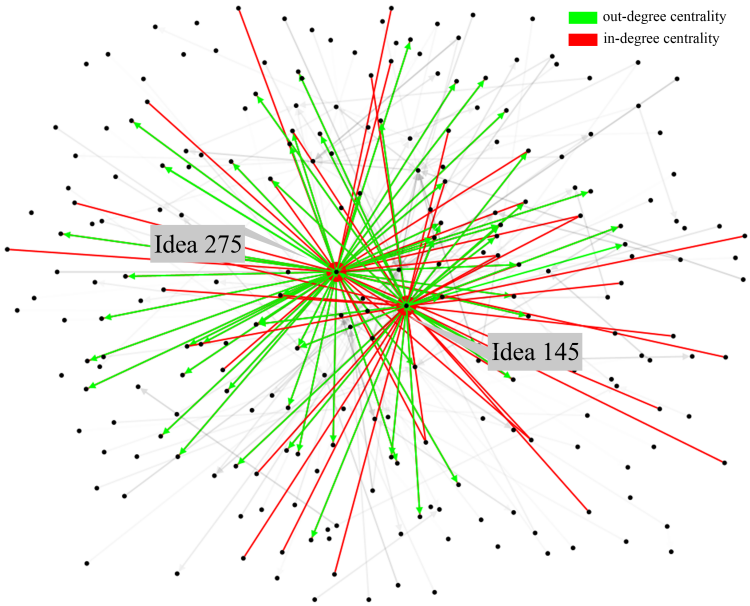


Figure 5: Example of ideas in 'Other' discussion topic.



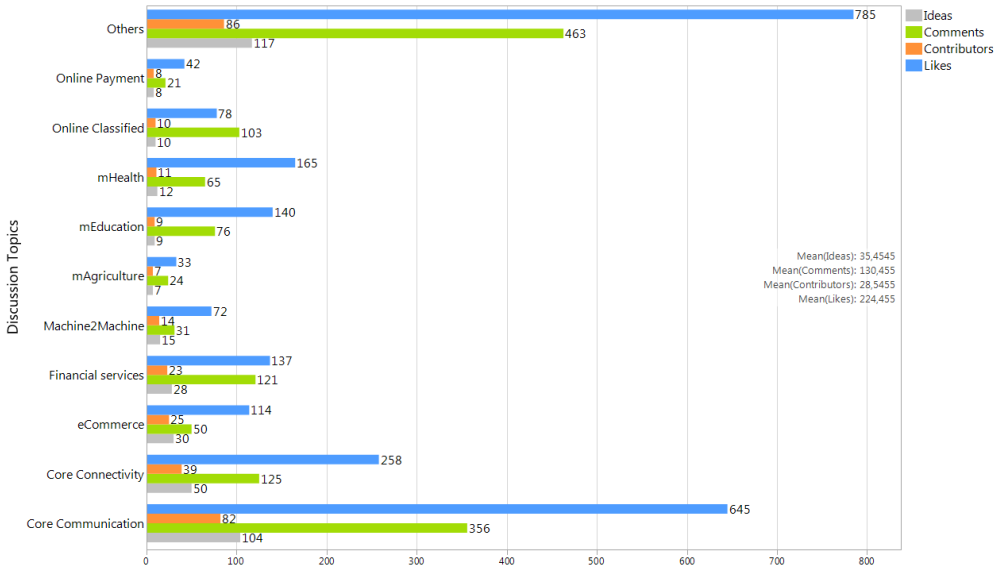
5.3 Content analysis

By conducting content analysis, we gained a deeper understanding of the platform's discussions and employees' contributions. In the beginning, the summarised results of the discussions are presented, followed by the detailed analysis of the interactions.

The analysis of 390 ideas and 1435 comments revealed both their content and their quality. The discussion topics of Explorathon provide a consensus on the context and content of the discussions, while the comments and 'likes' provide a consensus on employees' interactions within the platform. The discussion topics, with the corresponding number of ideas, comments, contributors, and 'likes', are illustrated in Figure 6. The results show that the topics 'Core communication' and 'Other' were discussed most in Explorathon (Figure 6). The first topic includes ideas about basic communication services, such as voice and SMS and the latter includes ideas about alternative topics compared to the rest of the suggested. Both topics attracted approximately the same amount of interest from contributors ('Core communication' = 82 and 'Other' = 86), while the number of ideas, comments and 'likes' were higher for the latter. This means that either the employees were interested in suggesting ideas other than the predefined topics or there were difficulties in categorising ideas into the topics. In addition, the topic of 'Core connectivity', which refers to ideas about core connectivity services from data traffic, attracted attention and a great number of ideas and 'likes'. The remaining topics gathered a relatively low number of ideas and discussions.

Overall, 68% of ideas suggested a new service, while 32% suggested a new product. The majority of submissions followed structured ways to present the ideas. The use of arguments to describe the ideas' potential (73%) was very common, while the majority of the ideas either provided technical details or a coherent description (82%). Also, 67% presented the requirements, needs, challenges and benefits, while only 15% of the ideas presented potential risks, competitors, and early results or posed a question. Finally, the use of examples, illustrations, links or sources to justify the innovativeness of contributions (35%) was less popular.

Figure 6: Number of ideas, comments, contributors and 'likes' across discussion topics.



The content analysis across the discussion topics revealed the interaction and contribution types. Hereafter, the results are presented, with definitions and example comments. In total, 11 interaction types were identified among employees: positive feedback, negative or non-relevant feedback, value recognition, involving other people into comments, comparing ideas, inviting people for collaboration, asking questions, sharing an experience, offering suggestions, confessing a problem, and explaining an idea. The main interaction type across all topics was 'positive feedback' (41.12%), which refers to positive comments that articulate congratulations, thanks or encouragement, for example, *'Great ideation for customer experience', 'Good initiative!' (ID 384).* The second-most common interaction type was 'value recognition' (17.53%), which is similar to positive feedback, with the addition of contributing to the ideas' potential effect and value, for example, *'Very convenient at least for Norwegian customers. Personally, I need that kind of service' (ID 154)*. The interaction type 'suggestions' with the third-highest percentage (13.26%) refers to comments with suggestions and/ or hints for idea implementation, extensions of ideas, or similar, for example, *'...maybe add some kind of easy messaging possibility because the children may not always be able to […]' (ID 24).* Furthermore, comments with questions on ideas (6%) aimed to receive more information, clarification or other, for example, *'How much does it cost to implement?' (ID 107)*. Comments that shared experiences (5.6%) included descriptions of personal experiences, examples or shared information sources that might help in the discussions, for example, *'In Norway, we see several initiatives where people volunteer to help the elderly' (ID 25)*. In some cases, the comments included an invitation or suggestion for collaboration with other employees, company departments or institutions (4.06%), for example, *'I will also suggest approaching […] for their advertisement and information broadcast' (ID 161)*. The confession of a problem included criticism or potential areas of concern or problems about ideas (3.97%), for example, *'Good idea in general, though not sure it helps with the phishing issue' (ID 240)*. It was also observed that some comments (3.5%) included comparisons with other submitted ideas, relevant work processes or tools, for example, *'Business unit X is about to launch a similar project in this subject' (ID 147)*. Additionally, comments that did not fit to other categories and aimed to explain or provide more information about a previously posted question or comment were coded as 'explanation' (2.46%), for example, *'In response to X's post: yes...this is ok with regulatory requirements' (ID 162)*. The explanations were provided mainly by idea owners. We also identified another interaction type that aimed to involve people or departments and invited them to provide feedback or answers (1.55%), for example, *'@Employee A, B what do you think?' (ID 216)*. Lastly, comments that did not fit in other categories, such as jokes, or comments that were written in a negative way constitute very small percentage of the total comments (0.95%), for example, *'ha ha ....we will block the scratch cards instantly ...lol' (ID 50)*.

Additionally, the results of the content analysis revealed the main contribution types across the discussion topics. Employees discussed ideas for eight target users: firm, customer, employee, family,

society/social life, sociocultural context, technology and daily life. Primarily, the majority of ideas (32.75%) focussed on benefitting the end user's everyday life activities, general/daily personal needs or values, such as savings, travels and parking, for example, *'If an app could indicate available parking spots based on where you're heading […]' (ID 232).* Second, the ideas' creators were interested in suggesting ideas that would primarily benefit the firm's strategy, values or needs (25.99%), for example, *'Change Telenor's […] on various occasions to show respect, commitment, engagement to that event or culture' (ID 369)*. Furthermore, the technology-driven ideas aim to bring new technology in order to solve various issues (15.42%), for example, *'Telenor could offer […] equipped with a Wi-Fi hotspot to deliver internet connectivity to specific locations for a limited time' (ID 132)*. Some ideas were customer-driven, with a specific focus on customers' values or needs (8.83%), for example, *'For a customer of Telenor, it may be exciting to get upgraded to become a customer of X' (ID 373)*. Sociocultural ideas (7.62%) refer primarily to social needs or cultural values inspired by a specific country and/or target to be applied in a specific context, for example, *'If we consider Bangladesh as an example, it is an agricultural country…' (ID 257).* Society-driven ideas (7.1%) aim to benefit general societal issues and/or social-related issues, for example, *'Empowering children through mobile education, networking and entertainment' (ID 304).* Furthermore, employee-driven ideas (1.21%) aimed to benefit employees' values or needs, for example, *'Make employee reimbursement for […] easy & fast' (ID 9).* Lastly, family-driven ideas (1.03%) aimed to benefit family-related needs or values, for example, *'Our idea is an app to […] concerning the family activities' (ID 231).*

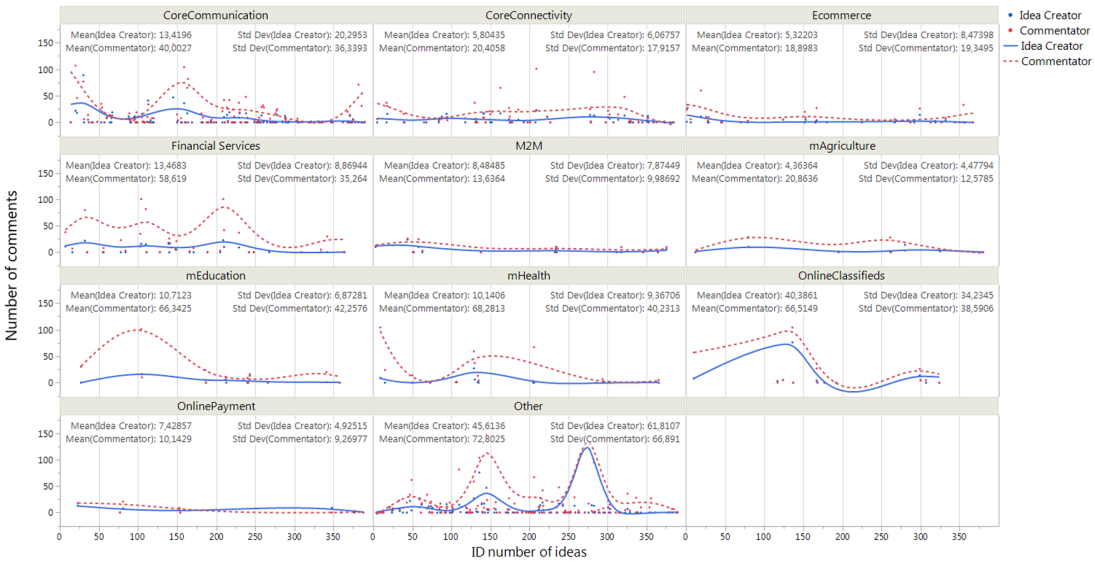
The results of the content analysis also revealed calls for collaboration to the entire company (internal, external or general calls). The idea contributors often suggested external collaborations (61.76%) with external firms, institutions or people who could potentially support, extend or implement the ideas, for example, *'What is required from Telenor to make this happen: partnership with apps vendor that can help develop the …' (ID 183).* The general calls for collaboration (25.5%) were open invitations to everyone for support or comment, for example, *'Please help in suggesting and designing the format' (ID 384).* The calls for internal collaborations (12.74%) included ideas that invited internal departments, groups or employees to contribute, communicate or comment, for example, *'Help is needed from Telenor employees: to suggest other uses of the app, to find a fair charging model and a trusted payment method' (ID 283)*. Table 6 (Appendix) shows a detailed analysis of the ideas and comments across themes. Based on these results, we conclude that the Explorathon platform reveals an interest in ideas that will benefit users' daily lives and that it also offers a platform for suggesting external collaboration and providing positive feedback among employees.

5.4 Linking SNA and content analysis

After we analysed how participants interact and contribute in Explorathon, we merged these results to identify the associations between interaction types and contributions. In Explorathon, the interaction types provided a varied quality of contributions to the development of ideas. Despite the good quality of initial ideas, a high number of interactions did not result exclusively in a meaningful contribution. According to the content analysis, the main interaction types across all topics were 'positive feedback' and 'value recognition', which contributed to positive reinforcement. However, both types made little contribution to improving the quality and the development of ideas. On the contrary, interaction types like 'suggestions' and 'confessing a problem' contributed significantly to the development of ideas by offering recommendations and directions for future improvement. Therefore, we applied weights using a five-point scale to represent the impact of employees' interactions to idea development. The interaction types 'positive feedback' and 'negative or non-relevant feedback' were classified with the minimum weight (weight: 1), while the interaction types 'value recognition' and 'involving into comments' were classified higher since they provided some potential for development (weight: 2). The interactions that included 'comparing' or 'inviting collaboration' were evaluated as equally important to the development of ideas (weight: 3). Greater impact on the future development of ideas was assigned for the interaction types 'asking questions' and 'sharing experience' (weight: 4). Finally, 'suggestions', 'confessing a problem' and 'explaining' were considered to have the greater impact for improving ideas (weight: 5).

Additionally, the quantitative study showed differences in the initiators of interactions. According to the SNA analysis, out-degree and in-degree centrality measures across topics and ideas involved both ideas' creators and other users (commentators). We combined the previous findings to examine the community's associations between interaction types and the quality of contributions. The results revealed differences in weights across discussion topics throughout the submission period (Figure 7). There were significant differences in the weights of comments initiated from two user roles: the idea creators (blue line) and other users (red line). Other users provided higher quality comments for most discussion topics compared to idea creators. However, specific topics, such as 'Online classifieds' and 'Other', illustrated similarly weighted activities for both user roles. This means that the interactions and corresponding weights for an idea could stem from an idea's creator, other members or both. Consequently, when using quantitative metrics of SNA to define the quality of ideas in a network, such as the number of comments or commentators, could be insufficient. For example, it is possible that a high number of comments will not exclusively result in meaningful contributions, but it will provide positive reinforcement. Additionally, comments might only be coming from idea contributors. This is useful to consider when metrics of SNA are used to define the quality of a network.

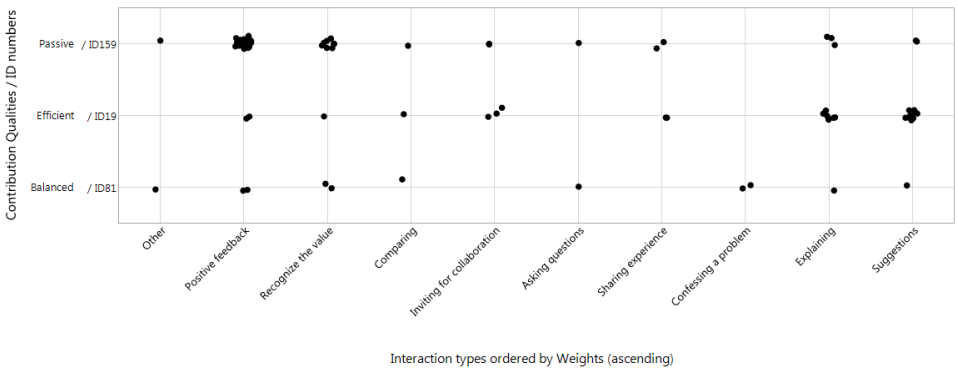
Figure 7: Comparison of weights for ideas' creators and other members (commentators) per discussion topic.



In the next step, we combined the structural positions of ideas from each discussion topic with the findings of the interaction types to reflect the quality of the contributions. We identified three different contribution qualities of ideas related to the interaction types, as follows: passive, balanced and efficient contribution. Passive contributions to ideas mainly include interactions that encompass low potential for idea development, such as comments with positive feedback and recognition of the idea's value. Balanced contributions involve comments of various interaction types that equally provide adequate idea development. Finally, efficient contributions mainly include great potential for idea development, such as comments with suggestions and questions. For the identification and assignment of structural positions to one of the three contribution qualities, based on the content analysis, we assumed that the content of discussions was directed at positive contributions.

We analysed the 17 selected ideas included in Explorathon's final screening process, applying the contribution qualities. A sample of ideas according to the three contribution qualities with weighted interactions is presented in Figure 8. In Explorathon, it was found that most of the selected ideas resulted in efficient contribution, while there were few ideas without comments or interactions. Although the selection criteria in the first screening phase were based more on quantitative evaluation metrics, such as the number of replies and likes, the Explorathon platform gathered efficient contributions with satisfactory quality for the selected ideas and according to company's evaluation criteria. The linking process allowed us to confirm or refine structural findings with the ideas' content; relying only on content analysis would not have been sufficient for examining user interactions. The use of combined qualitative and quantitative metrics for the evaluation could be a fruitful idea-selection method.

Figure 8: Contribution qualities according to weighted interaction types for a sample of ideas.



6. Discussion and conclusions

The Explorathon platform was developed to support the company's growth by identifying new business propositions and increase employee engagement as part of the company's innovation culture. The platform demonstrated remarkable results, where submitted ideas met the firm's expectations and strengthened employee engagement and collaboration across BUs. In fact, 38.1% of employees submitted one or more ideas (390 ideas were submitted in 10 days; mean = 39 ideas/day), indicating a high number of ideas for an innovation platform compared with previous studies (e.g., Dahl, Lawrence & Pierce, 2011; Hutter et al., 2011), given the short submission period. In addition, the 1435 submitted comments indicate the increased interaction activity of employees in discussing ideas. Previous studies exhibited similar high numbers of comments, but not in such a short time (e.g., Hutter et al., 2011). To answer the research question, we found that 11 interaction types support the communication among employees in the innovation platform, which were raised by various discussion topics. Furthermore, eight contribution types with three embedded collaboration types were identified in the innovation community. These results demonstrate that diverse interactions co-exist in innovation platforms, with a diverse impact on quality of ideas. We suggest that interaction types affect the idea development with different weights, while an idea's total weight of interactions could be used as a measurement of its contribution quality.

Our findings complement existing research and extend the use of interaction types and weighted contributions in the analysis of innovation platforms and communities. One way of studying the platform's informal communication and user interactions is to analyse the content of interactions. To date, studies have examined the content of interactions for a different purpose or assumed an equal effect on the observed innovation network (Hemetsberger, 2002; Björk & Magnusson, 2009; Hutter et al., 2011; Füller et al., 2014). Compared to 19 interaction types that were found in a design contest community (Hutter et al., 2011), we concluded that the original coding scheme produces overlaps in our dataset and therefore we eliminated the interaction types to reflect better the content of the comments, while another coding scheme with six interaction types was found inadequate for our dataset (Füller et al., 2014). The presence of multiple interactions among the same users in an idea

network and their effect on idea development characterises the intra-organisational innovation platform as multiple network. Multiple networks of innovation have been studied in organisational contexts, but not in innovation platforms (Mesch and Talmud, 2006; Phelp, Heidl & Wadhwa, 2012; Aalbers & Dolfsma, 2015), hence the lack of research in this direction. Previous studies analysed the interactions to assign user behaviours, relying primarily on quantitative data (Hutter et al., 2011; Füller et al., 2014). Furthermore, in previous studies the interactions of the designers and consumers in innovation platforms were studied broadly (e.g., Hutter et al., 2011; Füller et al., 2014), while employees' interactions in intra-organisational innovation platforms did not receive qualitative analysis. To the best of our knowledge, this paper is one of the first to analyse the content of interactions in innovation platforms and how interactions support the quality of the contributions by assigning weights, using a mixed-methods approach.

From a platform perspective, user roles were significant in maintaining interactions and weighted contributions over time. First, the involvement of managers from different departments contributed to positive reinforcement of participation, since—in addition to being participants—they tried to engage employees and generate interactions, for example, by asking questions, making suggestions for ideas or involving other users in discussions. Our results supported previous studies, where the importance of managers in innovation communities has been identified as crucial in ensuring a constructive process that produces the desired outcomes for managers, thereby enabling them to engage in quick interventions and track progress (Dahl, Lawrence & Pierce, 2011). Second, our study also supported the claims that feedback provided by platform moderators shortly after an idea submission is positively associated with active participation and that longer active participation in platform interactions positively benefits the participants (Bockstedt et al., 2016; Wooten & Ulrich, 2017). We found that the role of idea contributors is equally important to the role of platform moderators in generating interactions among participants and that idea contributors' feedback could positively benefit both the quality and number of submitted comments on their idea(s). As Figure 7 illustrates, when idea contributors reply, there are higher weighted comments from other members as well. Third, in Explorathon, most of the comments concerned the interaction types 'positive feedback', 'value recognition' and 'suggestions'; therefore, the positive feedback in the innovation platform contributed to its collaborative climate. Again, it is notable that ideas with interaction types like 'positive feedback' did not necessarily lead to efficient contributions and idea development. For example, idea #275 (Figure 5) received many 'positive feedback' responses; however, the total contribution quality was passive due to the low significance of comments for the idea development. Therefore, the manager's role of ensuring a quality process could also relate to controlling contribution quality so that the contributions lead to the desired outcomes.

Furthermore, our findings complement and extend prior research in evaluation of innovation platforms based on the use of interaction and contribution types. We argue that the quality of ideas could be determined by users' interactions. Our suggested types of contribution qualities—passive, efficient and balanced contribution—are only indicative of the content of interactions, and they complement other evaluation metrics of the community. Also, this study contributes to the direction of fine-grained measurements for innovation networks (Hemphälä & Magnusson, 2012), combining common social network metrics (i.e., in-degree and out-degree centrality) with qualitative analysis to extract the quality of the contributions. Prior studies have explored quantitative metrics, such as common social network metrics and ratings (Füller et al., 2014; Wooten & Ulrich, 2017), to identify the quality of the contributions in innovation communities. However, in this paper, we showed that certain metrics of network interactions do not necessarily lead to trustworthy metrics for a community's contribution quality. For example, a high amount of 'positive feedback' offered different kinds of contributions compared with a high amount of the 'asking questions' interaction type. Consequently, the use of solely quantitative metrics could be risky for evaluating a platform's contributions. Similarly, other quantitative metrics, such as votes, should be carefully considered in innovation communities in firms' evaluations due to the social biases in such communities (Hofstetter et al., 2017). Community evaluations, such as votes or rating ideas, may differentiate between users and the firm's evaluation team members (Hofstetter et al., 2017; Velamuri et al., 2017). For this reason, such evaluations can be used to efficiently complement firms' decisions in filtering and selecting ideas for further development.

From the methodological point of view, our empirical findings confirm the value of the mixed-methods approach when exploring interactions and contributions in innovation communities and platforms (Hutter et al., 2011; Hemphälä & Magnusson, 2012; Füller et al., 2014). Although the quantitative analysis reveals the most connected nodes and ties in a network, only with combined qualitative methods could the impact of interactions on the quality of ideas be defined. Moreover, we gained better knowledge about the interaction types by employing a mixed-methods approach. For instance, for discussion topics with similar numbers of interactions, such as 'Financial services' and 'Core connectivity', the weighted interactions in the quantitative study clarified their differences and impact on the quality of ideas.

Another contribution of this paper is the detailed description of the Explorathon process, from the initial to final stages, and the description of the coding schemes for qualitative analysis of ideas and comments. While Explorathon's call for generating incremental innovations resulted in a great number and variety of ideas, the subsequent innovation processes in Telenor focusses on a group-oriented and radical innovation process. Specifically, the current innovation process follows an internal-BU group-oriented interaction and collaboration, with the focus on developing ideas further for final products

and services. Despite the equal number of implemented ideas between two innovation processes, Explorathon created an interaction space beyond the local boundaries for employees to propose and gain exposure for ideas formally and use time to comment on or develop ideas.

6.1 Research limitations

The results should be considered in the light of several limitations. While the present study provides some evidence for the interactions types and the relations with the quality of ideas, further research is needed to follow the innovation process at every phase closely and examine the evolvement of ideas. Although our study focusses on online interactions through the platform, the fact that ideas were submitted through the platform did not preclude other offline employees' interactions surrounding the ideas. During the Explorathon's submission period, employees interacted both online and offline, as well as in the following screening phases. In fact, there was increased local and BU-internal interaction regarding ideas, where employees who work in the same place (but perhaps rarely meet) had an occasion to interact both online and offline. For instance, ideas were discussed locally in the research departments and in face-to-face meetings, during the submission and evaluation process. However, we couldn't follow and examine the offline interactions that might affected the online interactions. Other limitations are related with the qualitative analysis of a large dataset, which requires a significant amount of time and resources. This is usually a limitation in order to extract timely information on the platform's interactions and the quality of the ideas. In addition, the results refer to a specific type of innovation platform, in an intra-organisational context, and therefore, limited generalisations for other types of innovation platforms or contexts can be extracted. Finally, potential cultural characteristics that may have affected the interactions among participants are not discussed in this study. For instance, BUs in Asia tend to comment on each other's ideas while this is not the case for other BUs.

6.2 Implications and future directions

The study has implications for both researchers and practitioners. From a research point of view, we applied and extended previous studies analysing innovation platforms and we suggested contribution qualities that can be used by researchers for investigating a platform's content, in terms of both ideas and comments. The obtained results reinforce the alternative of identifying quality ideas using combined methods rather than relying only on scoring systems. This study also highlighted the importance of alternative measures for idea evaluation, apart from quantitative measures, such as 'likes' and the number of replies. The use of combined metrics for the evaluation could reflect the extent to which ideas have evolved during the process in innovation platforms. One measure that reflects the users' interactions around ideas in an innovation platform is the suggested contribution qualities of ideas.

The study has also managerial implications for firms and practitioners, such as innovation managers. When firms employ innovation platforms for ideation, the description of Explorathon could offer insights for both the platform development and the process of innovation management. Firms could embrace the development and communication process of Explorathon to employees, as well as its platform functionalities. The innovation management of the platform should focus on enabling collaboration and communication among employees, and therefore functionalities like voting and providing 'likes' should be considered from innovation managers. In addition, the communication campaign should be organised by the innovation managers together with other department- or BU-based central network actors to raise awareness, encourage participation and engagement around the innovation platform. The innovation management should also consider our results on user roles, where the adoption of user roles could trigger interactions among participants and increase the quality of the contributions. Our study results support the view that idea contributors could also become facilitators for their own ideas and engage more participants into network interactions and eventually advance the quality of their idea.

Most importantly, the results underline the benefits of interactions among participants in such platforms. It is crucial for companies to facilitate meaningful interactions among participants, therefore the design of the innovation platform should embed diverse interactions and feedback to ideas. Companies and practitioners should focus more on establishing the platform interactions by enabling various interaction types, like asking questions, making suggestions and involving other people. Together with the typical functionalities of innovation platforms to vote, comment, and 'like' an idea, firms could extend the options for interaction and present ways of interaction. Furthermore, other insights refer to the identification of community interests and characteristics that will improve firms' future innovation activities, for instance, regarding topics of interest, roles in the community and preferred interaction types. One solution could be the standardised submission options in the platform that would provide automatic ways to extract and process the contributions, while it could enable several analyses, with multiple tools and in shorter time. Furthermore, this study highlights the importance of alternative measures for idea evaluation, apart from quantitative measures, such as 'likes' and the number of replies, which reflect the extent to which ideas have evolved during the process in innovation platforms.

As innovation platforms become more prevalent, the issue of layered user interactions and the effect on user contributions become increasingly relevant. Future research should focus on exploring user interactions and multiple networks of communication more systematically, based on various types of innovation platforms, user groups and research settings. Using combined qualitative and quantitative methods, future research should explore additional fine-grained measurements for innovation. Contribution qualities, as studied in this article, are comprised in one measurement, and identification

and weighing of further factors can be explored in future studies. Other research fields could provide promising user contribution measures, such as research on open source communities (e.g., Adler, 2008). Finally, a comparison of our study across various innovation platforms would allow for a stronger generalisation of our findings.

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Appendix

Table 3: Content analysis' themes for ideas regarding the target user group.

Theme	**Code**	**Description**	**Examples of ideas**
Firm-driven	FIR	The idea refers primarily to firms' strategy, values or needs.	*'The proposal is to provide unlimited […] for the period of 3 years, for our subscribers' (ID 349)* *'Change Telenor's […] on various occasions to show respect, commitment, engagement to that event or culture' (ID 369)*
Customer-driven	CUS	The idea targets primarily to benefit customers' values or needs.	*'There are varied lifestyles [...] the focus should be on the customer personality and needs' (ID 186)* *'For a customer of Telenor, it may be exciting to get upgraded to become a customer of X' (ID 373)*
Employee-driven	EM	The idea targets primarily to benefit employees' needs or values.	*'This feature will enable our campaign managers to know about our customer expectations and to design for the right type of customers' (ID 27)*

			'Make employee reimbursement for […] easy & fast' (ID 9)
Family-driven	FAM	The idea targets primarily to benefit family-related needs or values.	*'This service is focused on the siblings (family, relatives or friends) of our customers who use internet' (ID 95)* *'Our idea is an app to […] concerning the family activities' (ID 231)*
Society-driven	SOC	The idea targets primarily to benefit general social related issues.	*'Early Flood Alert notification' (ID 53)* *'Empowering children through mobile education, networking and entertainment' (ID 304)*
Sociocultural-driven	SCU	The idea refers primarily to social needs or cultural values inspired by a specific country and/or target to be applied to a specific country.	*'Thailand, India, and Bangladesh are emerging countries with a lot of SME's […]' (ID 352)* *'If we consider Bangladesh as an example, it is an agricultural country…' (ID 257)*
Technology-driven	TEC	The idea targets primarily to bring new technology to solve various issues.	*'Telenor mobile payment could facilitate payment with a […]' (ID 64)* *'Telenor could offer […] equipped with a Wi-Fi hotspot to deliver internet connectivity to specific locations for a limited time' (ID 132)*
Daily life-driven	GEN	The idea refers primarily to general/daily personal needs or values.	*'Customers can control their home and office appliances including main electricity switch board' (ID 38)* *'If an app could indicate available parking spots based on where you're heading […]' (ID 232)*

Table 4: Content analysis' themes for ideas regarding the intended collaboration.

Theme	**Code**	**Description**	**Examples of ideas**
Internal collaboration	INT	The idea suggests collaboration and/or communication with internal departments, groups or people.	*'For this idea, a collaboration is needed among Telenor BU1, Telenor BU2, Canal Digital' (ID 67)* *'Help needed from Telenor employees: to suggest other uses of the app, to find a fair*

			charging model and a trusted payment method' (ID 283)
External collaboration	EXT	The idea suggests collaboration and/or communication with external departments, groups or people.	*'Telenor should have ties with financial institutions' (ID 298)* *'What is required from Telenor to make this happen: partnership with apps vendor that can help develop the […]' (ID 183)*
General call for collaboration	GEN	The idea suggests a general call for collaboration and/or communication.	*'Friends, please comment and provide valuable feedback on questions like […]' (ID 226)* *'Please help in suggesting and designing the format' (ID 384)*

Table 5: Content analysis' themes for comments regarding the interaction types.

Theme	**Code**	**Description**	**Examples of comments**	**Weight**
Positive feedback	POS	The comment refers to positive expressions like congratulations, thanking, encouraging, or similar.	*'It' s an outstanding idea' (ID18)* *'Great ideation for customer experience', 'Good Initiative!' (ID 384)*	1
Negative or non-relevant feedback	NEG	The comment is not fitted in other categories (e.g. jokes) or is written in a negative way.	*'I really don't think this is commercially attractive to Telenor' (ID 75)* *'ha ha ....we will block the scratch cards instantly ...lol' (ID 50)*	1
Value recognition	REC	The comment refers to potential impact and value of the idea for customers, firm, society, or other.	*'This is a good and practical idea that will definitely improve customer experience and help us' (ID 87)* *'Very convenient at least for Norwegian customers. Personally, I need that kind of service' (ID 154)*	2
Involving into comments	INV	The comment invites people or departments to provide feedback for a specific idea.	*'@Employee C and @Employee D can we get some people to comment on this?' (ID 55)* *'@Employee A, B what do you think?' (ID 216)*	2
Comparing	COM	The comment includes	*'Great concept, its similar to how the*	3

		comparison with other submitted ideas, and other relevant work processes or tools, etc.	*concept […] in the gaming world works' (ID 225)* *'Business unit X is about to launch a similar project in this subject' (ID 147)*	
Inviting collabora-tion	COL	The comment includes invitation or suggestion for collaboration with departments or people.	*'Good idea! It can be merged with other ideas for mobile banking to make it stronger' (ID 55)* *'I will also suggest approaching […] for their advertisement and information broadcast' (ID 161)*	3
Asking questions	ASK	The comment includes questions about receiving more information due to poor description, clarification, etc.	*'Does anyone from the business unit X know this field to comment?' (ID 34)* *'How much does it cost to implement?' (ID 107)*	4
Sharing an experience	SHA	The comment includes personal experiences, examples, or other sources that might help on the discussions.	*'I will also add the fact that USA has just placed a new […]' (ID 23*) *'In Norway, we see several initiatives where people volunteer to help the elderly' (ID 25)*	4
Sugges-tions	SUG	The comment includes suggestions and/ or hints for ideas' implementation, extension, etc.	*'Basic functionalities need to be implemented with some logistic operations for this idea' (ID 173)* *'Maybe add some kind of easy messaging possibility because the children may not always be able to […]' (ID 24)*	5
Confessing a problem	PRO	The comment includes criticism or potential areas of concern/ problems.	*'Two key challenges would be the technical device usability assurance and the language of the knowledge platform…' (ID 58)* *'Good idea in general, though not sure it helps with the phishing issue' (ID 240)*	5
Explaining	EXP	The comment targets to	*'In response to Employee F's post:*	5

		explain or provide more information to a previously posted question or comment.	*Well, for people who click the links without first letting their mouse over the link, no.' (ID 162)* *'In response to X's post: yes...this is ok with regulatory requirements' (ID 162)*.	

Table 6: Summarised results of the number of contributions in each discussion topic, analysed according to the target user, intended collaboration and interaction types.

Code	cCOM	cCON	eCOM	fSER	oPAY	oCLA	M2M	mEDU	mAGR	mHEA	OTH	Sum
Target user												
FIR	52	14	18	11	2	6	3	2	1	-	41	150
CUS	27	6	2	1	2	1	-	-	-	-	12	51
EM	2	-	-	1	-	-	-	-	-	-	4	7
FAM	5	-	-	1	-	-	-	-	-	-	-	6
SOC	9	3	3	2	-	1	-	-	2	7	14	41
SCU	12	5	4	10	-	-	-	1	1	4	7	44
TEC	19	10	1	4	4	2	9	1	1	2	36	89
DAI	41	40	20	17	4	3	5	8	4	6	41	189
Sum	167	78	48	47	12	13	17	12	9	19	155	577
Collaboration												
INT	3	1	1	3	-	-	-	-	-	1	4	13
EXT	12	11	7	8	-	-	4	3	1	4	13	63
GEN	4	2	1	2	3	2	2	-	1	1	8	26
Sum	19	14	9	13	3	2	6	3	2	6	25	102
Interaction Types												
POS	214	82	21	76	7	84	14	48	14	42	350	952
NEG	4	2	1	-	1	3	1	1	1	1	7	22
REC	116	32	12	33	5	21	3	32	8	13	131	406
INV	11	3	2	6	-	-	3	-	-	-	11	36
COM	21	9	3	5	2	4	1	4	1	2	29	81
COL	21	10	6	7	2	3	2	5	4	5	29	94

ASK	38	12	8	10	5	8	8	5	-	5	39	138
SHA	42	16	12	6	-	6	2	1	1	4	40	130
SUG	86	27	18	33	4	18	8	10	4	21	78	307
PRO	25	7	3	15	2	2	5	3	2	6	22	92
EXP	24	2	1	5	4	2	2	2	-	1	14	57
Sum	602	202	87	196	32	151	49	111	35	100	750	2315

Table 7: Top weighted ideas for each discussion topic, with centrality measures, weights, number of 'likes', discussions, and contribution qualities.

Ideas	**In-degree centrality (in topic)**	**Out-degree centrality (in topic)**	**Ideas' Creator weight**	**Others' weight**	**Sum weight**	**Likes**	**Discussions**	***Contribution quality (in-coming)**	***Contribution quality (out-coming)**
cCOM ID 30	1,54	1,54	89	77	166	42	25	BC	EC
cCOM ID 159	1,54	1,54	36	104	140	27	36	PC	PC
cCON ID 322	1,27	1,27	13	48	61	9	13	PC	PC
cCON ID 18	1,27	1,27	16	31	47	5	8	PC	EC
eCOM ID 19	1,05	1,05	11	60	71	12	10	EC	EC
eCOM ID 2	1,05	1,05	27	33	60	8	8	EC	EC
fSER ID 209	1,37	1,37	23	101	124	33	26	PC	PC
fSER ID 32	1,37	1,37	22	80	102	20	24	PC	PC
mAGR ID 80	1,18	1,18	10	29	39	10	7	PC	EC
mAGR ID 261	1,18	1,18	2	28	30	9	13	PC	PC

mEDU ID 104	1,09	1,09	16	101	117	55	47	PC	PC
mEDU ID 27	1,09	1,09	0	30	30	4	7	PC	No reply
mHEA ID 9	1,27	1,27	9	104	113	31	36	PC	PC
mHEA ID 129	1,27	1,27	27	59	86	75	15	EC	PC
M2M ID 44	1,30	1,30	24	26	50	10	9	EC	EC
M2M ID 58	1,30	1,30	10	25	35	4	7	EC	EC
oCLA ID 136	1,84	1,84	76	104	180	39	53	PC	PC
oCLA ID 10	1,84	1,84	8	57	65	19	19	PC	PC
oPAY ID 23	1,42	1,42	13	18	31	10	7	PC	BC
oPAY ID 81	1,42	1,42	8	21	29	9	6	BC	BC
OTH ID 275	1,71	1,71	160	163	323	49	109	PC	PC
OTH ID 145	1,71	1,71	47	148	195	46	82	PC	PC

* Contribution qualities refer as PC: Passive Contribution, BC: Balanced Contribution and EC: Efficient Contribution.